CODE NO. AERB/NRF-TS/SC-1 (Rev.1)

GOVERNMENT OF INDIA

AERB SAFETY CODE

SAFE TRANSPORT OF RADIOACTIVE MATERIAL

ATOMIC ENERGY REGULATORY BOARD

सत्यमेव जयते
भारत सरकार
GOVERNMENT OF INDIA
परमाणु ऊर्जा नियामक परिषद
ATOMIC ENERGY REGULATORY BOARD

Safety Regulation
Since 1983

दिनेश कुमार शुक्ला
DINESH KUMAR SHUKLA
अध्यक्ष
CHAIRMAN

Ref: AERB/IT&RDD/RDS/Addn-TS/SC-1/2025/66 **November 28, 2025**

The IAEA regulations for the Safe Transport of Radioactive Material, SSR-6, Rev.1 (2018 Edition) introduced requirements related to ageing mechanism in design approval of package and special form radioactive material. In order to align with IAEA Regulations (SSR-6, Rev.1, 2018 Edition) for ensuring consistency and facilitating international cooperation and compliance, an addendum to the present Safety Code on 'Safe Transport of Radioactive Material', AERB/NRF-TS/SC-1 (Rev.1), 2016 is hereby issued.

The enclosed addendum brings out the sections of the Safety Code where the requirements have been introduced. The requirements in the addendum shall be read in conjunction with the Safety Code on 'Safe Transport of Radioactive Material', AERB/NRF-TS/SC-1 (Rev.1), 2016.

D. Shukla.

(Dinesh Kumar Shukla)

नियामकभवन, अणुशक्तिनगर, मुंबई - 400 094
NIYAMAK BHAVAN, ANUSHAKTINAGAR, MUMBAI - 400 094
दूरभाष / TELEPHONE : +91-22-2556 2343, 2599 0604 फ़ेक्स / FAX : +91-22-2556 2344, 2556 5717, 2558 3230
ई-मेल / E-mail : chairman@aerb.gov.in / dkshukla@aerb.gov.in, वेबसाइट / WEBSITE : www.aerb.gov.in

Addendum to AERB Safety Code on SAFE TRANSPORT OF RADIOACTIVE MATERIAL, AERB/NRF-TS/SC-1 (Rev.1), 2016

Sr. No.	Section	Additional Clause(s)
1.	**1.3 Scope** **Section 1.3.1**	**Application of the Provisions of the Safety Code** ..For the purpose of this safety code the term, transport shall be deemed to comprise all operations and conditions associated with, and involved in, the movement of radioactive material; these include the design, manufacture, maintenance and repair of packaging; and the preparation, consigning, loading, carriage including in-transit storage, unloading and receipt at the final destination of radioactive material and packages…
	Revised section 1.3.1	..For the purpose of this safety code the term, transport shall be deemed to comprise all operations and conditions associated with, and involved in, the movement of radioactive material; these include the design, manufacture, maintenance and repair of packaging; and the preparation, consigning, loading, carriage including in-transit storage, **Shipment after storage**, unloading and receipt at the final destination of radioactive material and packages…
	BASIS: **New Requirement** **(Para 106 of IAEA SSR 6 Rev.1, 2018)**	
2.	**Section 5.3** **New Section 5.3.7.A** **BASIS:** **New Requirement** **(Para 613A of IAEA SSR 6, Rev.1, 2018)**	**General Requirements for All Packagings and Packages** The *design* of the *package* shall take into account ageing mechanisms.

3.	**Section 6.2** **New Section 6.2 (iv)** **BASIS:** **New Requirement** **503(e) of IAEA SSR 6, Rev.1, 2018**	For *packages* intended to be used for *shipment* after storage, it shall be ensured that all *packaging* components and *radioactive contents* have been maintained during storage in a manner such that all the requirements specified in the relevant provisions of this safety code and in the applicable certificates of *approval* have been fulfilled.
4.	**Section 7.4.2.2** **New Section 7.4.2.2 (j)** **BASIS:** **New Requirement** **(Para 809 (f) of IAEA SSR 6, Rev.1,2018)**	7.4.2.2 An application for approval shall include: **7.4.2.2 (j)** If the *package* is to be used for *shipment* after storage, a justification of considerations to ageing mechanisms in the safety analysis and within the proposed operating and maintenance instructions.
5.	**Section 7.4.2.2** **New Requirement 7.4.2.2 (k)** **BASIS:** **New Requirement** **(Para 809 (k) of IAEA SSR 6, Rev.1,2018)**	**7.4.2.2 (k)** For *packages* which are to be used for *shipment* after storage, a gap analysis programme describing a systematic procedure for a periodic evaluation of changes of regulations, changes in technical knowledge and changes of the state of the *package design* during storage.
6.	**Section 7.6.1** Existing Requirement	Packages not requiring Competent Authority's Approval of Design under the 1985 and 1985 (As Amended 1990) Editions of the IAEA Regulations for the Safe Transport of Radioactive Material Packages not requiring competent authority

	Revised Requirement **BASIS:** **Revised Requirement** **(TRANSITIONAL ARRANGEMENT of IAEA SSR 6, Rev.1,2018)**	approval of design under the 1985, 1985 (As Amended 1990), **1996 Edition, 1996 Edition (Revised), 1996 (As Amended 2003), 2005, 2009 and 2012** Editions of the IAEA Regulations for the Safe Transport of Radioactive Material
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	New Section 7.6.1.3	7.6.1.3 Packages that meet the requirements of the 1996 Edition, 1996 Edition (Revised), 1996 (As Amended 2003), 2005, 2009 or 2012 Editions of the IAEA Regulations for the Safe Transport of Radioactive Material: (a) May continue in transport provided that they were prepared for transport prior to 31 December 2025 and are subject to the requirements of para. 7.6.3, if applicable; or (b) May continue to be used, provided that all the following conditions are met: (i) The applicable requirements of para. 2.3.1 of this safety code are applied; (ii) The activity limits and classification specified in this safety code are applied. (iii) The requirements and controls for transport specified in this safety code are applied (iv) The *packaging* was not manufactured or modified after 31 December 2025.
	BASIS: **New Requirement** **Transitional Arrangements** **(Para 819 (b) of IAEA SSR 6, Rev.1,2018)**	

7.	**Section 7.6.2** Existing Requirement	Packages approved under the 1973, 1973 (As Amended), 1985 and 1985 (As Amended 1990) Editions of the IAEA Regulations for the Safe Transport of Radioactive Material
	Revised Requirement	Package designs approved under the 1985, 1985 (As Amended 1990), **1996 Edition, 1996 Edition (Revised), 1996 (As Amended 2003), 2005, 2009 and 2012** Editions of the IAEA Regulations for the Safe Transport of Radioactive Material
	BASIS: **Revised Requirement** **(TRANSITIONAL ARRANGEMENT of IAEA SSR 6, Rev.1,2018)**	
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	New Requirement	*7.6.2.1A Packagings* that were manufactured to a *package design* approved by the *competent authority* under the provisions of the 1996 Edition, 1996 Edition (Revised), 1996 (As Amended 2003), 2005, 2009 and 2012 Editions of the IAEA Regulations for the Safe Transport of Radioactive Material may continue to be used provided that all of the following conditions are met: (i) The *package design* is subject to *multilateral approval* after 31 December 2025. (ii) The applicable requirements of para. 2.3.1 of this safety code are applied; (iii) The activity limits and classification specified in this safety code are applied. (iv) The requirements and controls for transport specified in this safety code are applied
	BASIS:	

	New Requirement Introduction of para 820 (b) of IAEA **SSR 6, Rev.1,2018**	
8.	**New Section 7.6.2.3** **BASIS:** **New Requirement** **(Para 821 A of** IAEA **SSR 6, Rev.1, 2018)**	No new manufacture of *packagings* of a *package design* meeting the provisions of the 1996 Edition, 1996 Edition (Revised), 1996 (As Amended 2003), 2005, 2009 and 2012 Editions of the IAEA Regulations for the Safe Transport of Radioactive Material shall be permitted to commence after 31 December 2028.
9.	**7.6.4** **Existing Requirement** **Revised Requirement**	Special form Radioactive Material Approved under the 1973, 1973(As Amended), 1985 and 1985 (As Amended 1990) Editions of the IAEA Regulations for the Safe Transport of Radioactive Material Special form radioactive material manufactured to a design that had received unilateral approval by the Competent Authority under the 1973, 1973 (As Amended), 1985 or 1985 (As Amended 1990) Editions of the IAEA regulations for the Safe Transport of Radioactive Material may continue to be used when in compliance with the mandatory management system in accordance with the applicable requirements of clause 2.3.1. No new manufacture of such special form radioactive material shall be commenced. Special form radioactive material approved under the 1985, 1985 (As Amended 1990), **1996 Edition, 1996 Edition (Revised), 1996 (As Amended 2003), 2005, 2009 and 2012 Editions of these Regulations.** *Special form radioactive material* manufactured to a *design* that had received *unilateral approval* by the *competent authority* under the 1985, 1985 (As Amended 1990), **1996 Edition, 1996 Edition (Revised), 1996 (As Amended 2003), 2005, 2009 and 2012** Editions of the IAEA Regulations for the Safe Transport of Radioactive Material may

	BASIS: **Revised Requirement** **(Para 823 of** IAEA **SSR 6, Rev.1,2018)**	continue to be used when in compliance with the mandatory management system in accordance with the applicable requirements of clause 2.3.1. There shall be no new manufacture of *special form radioactive material* to a *design* that had received *unilateral approval* by the *competent authority* under the 1985 or 1985 (As Amended 1990) Editions of the IAEA Regulations for the Safe Transport of Radioactive Material. **No new manufacture of *special form radioactive material* to a *design* that had received *unilateral approval* by the *competent authority* under the 1996 Edition, 1996 Edition (Revised), 1996 (As Amended 2003), 2005, 2009 and 2012 Editions of the IAEA Regulations for the Safe Transport of Radioactive Material shall be permitted to commence after 31 December 2025.**

AERB SAFETY CODE NO. AERB/NRF-TS/SC-1 (Rev.1)

SAFE TRANSPORT OF RADIOACTIVE MATERIAL

Approved by the Board in November 2015

Atomic Energy Regulatory Board
Mumbai – 400 094
India

March 2016

Price:

Orders for this safety code should be addressed to:

The Chief Administrative Officer
Atomic Energy Regulatory Board
NiyamakBhavan
Anushaktinagar
Mumbai-400 094
India

FOREWORD

Activities concerning establishment and utilisation of nuclear facilities and use of radiation sources are to be carried out in India in accordance with the provisions of the Atomic Energy Act, 1962. In pursuance of the objective of ensuring safety of members of the public and occupational workers as well as protection of environment, the Atomic Energy Regulatory Board (AERB) has been entrusted with the responsibility of laying down safety standards and framing rules and regulations for such activities. The Board has, therefore, undertaken a programme of developing safety codes, safety standards, and related guides and manuals for the purpose. While some of these documents cover aspects such as siting, design, construction, operation, quality assurance and decommissioning of nuclear and radiation facilities, other documents cover regulatory aspects of these facilities.

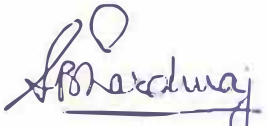
Safety codes and safety standards are formulated on the basis of nationally and internationally accepted safety criteria for design, construction and operation of specific equipment, structures, systems, and components of nuclear and radiation facilities. Safety codes establish the objectives and set of requirements that shall be fulfilled to provide adequate assurance for safety. Safety guides elaborate various requirements and furnish approaches for their implementation. Safety manuals deal with specific topics and contain detailed scientific and technical information on the subject. These documents are prepared by experts in the relevant fields and are extensively reviewed by advisory committees of the Board before they are published. The documents are revised when necessary, in the light of experience and feedback from users as well as new developments in the field.

The safety code on 'Transport of Radioactive Material, AERB/SC/TR-1; 1986 issued by AERB specified requirements for the design and test of special form radioactive material and different types of packages for the transport, control measures to be implemented during transport including the limits on the levels of radioactive contamination, radiation level and temperature at the external surface of a package, marking and labelling. This revised safety code, additionally, includes design and test requirements for low dispersible radioactive material, Type C packages, fissile-excepted material and management system in line with the applicable international instruments.

The revised code is effective from the date of issue and supersedes the earlier code AERB/SC/TR-1 (1986). Annexures and References are included to provide further information that might be helpful to the user.

Specialists in the field drawn from the Atomic Energy Regulatory Board, the Bhabha Atomic Research Centre and other consultants have prepared this safety code. It has been reviewed by experts, the Committee for the Safe Transport of Radioactive Material (COSTRAM) and the Standing Committee for Review and Revision of AERB Radiation Safety Documents (SC-RRR-SD) and Advisory Committee on Radiological Safety (ACRS). The draft safety code was placed on AERB website for public comments.

AERB wishes to thank all individuals and organisations who have prepared and reviewed the draft and helped in its finalisation. The list of experts, who have participated in this task, along with their affiliations, is included for information.



(S.A. Bhardwaj)
Chairman, AERB

DEFINITIONS

Cargo Aircraft

Any aircraft, other than a passenger aircraft, that is carrying goods or property.

Carrier

Any person, organisation or government, undertaking the carriage of radioactive material by any mode of transport. The term includes both carriers for hire (also known as contract carriers) and carriers on own account (known as private carriers).

Competent Authority

Any official or authority appointed, approved or recognised by the Government of India for the purpose of the Rules promulgated under the Atomic Energy Act, 1962.

Consignee

Any person, organisation or government that is entitled to take delivery of a consignment.

Consignor

Any person, organisation or government that prepares a consignment for transport, and is named as consignor in the transport documents.

Confinement System

The assembly of fissile material and packaging components specified by the designer and agreed to by the competent authority as intended to preserve criticality safety.

Consignment

Any package or packages, or load of radioactive material, presented by a consignor for transport.

Containment System

The assembly of components of the packaging specified by the designer as intended to retain the radioactive material during transport.

Contamination

The presence of a radioactive substance on a surface in quantities in excess of 0.4 $Bq.cm^{-2}$ for beta and gamma emitters and low toxicity alpha emitters, or 0.04 $Bq.cm^{-2}$ for all other alpha emitters.

Conveyance

(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.
(c) For transport by air: any aircraft.

Criticality Safety Index (CSI)

A number assigned to a package, overpack or freight container containing fissile material to provide control over the accumulation of such packages, overpacks or freight containers containing fissile material.

Design

The description of fissile material excepted under para. 4.6.1.1(f), special form radioactive material, low dispersible radioactive material, package or packaging that enables such an item to be fully identified.

The description may include specifications, engineering drawings, reports demonstrating compliance with regulatory requirements, and other relevant documents as specified by the competent authority.

Defined Deck Area

The area of the weather deck of a vessel, or of a vehicle deck of a roll-on/roll-off ship or ferry, that is allocated for the stowage of radioactive material.

Fixed Contamination

Contamination other than non-fixed contamination.

Intermediate Bulk Container (IBC)

A portable packaging that:

(a) has a capacity of not more than 3 m^3,
(b) is designed for mechanical handling, and
(c) is resistant to the stresses produced in handling and transport, as determined by tests.

Low Dispersible Radioactive Material

A solid radioactive material or a solid radioactive material in a sealed capsule (not in powder form) and which meets the requirements laid down by the Competent Authority in this regard.

Low Toxicity Alpha Emitters

Natural uranium, depleted uranium, natural thorium, uranium-235, uranium-238, thorium-232, thorium-228 and thorium-230 when contained in ores or physical and chemical concentrates; or alpha emitters with a half-life of less than 10 days.

Maximum Normal Operating Pressure

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 in the absence of venting, external cooling by an ancillary system, or operational controls during transport.

Multilateral Approval

Approval by the relevant competent authority of the country of origin of the design or shipment, as applicable, and also, where the consignment is to be transported through or into any other country, approval by the Competent Authority of that country.

Non-Fixed Contamination

Contamination that can be removed from a surface during routine conditions of transport.

Overpack

An enclosure used by a single consignor to contain one or more packages and to form one unit for convenience of handling and stowage during transport.

Package

The complete product of the packing operation, consisting of the packaging and its contents prepared for transport. The types of package which are covered by this safety code are subject to activity limits and material restrictions specified in Sections III, IV and V and meet the corresponding requirements i.e.:

(a) Excepted package
(b) Industrial package Type 1 (Type IP-1)
(c) Industrial package Type 2 (Type IP-2)
(d) Industrial package Type 3 (Type IP-3)
(e) Type A package
(f) Type B(U) package
(g) Type B(M) package
(h) Type C package.

Packages containing fissile material or uranium hexafluoride are subject to additional requirements.

Packaging

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

Passenger Aircraft

An aircraft that carries any person other than a crew member, a carrier's employee in an official capacity, an authorised representative of an appropriate national authority, or a person accompanying a consignment or other cargo.

Radiation Level

The dose rate expressed in millisieverts per hour or microsieverts per hour.

Radioactive Contents

The radioactive material together with any contaminated or activated solids, liquids and gases within the packaging.

Special Form Radioactive Material

It is either an indispersible solid radioactive material or a sealed capsule containing radioactive material, conforming to the requirements specified and approved by the Competent Authority for special form radioactive material.

Through or Into

The countries in which a consignment is transported but specifically excludes countries over which a consignment is carried by air, provided that there are no scheduled stops in those countries.

Transport Index (TI)

A number assigned to a package, overpack or freight container, or to unpackaged LSA-I or SCO-I that is used to provide control over radiation exposure.

Unilateral Approval

An approval of a design that is issued by the Competent Authority of the country of origin of the design only.

Unirradiated Thorium

Thorium containing not more than 10^{-7} g of uranium-233 per gram of thorium-232.

Uranium: Natural, Depleted, Enriched

Natural Uranium:

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

Uranium containing a lesser mass percentage of uranium-235 than natural uranium.

Enriched Uranium

Uranium containing a greater mass percentage of uranium-235 than 0.72%.

[In all cases, a very small mass percentage of uranium-234 is present.]

SPECIAL DEFINITIONS
(Specific for the present safety code)

A_1

The activity value of *special form radioactive material* that is listed in Table-I or derived in Section 3 and is used to determine the activity limits for the requirements of this safety cssde.

A_2

The activity value of *radioactive material*, other than *special form radioactive material*, that is listed in Table-I or derived in Section 3 and is used to determine the activity limits for the requirements of this safety code.

Exclusive Use

The sole use, by a single consignor, of a conveyance or of a large freight container, in respect of which all initial, intermediate and final loading and unloading and shipment are carried out in accordance with the directions of the consignor or consignee, where so specified in the this safety code.

Fissile-Excepted

A consignment of radioactive material containing any fissile material in small quantities that do not warrant any of the specific additional requirements prescribed for fissile materials for ensuring criticality safety.

Fissile Material

A material containing any of the fissile nuclides. Excluded from the definition of fissile material are the following:

(a) Natural uranium or depleted uranium that is unirradiated
(b) Natural uranium or depleted uranium that has been irradiated in thermal reactors only
(c) Material with fissile nuclides less than a total of 0.25 g
(d) Any combination of (a), (b) and/or (c).

These exclusions are only valid if there is no other material with fissile nuclides in the package or in the consignment if shipped unpackaged.

Fissile Nuclides

Uranium-233, Uranium-235, Plutonium-239 and Plutonium-241.

Large Freight Container:

A freight container shall mean an article of transport equipment that is of a permanent character and accordingly strong enough to be suitable for repeated use; specially designed to facilitate the transport of goods, by one or other modes of transport, without intermediate reloading, designed to be secured and/or readily handled, having fittings for these purposes. The term ‘freight container’ does not include the vehicle. A large freight container is a freight container that has an internal volume of more than 3 m^3.

Low Specific Activity (LSA) Material

Radioactive material that 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 should not be considered in determining the estimated average specific activity.

Management System

A set of interrelated or interacting elements (system) for establishing policies and objectives and enabling the objectives to be achieved in an efficient and effective manner.

Radiation Protection Programme

Systematic arrangements that are aimed at providing adequate consideration of radiation protection measures.

Radioactive Material

Any material containing radionuclides where both the activity concentration and the total activity in the consignment exceed the values specified in clauses 3.2 and 3.3 of this safety code.

Rules

Atomic Energy (Radiation Protection) Rules, 2004.

Small Freight Container

A freight container that has an internal volume of not more than 3 m^3.

Shipment

The specific movement of a consignment from origin to destination.

Special Arrangement

Those provisions, approved by the Competent Authority, under which consignments that do not satisfy all the applicable requirements of this safety code may be transported.

Specific Activity of a Material

The activity per unit mass of the material in which the radionuclides are essentially uniformly distributed.

Surface Contaminated Object (SCO)

A solid object that is not itself radioactive but which has radioactive material distributed on its surface.

Tank

A portable tank (including a tank container), a road tank vehicle, a rail tank wagon or a receptacle that contains solids, liquids, or gases, having a capacity of not less than 450 L when used for the transport of gases.

Unirradiated Uranium

Uranium containing not more than 2×10^3 Bq of plutonium per gram of uranium-235, not more than 9×10^6 Bq of fission products per gram of uranium-235 and not more than 5×10^{-3} g of uranium-236 per gram of uranium-235.

Vehicle

A road vehicle (including an articulated vehicle, i.e. a tractor and semi-trailer combination), rail, road, car or railway wagon. Each trailer should be considered as a separate vehicle.

Vessel

Any seagoing vessel or inland waterway craft used for carrying cargo.

Words and terms not defined here but defined in the Rules, shall have the meaning assigned to them in the Rules.

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1. INTRODUCTION

1.1 General

Radiation finds application in many fields such as medicine, industry, agriculture and research. There are many applications of radioactive sources in medical diagnosis and treatment of cancer. These radiation sources are used for non-destructive testing of welding and casting and also in process control in the production industry. Radioactive materials are used in agriculture and food preservation. It is necessary to transport radioactive material from the supplier to the user and from the user to the disposal facility. Production of nuclear power involves transport of radioactive material.

There are international regulations for the safe transport of radioactive material by various modes such as road, rail, air, sea, inland waterway and post. This safety code is based on the Regulations published by the International Atomic Energy Agency (IAEA) [1]. The IAEA Regulations are adopted in their entirety by the United Nations and included in the UN Recommendations on the safe transport of dangerous goods [2]. The UN recommendations are incorporated in the various international instruments for safe transport of dangerous goods for example [3] and [4].

There are Regulations published by the International Atomic Energy Agency (IAEA) [1]. The IAEA Regulations are adopted in their entirety by the United Nations and included in the UN Recommendations on the safe transport of dangerous goods [2]. The UN recommendations are incorporated in the various international instruments for safe transport of dangerous goods for example [3] and [4].

Requirements for the transport of radioactive material which are prescribed by the Competent Authority in this safety code, issued under rule 16 of the Atomic Energy (Radiation Protection) Rules, 2004 shall be duly complied with by persons and/or institutions licensed to handle radioactive material.

1.2 Objective

1.2.1 Requirements for the Safe Transport of Radioactive Material

The objective of this safety code is to establish requirements that shall be satisfied to ensure safety and to protect persons, property and the environment from the effects of radiation in the transport of radioactive material. Protection shall be achieved by meeting the requirements for:

(a) Containment of the radioactive contents
(b) Control of external radiation levels
(c) Prevention of criticality, where applicable
(d) Prevention of damage caused by heat, where applicable.

1.2.2 Safety of Persons and Protection of Property and the environment

For assuring the safety of persons and the protection of property and the environment in the transport of radioactive material, the provisions of this safety code shall be complied with. For achieving confidence in this regard management systems shall be established by the concerned stakeholders.

1.3 Scope

1.3.1 Application of the Provisions of the Safety Code

This safety code shall apply to the transport of radioactive material by all modes by land, water, or in the air, including transport that is incidental to the use of the radioactive material. For the purpose of this safety code the term, transport shall be deemed to comprise all operations and conditions associated with, and involved in, the movement of radioactive material; these include the design, manufacture, maintenance and repair of packaging; and the preparation, consigning, loading, carriage including in-transit storage, unloading and receipt at the final destination of radioactive material and packages. The requirements specified in this safety code shall be duly complied with so as to meet the performance standards which are characterized in terms of three general severity levels:

(a) Routine conditions of transport (incident free)
(b) Normal conditions of transport (minor mishaps)
(c) Accident conditions of transport.

1.3.2 Restriction on the Application of the Provisions of Safety Code

The provisions of this safety code do not apply to the following:

(a) Radioactive material that is an integral part of the means of transport.
(b) Radioactive material moved within an establishment that is subject to appropriate safety regulations in force in the establishment and where the movement does not involve public roads or railways.
(c) Radioactive material implanted or incorporated into a person or live animal for diagnosis or treatment.
(d) Radioactive material in or on a person who is to be transported for medical treatment because the person has been subject to accidental or deliberate intake of radioactive material or to contamination.
(e) Radioactive material in consumer products that have received regulatory approval, following their sale to the end user.
(f) Natural material and ores containing naturally occurring radionuclides, which may have been processed, provided the activity concentration of the material does not exceed 10 times the values specified in Table-I, or calculated in accordance with clauses 3.3.1(a) and 3.3.2-3.3.5of this safety code. For natural materials and ores containing naturally occurring radionuclides that are not in secular equilibrium, the calculation of the activity concentration shall be determined as follows:

$$X_m = 1 / \sum_i (f(i) / X(i)) \quad \text{.....(1)}$$

where
f(i) is the fraction of activity or activity concentration of radionuclide i in the mixture.
X(i) is the appropriate value of A_1 or A_2, or the activity concentration limit for exempt material or the activity limit for an exempt consignment as appropriate for the radionuclide iX_m is the derived value of A_1 or A_2, or the activity concentration limit for exempt material or the activity limit for an exempt consignment in the case of a mixture.

(g) Non-radioactive solid objects with radioactive substances present on any surface in quantities not in excess of 0.4 $Bq.cm^{-2}$ for beta and gamma emitters and low toxicity alpha emitters, or 0.04 $Bq.cm^{-2}$ for all other alpha emitters.

1.3.3 Routing and Physical Protection

The provisions of this safety code do not specify controls such as routing or physical protection that may be instituted for reasons other than radiological safety. Any such controls shall take into account radiological and non-radiological hazards, and shall not detract from the standards of safety that the provisions of this safety code are intended to provide.

1.3.4 Security of Radioactive Material during Transport

Measures shall be taken to ensure that radioactive material is kept secure in transport so as to prevent theft or damage and to ensure that control of the material is not relinquished inappropriately.

1.3.5 Subsidiary Risk

For radioactive material having subsidiary risks, and for transport of radioactive material with other dangerous goods, the relevant transport regulations for dangerous goods shall apply in addition to the provisions of this safety code.

1.4 Structure

This safety code is structured so that Section 2 provides general provisions; Section 3 lists the basic radionuclide values, viz., A_1 and A_2 values, for a large number of radionuclides and prescribes methods of calculating these values for mixtures of radionuclides; Section 4 provides classification of radioactive material and the design requirements of LSA-III, special form and low dispersible form radioactive material including test requirements; Section 5 provides classification of packages, the design requirements for the packagings and packages including test requirements; Section 6 prescribes controls for transport of radioactive material; and Section 7 provides requirements for approvals and administration.

2. GENERAL PROVISIONS FOR RADIOLIOGICAL SAFETY

2.1 Radiation Protection

2.1.1 Dose Limitation

Doses received by persons in connection with activities relating to transport of radioactive material shall be kept below the applicable dose limits. Protection and safety shall be optimised in order that the magnitude of individual doses, the number of persons exposed and the likelihood of incurring exposure are kept as low as reasonably achievable, economic and social factors being taken into account, within the restriction that the doses to individuals are subject to dose constraints. A structured and systematic approach shall be developed and adopted by all organisations connected with transport of radioactive material taking into consideration the interfaces between transport and other activities.

2.1.2 Radiation Protection Programme

A radiation protection programme (RPP) shall be established for the transport of radioactive material. The nature and extent of the measures to be employed in the programme shall be related to the magnitude and likelihood of radiation exposures. The programme shall incorporate the requirements specified in this safety code relating to dose limitation, emergency procedures, training programme and segregation of packages, overpacks and freight containers containing radioactive material and unpackaged radioactive material from workers, public, photographic films, and other dangerous goods during transport and storage in transit. All documents relating to the RPP shall be available, on request, for inspection by Regulatory Body.

2.1.3 Workplace Monitoring and Individual Monitoring

For occupational exposures arising from transport activities, where it is assessed that the effective dose is likely to exceed 1 mSv in a year, individual monitoring shall be conducted and appropriate records shall be maintained.

2.2 Emergency Response

(a) In the event of accidents or incidents during the transport of radioactive material, emergency provisions shall be observed to protect persons, property and the environment. [5 and 6].

(b) Emergency procedures shall take into account the formation of other dangerous substances that may result from the reaction between the contents of a consignment and the environment in the event of an accident.

2.3 Management System

2.3.1 Management System to Ensure Compliance with the Provisions of this Safety Code

A management system shall be established and implemented for all activities within the scope (clause 3.1) of this safety code, to ensure compliance with the relevant provisions of this safety code.

2.3.2 Demonstration of Compliance with the Provisions of the Safety Code

Certification that the design specification has been fully implemented shall be made available to the Competent Authority. Since the Competent Authority approval, where required, is contingent upon the adequacy of the management system, the manufacturer, consignor or user shall be prepared to:

(a) provide facilities for inspection during manufacture and use; and
(b) demonstrate compliance with the provisions of this safety code to the Regulatory Body.

2.4 Non-compliance

2.4.1 Contravention of the applicable provisions of Radiation Protection Rules, 2004

Contravention of the applicable provisions of Radiation Protection Rules, 2004 or any of the terms and conditions of approval issued thereunder may entail modification, suspension or revocation of the approval issued in respect of a package and/or shipment (Rule 10) and also attract the provisions of Rule 35 of the said Rules, where applicable.

2.4.2 Non-compliance with Limits on Radiation Level and Contamination

In the event of non-compliance with any limit specified in this safety code applicable to radiation level or contamination:

(a) The consignor, consignee, carrier and any organisation involved during transport who may be affected, as appropriate, shall be informed of the non-compliance by:
    (i) The carrier if the non-compliance is identified during transport; or
    (ii) The consignee if the non-compliance is identified at receipt.
(b) The carrier, consignor or consignee, as appropriate, shall:
    (i) take immediate steps to mitigate the consequences of the non-compliance;
    (ii) investigate the non-compliance and its causes, circumstances and consequences;
    (iii) take appropriate action to remedy the causes and circumstances that led to the non-compliance and to prevent a recurrence of circumstances similar to those that led to the non-compliance; and
    (iv) communicate to the Competent Authority the causes of the non-compliance and corrective or preventive actions taken or to be taken.
(c) The communication of the non-compliance to the consignor and the Competent Authority, respectively, shall be made as soon as practicable and it shall be immediate whenever an emergency exposure situation has developed or is developing.

2.5 Special Arrangement

(a) Consignments for which conformity with the other provisions of this safety code is impracticable shall not be transported except under special arrangement.
(b) Provided the Competent Authority is satisfied that conformity with the other provisions of this safety code is impracticable and that the requisite standards of safety established by the provisions of this safety code have been demonstrated through means alternative to the other provisions, the Competent Authority may

approve special arrangement transport operations for single or a planned series of multiple consignments.

(c) The overall level of safety in transport shall be at least equivalent to that which would be provided if all the applicable requirements had been met.

(d) For consignments of this type, multilateral approval shall be required.

2.6 Training

2.6.1 Training for Personnel

Persons engaged in the transport of radioactive material shall receive training, commensurate with their responsibilities, concerning radiation protection, including the precautions to be observed in order to restrict the exposure that they receive in the course of their work and the exposure of other persons who might be affected by their actions in connection with the transport of radioactive material and the contents of this safety code.

2.6.2 Personnel to be Trained and Contents of the Training

Individuals such as those who classify radioactive material; pack radioactive material; mark and label radioactive material; prepare transport documents for radioactive material; offer or accept radioactive material for transport; carry or handle radioactive material in transport; mark or placard or load or unload packages of radioactive material into or from transport vehicles, bulk packagings or freight containers; or are otherwise directly involved in the transport of radioactive material as determined by the Competent Authority; shall receive the following training:

(a) General awareness/familiarisation Training:
   (i) Each person shall receive training designed to provide familiarity with the general provisions of this safety code.
   (ii) Such training shall include a description of radioactive material that are commonly transported; labelling, marking, placarding and packaging and segregation requirements; a description of the purpose and content of the radioactive material transport document; and a description of available emergency response documents.

(b) Function specific training: Each person shall receive detailed training concerning specific radioactive material transport requirements that are applicable to the function that person performs.

(c) Safety training: Commensurate with the risk of exposure in the event of a release and the functions performed, each person shall receive training on:
   (i) methods and procedures for accident avoidance, such as proper use of package handling equipment and appropriate methods of stowage of radioactive material;
   (ii) available emergency response information and how to use it;
   (iii) general dangers presented by the various categories of radioactive material and how to prevent exposure to those hazards, including, if appropriate, the use of personal protective clothing and equipment; and
   (iv) immediate procedures to be followed in the event of an unintentional release of radioactive material, including any emergency response procedures for which the person is responsible and personal protection procedures to be followed.

2.6.3 Training Records

Records of all safety training undertaken shall be kept by the employer and made available to the employee if requested.

2.6.4 Re-training

The training required in clause 2.6.2 shall be provided or verified upon employment in a position involving radioactive material transport and shall be periodically supplemented with retraining as deemed appropriate by the Competent Authority.

3. BASIC RADIONUCLIDE VALUES

3.1 General Provisions

Radioactive material shall be classified in accordance with the provisions of this section and further assigned to one of the UN numbers specified in Table-II.

3.2 Basic Radionuclide Values

The following basic values for individual radionuclides are given in Table-I:

(a) A_1 and A_2 in TBq;
(b) Activity concentration limits for exempt material in $Bq.g^{-1}$;
(c) Activity limits for exempt consignments in Bq.

3.3 Determination of Basic Radionuclide Values

3.3.1 For individual radionuclides:

(a) That are not listed in Table-I, the determination of the basic radionuclide values, namely, A_1 and A_2 in TBq, the activity concentration limits for exempt material in $Bq.g^{-1}$ and the activity limits for exempt consignments in Bq shall require multilateral approval. Alternatively, the radionuclide values in Table-III may be used without obtaining Competent Authority's approval. For these radionuclides, activity concentrations for exempt material and activity limits for exempt consignments shall be calculated in accordance with the principles established in the IAEA BSS [7]. It is permissible to use an A_2 value calculated using a dose coefficient for the appropriate lung absorption type, as recommended by the International Commission on Radiological Protection, if the chemical forms of each radionuclide under both normal and accident conditions of transport are taken into consideration.

(b) Where the radioactive material is enclosed in or is included as a component part of the instrument or other manufactured article and the active material is completely enclosed by non-active components (a device performing the sole function of containing radioactive material shall not be considered to be an instrument or manufactured article), alternative basic radionuclide values to those in Table-I for the activity limit for an exempt consignment may be used. However, multilateral approval shall be obtained for using the values. Such alternate activity limits for an exempt consignment shall be calculated in accordance with the principles set out in the IAEA BSS [7].

3.3.2 Individual Radionuclides not Listed in Table-I of this Safety Code

In the calculations of A_1 and A_2 for a radionuclide not listed 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 that 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 longer than that of the parent nuclide, the parent and such daughter nuclides shall be considered as mixtures of different nuclides.

3.3.3 Mixtures of Radionuclides

For mixtures of radionuclides, the basic radionuclide values referred to in clause 3.2 may be determined as follows:

$$X_m = 1 / \sum_i (f(i) / X(i)) \text{.....(2)}$$

where

f(i) is the fraction of activity or activity concentration of radionuclide i in the mixture.
X(i) is the appropriate value of A_1 or A_2, or the activity concentration limit for exempt material or the activity limit for an exempt consignment as appropriate for the radionuclide i.
Xm is the derived value of A_1 or A_2, or the activity concentration limit for exempt material or the activity limit for an exempt consignment in the case of a mixture.

3.3.4 Radionuclides with Unknown Activity

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 radionuclide value, as appropriate for the radionuclides in each group, may be used in applying, as appropriate, the formula for mixture of radionuclides given in para 3.3.3 and the condition given below, namely:

$$\sum_i \{B(i)/A_1(i)\} + \sum\{C(j)/A_2(j)\} \leq 1 \text{.....(3)}$$

where

B(i) is the activity of radionuclide i as special form radioactive material;
$A_1(i)$ is the A_1 value for radionuclide i;
C(j) is the activity of radionuclide j as other than special form radioactive material;
$A_2(j)$ is the A_2 value for radionuclide j.

Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest radionuclide values for the alpha emitters or beta/gamma emitters, respectively.

3.3.5 Radionuclides and Mixtures for which Data are not Available

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

TABLE-I

BASIC RADIONUCLIDE VALUES

Radionuclide (Atomic Number)	A_1 (TBq)	A_2 (TBq)	Activity Concentration Limit for Exempt Material ($Bq.g^{-1}$)	Activity Limit for an Exempt Consignment (Bq)
Actinium (89)				
Ac-225 (a)	8×10^{-1}	6×10^{-3}	1×10^{1}	1×10^{4}
Ac-227 (a)	9×10^{-1}	9×10^{-5}	1×10^{-1}	1×10^{3}
Ac-228	6×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{6}
Silver (47)				
Ag-105	2×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Ag-108m (a)	7×10^{-1}	7×10^{-1}	1×10^{1} (b)	1×10^{6} (b)
Ag-110m (a)	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{6}
Ag-111	2×10^{0}	6×10^{-1}	1×10^{3}	1×10^{6}
Aluminium (13)				
Al-26	1×10^{-1}	1×10^{-1}	1×10^{1}	1×10^{5}
Americium (95)				
Am-241	1×10^{1}	1×10^{-3}	1×10^{0}	1×10^{4}
Am-242m (a)	1×10^{1}	1×10^{-3}	1×10^{0} (b)	1×10^{4} (b)
Am-243 (a)	5×10^{0}	1×10^{-3}	1×10^{0} (b)	1×10^{3} (b)
Argon (18)				
Ar-37	4×10^{1}	4×10^{1}	1×10^{6}	1×10^{8}
Ar-39	4×10^{1}	2×10^{1}	1×10^{7}	1×10^{4}
Ar-41	3×10^{-1}	3×10^{-1}	1×10^{2}	1×10^{9}
Arsenic (33)				
As-72	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
As-73	4×10^{1}	4×10^{1}	1×10^{3}	1×10^{7}
As-74	1×10^{0}	9×10^{-1}	1×10^{1}	1×10^{6}
As-76	3×10^{-1}	3×10^{-1}	1×10^{2}	1×10^{5}
As-77	2×10^{1}	7×10^{-1}	1×10^{3}	1×10^{6}
Astatine (85)				
At-211 (a)	2×10^{1}	5×10^{-1}	1×10^{3}	1×10^{7}

Gold (79)				
Au-193	7×10^{0}	2×10^{0}	1×10^{2}	1×10^{7}
Au-194	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Au-195	1×10^{1}	6×10^{0}	1×10^{2}	1×10^{7}
Au-198	1×10^{0}	6×10^{-1}	1×10^{2}	1×10^{6}
Au-199	1×10^{1}	6×10^{-1}	1×10^{2}	1×10^{6}
Barium (56)				
Ba-131 (a)	2×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Ba-133	3×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Ba-133m	2×10^{1}	6×10^{-1}	1×10^{2}	1×10^{6}
Ba-140 (a)	5×10^{-1}	3×10^{-1}	1×10^{1} (b)	1×10^{5} (b)
Beryllium (4)				
Be-7	2×10^{1}	2×10^{1}	1×10^{3}	1×10^{7}
Be-10	4×10^{1}	6×10^{-1}	1×10^{4}	1×10^{6}
Bismuth (83)				
Bi-205	7×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{6}
Bi-206	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
Bi-207	7×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{6}
Bi-210	1×10^{0}	6×10^{-1}	1×10^{3}	1×10^{6}
Bi-210m (a)	6×10^{-1}	2×10^{-2}	1×10^{1}	1×10^{5}
Bi-212 (a)	7×10^{-1}	6×10^{-1}	1×10^{1} (b)	1×10^{5} (b)
Berkelium (97)				
Bk-247	8×10^{0}	8×10^{-4}	1×10^{0}	1×10^{4}
Bk-249 (a)	4×10^{1}	3×10^{-1}	1×10^{3}	1×10^{6}
Bromine (35)				
Br-76	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}
Br-77	3×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Br-82	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{6}
Carbon (6)				
C-11	1×10^{0}	6×10^{-1}	1×10^{1}	1×10^{6}
C-14	4×10^{1}	3×10^{0}	1×10^{4}	1×10^{7}
Calcium (20)				
Ca-41	Unlimited	Unlimited	1×10^{5}	1×10^{7}
Ca-45	4×10^{1}	1×10^{0}	1×10^{4}	1×10^{7}

Ca-47 (a)	3×10^{0}	3×10^{-1}	1×10^{1}	1×10^{6}
Cadmium (48)				
Cd-109	3×10^{1}	2×10^{0}	1×10^{4}	1×10^{6}
Cd-113m	4×10^{1}	5×10^{-1}	1×10^{3}	1×10^{6}
Cd-115 (a)	3×10^{0}	4×10^{-1}	1×10^{2}	1×10^{6}
Cd-115m	5×10^{-1}	5×10^{-1}	1×10^{3}	1×10^{6}
Cerium (58)				
Ce-139	7×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Ce-141	2×10^{1}	6×10^{-1}	1×10^{2}	1×10^{7}
Ce-143	9×10^{-1}	6×10^{-1}	1×10^{2}	1×10^{6}
Ce-144 (a)	2×10^{-1}	2×10^{-1}	1×10^{2} (b)	1×10^{5} (b)
Californium (98)				
Cf-248	4×10^{1}	6×10^{-3}	1×10^{1}	1×10^{4}
Cf-249	3×10^{0}	8×10^{-4}	1×10^{0}	1×10^{3}
Cf-250	2×10^{1}	2×10^{-3}	1×10^{1}	1×10^{4}
Cf-251	7×10^{0}	7×10^{-4}	1×10^{0}	1×10^{3}
Cf-252	1×10^{-1}	3×10^{-3}	1×10^{1}	1×10^{4}
Cf-253 (a)	4×10^{1}	4×10^{-2}	1×10^{2}	1×10^{5}
Cf-254	1×10^{-3}	1×10^{-3}	1×10^{0}	1×10^{3}
Chlorine (17)				
Cl-36	1×10^{1}	6×10^{-1}	1×10^{4}	1×10^{6}
Cl-38	2×10^{-1}	2×10^{-1}	1×10^{1}	1×10^{5}
Curium (96)				
Cm-240	4×10^{1}	2×10^{-2}	1×10^{2}	1×10^{5}
Cm-241	2×10^{0}	1×10^{0}	1×10^{2}	1×10^{6}
Cm-242	4×10^{1}	1×10^{-2}	1×10^{2}	1×10^{5}
Cm-243	9×10^{0}	1×10^{-3}	1×10^{0}	1×10^{4}
Cm-244	2×10^{1}	2×10^{-3}	1×10^{1}	1×10^{4}
Cm-245	9×10^{0}	9×10^{-4}	1×10^{0}	1×10^{3}
Cm-246	9×10^{0}	9×10^{-4}	1×10^{0}	1×10^{3}
Cm-247 (a)	3×10^{0}	1×10^{-3}	1×10^{0}	1×10^{4}
Cm-248	2×10^{-2}	3×10^{-4}	1×10^{0}	1×10^{3}
Cobalt (27)				
Co-55	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{6}
Co-56	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}

Co-57	1×10^{1}	1×10^{1}	1×10^{2}	1×10^{6}
Co-58	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Co-58m	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{7}
Co-60	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}
Chromium (24)				
Cr-51	3×10^{1}	3×10^{1}	1×10^{3}	1×10^{7}
Caesium (55)				
Cs-129	4×10^{0}	4×10^{0}	1×10^{2}	1×10^{5}
Cs-131	3×10^{1}	3×10^{1}	1×10^{3}	1×10^{6}
Cs-132	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{5}
Cs-134	7×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{4}
Cs-134m	4×10^{1}	6×10^{-1}	1×10^{3}	1×10^{5}
Cs-135	4×10^{1}	1×10^{0}	1×10^{4}	1×10^{7}
Cs-136	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{5}
Cs-137 (a)	2×10^{0}	6×10^{-1}	1×10^{1} (b)	1×10^{4} (b)
Copper (29)				
Cu-64	6×10^{0}	1×10^{0}	1×10^{2}	1×10^{6}
Cu-67	1×10^{1}	7×10^{-1}	1×10^{2}	1×10^{6}
Dysprosium (66)				
Dy-159	2×10^{1}	2×10^{1}	1×10^{3}	1×10^{7}
Dy-165	9×10^{-1}	6×10^{-1}	1×10^{3}	1×10^{6}
Dy-166 (a)	9×10^{-1}	3×10^{-1}	1×10^{3}	1×10^{6}
Erbium (68)				
Er-169	4×10^{1}	1×10^{0}	1×10^{4}	1×10^{7}
Er-171	8×10^{-1}	5×10^{-1}	1×10^{2}	1×10^{6}
Europium (63)				
Eu-147	2×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Eu-148	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{6}
Eu-149	2×10^{1}	2×10^{1}	1×10^{2}	1×10^{7}
Eu-150 (short lived)	2×10^{0}	7×10^{-1}	1×10^{3}	1×10^{6}
Eu-150 (long lived)	7×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{6}
Eu-152	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Eu-152m	8×10^{-1}	8×10^{-1}	1×10^{2}	1×10^{6}
Eu-154	9×10^{-1}	6×10^{-1}	1×10^{1}	1×10^{6}
Eu-155	2×10^{1}	3×10^{0}	1×10^{2}	1×10^{7}

Eu-156	7×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{6}
Fluorine (9)				
F-18	1×10^{0}	6×10^{-1}	1×10^{1}	1×10^{6}
Iron (26)				
Fe-52 (a)	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{6}
Fe-55	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{6}
Fe-59	9×10^{-1}	9×10^{-1}	1×10^{1}	1×10^{6}
Fe-60 (a)	4×10^{1}	2×10^{-1}	1×10^{2}	1×10^{5}
Gallium (31)				
Ga-67	7×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Ga-68	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{5}
Ga-72	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}
Gadolinium (64)				
Gd-146 (a)	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{6}
Gd-148	2×10^{1}	2×10^{-3}	1×10^{1}	1×10^{4}
Gd-153	1×10^{1}	9×10^{0}	1×10^{2}	1×10^{7}
Gd-159	3×10^{0}	6×10^{-1}	1×10^{3}	1×10^{6}
Germanium (32)				
Ge-68 (a)	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{5}
Ge-71	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{8}
Ge-77	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
Hafnium (72)				
Hf-172 (a)	6×10^{-1}	6×10^{-1}	1×10^{1}	1×10^{6}
Hf-175	3×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Hf-181	2×10^{0}	5×10^{-1}	1×10^{1}	1×10^{6}
Hf-182	Unlimited	Unlimited	1×10^{2}	1×10^{6}
Mercury (80)				
Hg-194 (a)	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Hg-195m (a)	3×10^{0}	7×10^{-1}	1×10^{2}	1×10^{6}
Hg-197	2×10^{1}	1×10^{1}	1×10^{2}	1×10^{7}
Hg-197m	1×10^{1}	4×10^{-1}	1×10^{2}	1×10^{6}
Hg-203	5×10^{0}	1×10^{0}	1×10^{2}	1×10^{5}
Holmium (67)				
Ho-166	4×10^{-1}	4×10^{-1}	1×10^{3}	1×10^{5}

Ho-166m	6×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{6}
Iodine (53)				
I-123	6×10^{0}	3×10^{0}	1×10^{2}	1×10^{7}
I-124	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
I-125	2×10^{1}	3×10^{0}	1×10^{3}	1×10^{6}
I-126	2×10^{0}	1×10^{0}	1×10^{2}	1×10^{6}
I-129	Unlimited	Unlimited	1×10^{2}	1×10^{5}
I-131	3×10^{0}	7×10^{-1}	1×10^{2}	1×10^{6}
I-132	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}
I-133	7×10^{-1}	6×10^{-1}	1×10^{1}	1×10^{6}
I-134	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
I-135 (a)	6×10^{-1}	6×10^{-1}	1×10^{1}	1×10^{6}
Indium (49)				
In-111	3×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
In-113m	4×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
In-114m (a)	1×10^{1}	5×10^{-1}	1×10^{2}	1×10^{6}
In-115m	7×10^{0}	1×10^{0}	1×10^{2}	1×10^{6}
Iridium (77)				
Ir-189 (a)	1×10^{1}	1×10^{1}	1×10^{2}	1×10^{7}
Ir-190	7×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{6}
Ir-192	1×10^{0} (c)	6×10^{-1}	1×10^{1}	1×10^{4}
Ir-194	3×10^{-1}	3×10^{-1}	1×10^{2}	1×10^{5}
Potassium (19)				
K-40	9×10^{-1}	9×10^{-1}	1×10^{2}	1×10^{6}
K-42	2×10^{-1}	2×10^{-1}	1×10^{2}	1×10^{6}
K-43	7×10^{-1}	6×10^{-1}	1×10^{1}	1×10^{6}
Krypton (36)				
Kr-79	4×10^{0}	2×10^{0}	1×10^{3}	1×10^{5}
Kr-81	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{7}
Kr-85	1×10^{1}	1×10^{1}	1×10^{5}	1×10^{4}
Kr-85m	8×10^{0}	3×10^{0}	1×10^{3}	1×10^{10}
Kr-87	2×10^{-1}	2×10^{-1}	1×10^{2}	1×10^{9}
Lanthanum (57)				
La-137	3×10^{1}	6×10^{0}	1×10^{3}	1×10^{7}

La-140	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}
Lutetium (71)				
Lu-172	6×10^{-1}	6×10^{-1}	1×10^{1}	1×10^{6}
Lu-173	8×10^{0}	8×10^{0}	1×10^{2}	1×10^{7}
Lu-174	9×10^{0}	9×10^{0}	1×10^{2}	1×10^{7}
Lu-174m	2×10^{1}	1×10^{1}	1×10^{2}	1×10^{7}
Lu-177	3×10^{1}	7×10^{-1}	1×10^{3}	1×10^{7}
Magnesium (12)				
Mg-28 (a)	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
Manganese (25)				
Mn-52	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
Mn-53	Unlimited	Unlimited	1×10^{4}	1×10^{9}
Mn-54	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Mn-56	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
Molybdenum (42)				
Mo-93	4×10^{1}	2×10^{1}	1×10^{3}	1×10^{8}
Mo-99 (a)	1×10^{0}	6×10^{-1}	1×10^{2}	1×10^{6}
Nitrogen (7)				
N-13	9×10^{-1}	6×10^{-1}	1×10^{2}	1×10^{9}
Sodium (11)				
Na-22	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{6}
Na-24	2×10^{-1}	2×10^{-1}	1×10^{1}	1×10^{5}
Niobium (41)				
Nb-93m	4×10^{1}	3×10^{1}	1×10^{4}	1×10^{7}
Nb-94	7×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{6}
Nb-95	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Nb-97	9×10^{-1}	6×10^{-1}	1×10^{1}	1×10^{6}
Neodymium (60)				
Nd-147	6×10^{0}	6×10^{-1}	1×10^{2}	1×10^{6}
Nd-149	6×10^{-1}	5×10^{-1}	1×10^{2}	1×10^{6}
Nickel (28)				
Ni-59	Unlimited	Unlimited	1×10^{4}	1×10^{8}
Ni-63	4×10^{1}	3×10^{1}	1×10^{5}	1×10^{8}
Ni-65	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{6}
Neptunium (93)				

Np-235	4×10^{1}	4×10^{1}	1×10^{3}	1×10^{7}
Np-236 (short lived)	2×10^{1}	2×10^{0}	1×10^{3}	1×10^{7}
Np-236 (long lived)	9×10^{0}	2×10^{-2}	1×10^{2}	1×10^{5}
Np-237	2×10^{1}	2×10^{-3}	1×10^{0} (b)	1×10^{3} (b)
Np-239	7×10^{0}	4×10^{-1}	1×10^{2}	1×10^{7}
Osmium (76)				
Os-185	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Os-191	1×10^{1}	2×10^{0}	1×10^{2}	1×10^{7}
Os-191m	4×10^{1}	3×10^{1}	1×10^{3}	1×10^{7}
Os-193	2×10^{0}	6×10^{-1}	1×10^{2}	1×10^{6}
Os-194 (a)	3×10^{-1}	3×10^{-1}	1×10^{2}	1×10^{5}
Phosphorus (15)				
P-32	5×10^{-1}	5×10^{-1}	1×10^{3}	1×10^{5}
P-33	4×10^{1}	1×10^{0}	1×10^{5}	1×10^{8}
Protactinium (91)				
Pa-230 (a)	2×10^{0}	7×10^{-2}	1×10^{1}	1×10^{6}
Pa-231	4×10^{0}	4×10^{-4}	1×10^{0}	1×10^{3}
Pa-233	5×10^{0}	7×10^{-1}	1×10^{2}	1×10^{7}
Lead (82)				
Pb-201	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Pb-202	4×10^{1}	2×10^{1}	1×10^{3}	1×10^{6}
Pb-203	4×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Pb-205	Unlimited	Unlimited	1×10^{4}	1×10^{7}
Pb-210 (a)	1×10^{0}	5×10^{-2}	1×10^{1} (b)	1×10^{4} (b)
Pb-212 (a)	7×10^{-1}	2×10^{-1}	1×10^{1} (b)	1×10^{5} (b)
Palladium (46)				
Pd-103 (a)	4×10^{1}	4×10^{1}	1×10^{3}	1×10^{8}
Pd-107	Unlimited	Unlimited	1×10^{5}	1×10^{8}
Pd-109	2×10^{0}	5×10^{-1}	1×10^{3}	1×10^{6}
Promethium (61)				
Pm-143	3×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Pm-144	7×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{6}
Pm-145	3×10^{1}	1×10^{1}	1×10^{3}	1×10^{7}
Pm-147	4×10^{1}	2×10^{0}	1×10^{4}	1×10^{7}
Pm-148m (a)	8×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{6}

Pm-149	2×10^{0}	6×10^{-1}	1×10^{3}	1×10^{6}
Pm-151	2×10^{0}	6×10^{-1}	1×10^{2}	1×10^{6}
Polonium (84)				
Po-210	4×10^{1}	2×10^{-2}	1×10^{1}	1×10^{4}
Praseodymium (59)				
Pr-142	4×10^{-1}	4×10^{-1}	1×10^{2}	1×10^{5}
Pr-143	3×10^{0}	6×10^{-1}	1×10^{4}	1×10^{6}
Platinum (78)				
Pt-188 (a)	1×10^{0}	8×10^{-1}	1×10^{1}	1×10^{6}
Pt-191	4×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Pt-193	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{7}
Pt-193m	4×10^{1}	5×10^{-1}	1×10^{3}	1×10^{7}
Pt-195m	1×10^{1}	5×10^{-1}	1×10^{2}	1×10^{6}
Pt-197	2×10^{1}	6×10^{-1}	1×10^{3}	1×10^{6}
Pt-197m	1×10^{1}	6×10^{-1}	1×10^{2}	1×10^{6}
Plutonium (94)				
Pu-236	3×10^{1}	3×10^{-3}	1×10^{1}	1×10^{4}
Pu-237	2×10^{1}	2×10^{1}	1×10^{3}	1×10^{7}
Pu-238	1×10^{1}	1×10^{-3}	1×10^{0}	1×10^{4}
Pu-239	1×10^{1}	1×10^{-3}	1×10^{0}	1×10^{4}
Pu-240	1×10^{1}	1×10^{-3}	1×10^{0}	1×10^{3}
Pu-241 (a)	4×10^{1}	6×10^{-2}	1×10^{2}	1×10^{5}
Pu-242	1×10^{1}	1×10^{-3}	1×10^{0}	1×10^{4}
Pu-244 (a)	4×10^{-1}	1×10^{-3}	1×10^{0}	1×10^{4}
Radium (88)				
Ra-223 (a)	4×10^{-1}	7×10^{-3}	1×10^{2} (b)	1×10^{5} (b)
Ra-224 (a)	4×10^{-1}	2×10^{-2}	1×10^{1} (b)	1×10^{5} (b)
Ra-225 (a)	2×10^{-1}	4×10^{-3}	1×10^{2}	1×10^{5}
Ra-226 (a)	2×10^{-1}	3×10^{-3}	1×10^{1} (b)	1×10^{4} (b)
Ra-228 (a)	6×10^{-1}	2×10^{-2}	1×10^{1} (b)	1×10^{5} (b)
Rubidium (37)				
Rb-81	2×10^{0}	8×10^{-1}	1×10^{1}	1×10^{6}
Rb-83 (a)	2×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Rb-84	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Rb-86	5×10^{-1}	5×10^{-1}	1×10^{2}	1×10^{5}

Rb-87	Unlimited	Unlimited	1×10^{4}	1×10^{7}
Rb (nat)	Unlimited	Unlimited	1×10^{4}	1×10^{7}
Rhenium (75)				
Re-184	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Re-184m	3×10^{0}	1×10^{0}	1×10^{2}	1×10^{6}
Re-186	2×10^{0}	6×10^{-1}	1×10^{3}	1×10^{6}
Re-187	Unlimited	Unlimited	1×10^{6}	1×10^{9}
Re-188	4×10^{-1}	4×10^{-1}	1×10^{2}	1×10^{5}
Re-189 (a)	3×10^{0}	6×10^{-1}	1×10^{2}	1×10^{6}
Re (nat)	Unlimited	Unlimited	1×10^{6}	1×10^{9}
Rhodium (45)				
Rh-99	2×10^{0}	2×10^{0}	1×10^{1}	1×10^{6}
Rh-101	4×10^{0}	3×10^{0}	1×10^{2}	1×10^{7}
Rh-102	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{6}
Rh-102m	2×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Rh-103m	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{8}
Rh-105	1×10^{1}	8×10^{-1}	1×10^{2}	1×10^{7}
Radon (86)				
Rn-222 (a)	3×10^{-1}	4×10^{-3}	1×10^{1} (b)	1×10^{8} (b)
Ruthenium (44)				
Ru-97	5×10^{0}	5×10^{0}	1×10^{2}	1×10^{7}
Ru-103 (a)	2×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Ru-105	1×10^{0}	6×10^{-1}	1×10^{1}	1×10^{6}
Ru-106 (a)	2×10^{-1}	2×10^{-1}	1×10^{2} (b)	1×10^{5} (b)
Sulphur (16)				
S-35	4×10^{1}	3×10^{0}	1×10^{5}	1×10^{8}
Antimony (51)				
Sb-122	4×10^{-1}	4×10^{-1}	1×10^{2}	1×10^{4}
Sb-124	6×10^{-1}	6×10^{-1}	1×10^{1}	1×10^{6}
Sb-125	2×10^{0}	1×10^{0}	1×10^{2}	1×10^{6}
Sb-126	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}
Scandium (21)				
Sc-44	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{5}
Sc-46	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{6}
Sc-47	1×10^{1}	7×10^{-1}	1×10^{2}	1×10^{6}

Sc-48	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
Selenium (34)				
Se-75	3×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Se-79	4×10^{1}	2×10^{0}	1×10^{4}	1×10^{7}
Silicon (14)				
Si-31	6×10^{-1}	6×10^{-1}	1×10^{3}	1×10^{6}
Si-32	4×10^{1}	5×10^{-1}	1×10^{3}	1×10^{6}
Samarium (62)				
Sm-145	1×10^{1}	1×10^{1}	1×10^{2}	1×10^{7}
Sm-147	Unlimited	Unlimited	1×10^{1}	1×10^{4}
Sm-151	4×10^{1}	1×10^{1}	1×10^{4}	1×10^{8}
Sm-153	9×10^{0}	6×10^{-1}	1×10^{2}	1×10^{6}
Tin (50)				
Sn-113 (a)	4×10^{0}	2×10^{0}	1×10^{3}	1×10^{7}
Sn-117m	7×10^{0}	4×10^{-1}	1×10^{2}	1×10^{6}
Sn-119m	4×10^{1}	3×10^{1}	1×10^{3}	1×10^{7}
Sn-121m (a)	4×10^{1}	9×10^{-1}	1×10^{3}	1×10^{7}
Sn-123	8×10^{-1}	6×10^{-1}	1×10^{3}	1×10^{6}
Sn-125	4×10^{-1}	4×10^{-1}	1×10^{2}	1×10^{5}
Sn-126 (a)	6×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}
Strontium (38)				
Sr-82 (a)	2×10^{-1}	2×10^{-1}	1×10^{1}	1×10^{5}
Sr-85	2×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Sr-85m	5×10^{0}	5×10^{0}	1×10^{2}	1×10^{7}
Sr-87m	3×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Sr-89	6×10^{-1}	6×10^{-1}	1×10^{3}	1×10^{6}
Sr-90 (a)	3×10^{-1}	3×10^{-1}	1×10^{2} (b)	1×10^{4} (b)
Sr-91 (a)	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
Sr-92 (a)	1×10^{0}	3×10^{-1}	1×10^{1}	1×10^{6}
Tritium (1)				
T(H-3)	4×10^{1}	4×10^{1}	1×10^{6}	1×10^{9}
Tantalum (73)				
Ta-178 (long lived)	1×10^{0}	8×10^{-1}	1×10^{1}	1×10^{6}
Ta-179	3×10^{1}	3×10^{1}	1×10^{3}	1×10^{7}
Ta-182	9×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{4}

Terbium (65)				
Tb-157	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{7}
Tb-158	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Tb-160	1×10^{0}	6×10^{-1}	1×10^{1}	1×10^{6}
Technetium (43)				
Tc-95m (a)	2×10^{0}	2×10^{0}	1×10^{1}	1×10^{6}
Tc-96	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{6}
Tc-96m (a)	4×10^{-1}	4×10^{-1}	1×10^{3}	1×10^{7}
Tc-97	Unlimited	Unlimited	1×10^{3}	1×10^{8}
Tc-97m	4×10^{1}	1×10^{0}	1×10^{3}	1×10^{7}
Tc-98	8×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{6}
Tc-99	4×10^{1}	9×10^{-1}	1×10^{4}	1×10^{7}
Tc-99m	1×10^{1}	4×10^{0}	1×10^{2}	1×10^{7}
Tellurium (52)				
Te-121	2×10^{0}	2×10^{0}	1×10^{1}	1×10^{6}
Te-121m	5×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Te-123m	8×10^{0}	1×10^{0}	1×10^{2}	1×10^{7}
Te-125m	2×10^{1}	9×10^{-1}	1×10^{3}	1×10^{7}
Te-127	2×10^{1}	7×10^{-1}	1×10^{3}	1×10^{6}
Te-127m (a)	2×10^{1}	5×10^{-1}	1×10^{3}	1×10^{7}
Te-129	7×10^{-1}	6×10^{-1}	1×10^{2}	1×10^{6}
Te-129m (a)	8×10^{-1}	4×10^{-1}	1×10^{3}	1×10^{6}
Te-131m (a)	7×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{6}
Te-132 (a)	5×10^{-1}	4×10^{-1}	1×10^{2}	1×10^{7}
Thorium (90)				
Th-227	1×10^{1}	5×10^{-3}	1×10^{1}	1×10^{4}
Th-228 (a)	5×10^{-1}	1×10^{-3}	1×10^{0} (b)	1×10^{4} (b)
Th-229	5×10^{0}	5×10^{-4}	1×10^{0} (b)	1×10^{3} (b)
Th-230	1×10^{1}	1×10^{-3}	1×10^{0}	1×10^{4}
Th-231	4×10^{1}	2×10^{-2}	1×10^{3}	1×10^{7}
Th-232	Unlimited	Unlimited	1×10^{1}	1×10^{4}
Th-234 (a)	3×10^{-1}	3×10^{-1}	1×10^{3} (b)	1×10^{5} (b)
Th (nat)	Unlimited	Unlimited	1×10^{0} (b)	1×10^{3} (b)
Titanium (22)				
Ti-44 (a)	5×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}

Thallium (81)				
Tl-200	9×10^{-1}	9×10^{-1}	1×10^{1}	1×10^{6}
Tl-201	1×10^{1}	4×10^{0}	1×10^{2}	1×10^{6}
Tl-202	2×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Tl-204	1×10^{1}	7×10^{-1}	1×10^{4}	1×10^{4}
Thulium (69)				
Tm-167	7×10^{0}	8×10^{-1}	1×10^{2}	1×10^{6}
Tm-170	3×10^{0}	6×10^{-1}	1×10^{3}	1×10^{6}
Tm-171	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{8}
Uranium (92)				
U-230 (fast lung absorption) (a)(d)	4×10^{1}	1×10^{-1}	1×10^{1} (b)	1×10^{5} (b)
U-230 (medium lung absorption)(a)(e)	4×10^{1}	4×10^{-3}	1×10^{1}	1×10^{4}
U-230 (slow lung absorption) (a)(f)	3×10^{1}	3×10^{-3}	1×10^{1}	1×10^{4}
U-232 (fast lung absorption)(d)	4×10^{1}	1×10^{-2}	1×10^{0} (b)	1×10^{3} (b)
U-232 (medium lung absorption)(e)	4×10^{1}	7×10^{-3}	1×10^{1}	1×10^{4}
U-232 (slow lung absorption)(f)	1×10^{1}	1×10^{-3}	1×10^{1}	1×10^{4}
U-233 (fast lung absorption)(d)	4×10^{1}	9×10^{-2}	1×10^{1}	1×10^{4}
U-233 (medium lung absorption)(e)	4×10^{1}	2×10^{-2}	1×10^{2}	1×10^{5}
U-233 (slow lung absorption)(f)	4×10^{1}	6×10^{-3}	1×10^{1}	1×10^{5}
U-234 (fast lung absorption)(d)	4×10^{1}	9×10^{-2}	1×10^{1}	1×10^{4}
U-234 (medium lung absorption)(e)	4×10^{1}	2×10^{-2}	1×10^{2}	1×10^{5}
U-234 (slow lung absorption)(f)	4×10^{1}	6×10^{-3}	1×10^{1}	1×10^{5}
U-235 (all lung absorption types)(a)(d)(e)(f)	Unlimited	Unlimited	1×10^{1} (b)	1×10^{4} (b)

U-236 (fast lung absorption)(d)	Unlimited	Unlimited	1×10^{1}	1×10^{4}
U-236 (medium lung absorption)(e)	4×10^{1}	2×10^{-2}	1×10^{2}	1×10^{5}
U-236 (slow lung absorption)(f)	4×10^{1}	6×10^{-3}	1×10^{1}	1×10^{4}
U-238 (all lung absorption types)(d)(e)(f)	Unlimited	Unlimited	1×10^{1} (b)	1×10^{4} (b)
U (natural)	Unlimited	Unlimited	1×10^{0} (b)	1×10^{3} (b)
U (enriched to 20% or less)(g)	Unlimited	Unlimited	1×10^{0}	1×10^{3}
U (depleted)	Unlimited	Unlimited	1×10^{0}	1×10^{3}
Vanadium (23)				
V-48	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}
V-49	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{7}
Tungsten (74)				
W-178 (a)	9×10^{0}	5×10^{0}	1×10^{1}	1×10^{6}
W-181	3×10^{1}	3×10^{1}	1×10^{3}	1×10^{7}
W-185	4×10^{1}	8×10^{-1}	1×10^{4}	1×10^{7}
W-187	2×10^{0}	6×10^{-1}	1×10^{2}	1×10^{6}
W-188 (a)	4×10^{-1}	3×10^{-1}	1×10^{2}	1×10^{5}
Xenon (54)				
Xe-122 (a)	4×10^{-1}	4×10^{-1}	1×10^{2}	1×10^{9}
Xe-123	2×10^{0}	7×10^{-1}	1×10^{2}	1×10^{9}
Xe-127	4×10^{0}	2×10^{0}	1×10^{3}	1×10^{5}
Xe-131m	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{4}
Xe-133	2×10^{1}	1×10^{1}	1×10^{3}	1×10^{4}
Xe-135	3×10^{0}	2×10^{0}	1×10^{3}	1×10^{10}
Yttrium (39)				
Y-87 (a)	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Y-88	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{6}
Y-90	3×10^{-1}	3×10^{-1}	1×10^{3}	1×10^{5}
Y-91	6×10^{-1}	6×10^{-1}	1×10^{3}	1×10^{6}
Y-91m	2×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Y-92	2×10^{-1}	2×10^{-1}	1×10^{2}	1×10^{5}
Y-93	3×10^{-1}	3×10^{-1}	1×10^{2}	1×10^{5}

Ytterbium (70)				
Yb-169	4×10^{0}	1×10^{0}	1×10^{2}	1×10^{7}
Yb-175	3×10^{1}	9×10^{-1}	1×10^{3}	1×10^{7}
Zinc (30)				
Zn-65	2×10^{0}	2×10^{0}	1×10^{1}	1×10^{6}
Zn-69	3×10^{0}	6×10^{-1}	1×10^{4}	1×10^{6}
Zn-69m (a)	3×10^{0}	6×10^{-1}	1×10^{2}	1×10^{6}
Zirconium (40)				
Zr-88	3×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Zr-93	Unlimited	Unlimited	1×10^{3} (b)	1×10^{7} (b)
Zr-95 (a)	2×10^{0}	8×10^{-1}	1×10^{1}	1×10^{6}
Zr-97 (a)	4×10^{-1}	4×10^{-1}	1×10^{1} (b)	1×10^{5} (b)

(a) A_1 and/or A_2 values for these parent radionuclides include contributions from daughter radionuclides with half-lives less than 10 days, are listed as follows:

Mg-28	Al-28
Ar-42	K-42
Ca-47	Sc-47
Ti-44	Sc-44
Fe-52	Mn-52m
Fe-60	Co-60m
Zn-69m	Zn-69
Ge-68	Ga-68
Rb-83	Kr-83m
Sr-82	Rb-82
Sr-90	Y-90
Sr-91	Y-91m
Sr-92	Y-92
Y-87	Sr-87m
Zr-95	Nb-95m
Zr-97	Nb-97m, Nb-97
Mo-99	Tc-99m
Tc-95m	Tc-95
Tc-96m	Tc-96

Ru-103	Rh-103m
Ru-106	Rh-106
Pd-103	Rh-103m
Ag-108m	Ag-108
Ag-110m	Ag-110
Cd-115	In-115m
In-114m	In-114
Sn-113	In-113m
Sn-121m	Sn-121
Sn-126	Sb-126m
Te-118	Sb-118
Te-127m	Te-127
Te-129m	Te-129
Te-131m	Te-131
Te-132	I-132
I-135	Xe-135m
Xe-122	I-122
Cs-137	Ba-137m
Ba-131	Cs-131
Ba-140	La-140
Ce-144	Pr-144m, Pr-144
Pm-148m	Pm-148
Gd-146	Eu-146
Dy-166	Ho-166
Hf-172	Lu-172
W-178	Ta-178
W-188	Re-188
Re-189	Os-189m
Os-194	Ir-194
Ir-189	Os-189m
Pt-188	Ir-188
Hg-194	Au-194

Hg-195m	Hg-195
Pb-210	Bi-210
Pb-212	Bi-212, Tl-208, Po-212
Bi-210m	Tl-206
Bi-212	Tl-208, Po-212
At-211	Po-211
Rn-222	Po-218, Pb-214, At-218, Bi-214, Po-214
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Po-211, Tl-207
Ra-224	Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
Ra-225	Ac-225, Fr-221, At-217, Bi-213, Tl-209, Po-213, Pb-209
Ra-226	Rn-222, Po-218, Pb-214, At-218, Bi-214, Po-214
Ra-228	Ac-228
Ac-225	Fr-221, At-217, Bi-213, Tl-209, Po-213, Pb-209
Ac-227	Fr-223
Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
Th-234	Pa-234m, Pa-234
Pa-230	Ac-226, Th-226, Fr-222, Ra-222, Rn-218, Po-214
U-230	Th-226, Ra-222, Rn-218, Po-214
U-235	Th-231
Pu-241	U-237
Pu-244	U-240, Np-240m
Am-242m	Am-242, Np-238
Am-243	Np-239
Cm-247	Pu-243
Bk-249	Am-245
Cf-253	Cm-249

(b) Parent nuclides and their progeny included in secular equilibrium are listed as follows:

Sr-90	Y-90
Zr-93	Nb-93m
Zr-97	Nb-97
Ru-106	Rh-106
Ag-108m	Ag-108

Cs-137	Ba-137m
Ce-144	Pr-144
Ba-140	La-140
Bi-212	Tl-208 (0.36), Po-212 (0.64)
Pb-210	Bi-210, Po-210
Pb-212	Bi-212, Tl-208 (0.36), Po-212 (0.64)
Rn-222	Po-218, Pb-214, Bi-214, Po-214
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Tl-207
Ra-224	Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
Ra-226	Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210
Ra-228	Ac-228
Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
Th-229	Ra-225, Ac-225, Fr-221, At-217, Bi-213, Po-213, Pb-209
Th-nat	Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
Th-234	Pa-234m
U-230	Th-226, Ra-222, Rn-218, Po-214
U-232	Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
U-235	Th-231
U-238	Th-234, Pa-234m
U-nat	Th-234, Pa-234m, U-234, Th-230, Ra-226, Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210
Np-237	Pa-233
Am-242m	Am-242
Am-243	Np-239

(c) The quantity may be determined from a measurement of the rate of decay or a measurement of the radiation level at a prescribed distance from the source.

(d) These values apply only to compounds of uranium that take the chemical form of UF_6, UO_2F_2 and $UO_2(NO_3)_2$ in both normal and accident conditions of transport.

(e) These values apply only to compounds of uranium that take the chemical form of UO_3, UF_4, UCl_4 and hexavalent compounds in both normal and accident conditions of transport.

(f) These values apply to all compounds of uranium other than those specified in (d) and (e) above.

(g) These values apply to unirradiated uranium only.

TABLE-II

EXCERPTS FROM LIST OF UN NUMBERS, PROPER SHIPPING NAMES AND DESCRIPTIONS

Assignment of UN Numbers	PROPER SHIPPING NAME and Description[a]
Excepted Package	
UN 2908	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – EMPTY PACKAGING
UN 2909	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – ARTICLES MANUFACTURED FROM NATURAL URANIUM OR DEPLETED URANIUM OR NATURAL THORIUM
UN 2910	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – LIMITED QUANTITY OF MATERIAL
UN 2911	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – INSTRUMENTS OR ARTICLES
UN 3507	URANIUM HEXAFLUORIDE, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, LESS THAN 0.1 kg PER PACKAGE, NON-FISSILE OR FISSILE-EXCEPTED.
Low Specific Activity Radioactive Material	
UN 2912	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-I), NON-FISSILE OR FISSILE-EXCEPTED[b]
UN 3321	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), NON-FISSILE OR FISSILE-EXCEPTED[b]
UN 3322	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-III), NON-FISSILE OR FISSILE-EXCEPTED[b]
UN 3324	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), FISSILE

UN 3325	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-III), FISSILE

Surface Contaminated Objects	
UN 2913	RADIOACTIVE MATERIAL, SURFACE CONTAMINATED OBJECTS (SCO-I or SCO-II), NON-FISSILE OR FISSILE-EXCEPTED[b]
UN 3326	RADIOACTIVE MATERIAL, SURFACE CONTAMINATED OBJECTS (SCO-I or SCO-II), FISSILE
Type A Package	
UN 2915	RADIOACTIVE MATERIAL, TYPE A PACKAGE, NON-SPECIAL FORM, NON-FISSILE OR FISSILE-EXCEPTED[b]
UN 3327	RADIOACTIVE MATERIAL, TYPE A PACKAGE, FISSILE, NON-SPECIAL FORM
UN 3332	RADIOACTIVE MATERIAL, TYPE A PACKAGE, SPECIAL FORM, NON-FISSILE OR FISSILE-EXCEPTED[b]
UN 3333	RADIOACTIVE MATERIAL, TYPE A PACKAGE, SPECIAL FORM, FISSILE
Type B(U) Package	
UN 2916	RADIOACTIVE MATERIAL, TYPE B(U) PACKAGE, NON-FISSILE OR FISSILE-EXCEPTED[b]
UN 3328	RADIOACTIVE MATERIAL, TYPE B(U) PACKAGE, FISSILE
Type B(M) Package	
UN 2917	RADIOACTIVE MATERIAL, TYPE B(M) PACKAGE, NON-FISSILE OR FISSILE-EXCEPTED[b]
UN 3329	RADIOACTIVE MATERIAL, TYPE B(M) PACKAGE, FISSILE
Type C Package	
UN 3323	RADIOACTIVE MATERIAL, TYPE C PACKAGE, NON-FISSILE OR FISSILE-EXCEPTED[b]
UN 3330	RADIOACTIVE MATERIAL, TYPE C PACKAGE, FISSILE

Special Arrangement	
UN 2919	RADIOACTIVE MATERIAL, TRANSPORTED UNDER SPECIAL ARRANGEMENT, NON-FISSILE OR FISSILE-EXCEPTED[b]
UN 3331	RADIOACTIVE MATERIAL, TRANSPORTED UNDER SPECIAL ARRANGEMENT, FISSILE
Uranium Hexafluoride	
UN 2977	RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, FISSILE
UN 2978	RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, NON-FISSILE OR FISSILE-EXCEPTED[b]

[a] The 'PROPER SHIPPING NAME' is found in the column 'PROPER SHIPPING NAME and description' and is restricted to that part shown in CAPITAL LETTERS. In the cases of UN 2909, UN 2911, UN 2913 and UN 3326, where alternative proper shipping names are separated by the word 'or', only the relevant proper shipping name shall be used.

[b] 'Fissile-excepted' refers only to material excepted under clause 4.6.1.1.

TABLE-III

BASIC RADIONUCLIDE VALUES FOR UNKNOWN RADIONUCLIDES OR MIXTURES

Radioactive Content	A_1 (TBq)	A_2 (TBq)	Activity Concentration Limit for Exempt Material ($Bq.g^{-1}$)	Activity Limit for an Exempt Consignment (Bq)
Only beta or gamma emitting nuclides are known to be present	0.1	0.02	1×10^{1}	1×10^{4}
Alpha emitting nuclides, but no neutron emitters are known to be present	0.2	9×10^{-5}	1×10^{-1}	1×10^{3}
Neutron emitting nuclides are known to be present or no relevant data are available	0.001	9×10^{-5}	1×10^{-1}	1×10^{3}

4. CLASSIFICATION, DESIGN AND TEST REQUIREMENTS FOR RADIOACTIVE MATERIALS

4.1 Demonstration of Compliance with the Performance Standards for Radioactive Material

4.1.1 Methods of Demonstration of Compliance

Demonstration of compliance with the performance standards required in this section shall be accomplished by any of the following methods or by a combination thereof:

(a) Performance of tests with specimens representing LSA-III material, or special form radioactive material, or low dispersible radioactive material, 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 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 that 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.

4.1.2 Methods of Assessment

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

4.2 Low Specific Activity Material

4.2.1 Conditions for Classification as LSA Material

Radioactive material may only be classified as LSA material if the conditions specified in the clauses 4.2.2, 6.7.1 to 6.7.7 are met.

4.2.2 Classification of LSA Material

LSA material shall be further classified as LSA-I or LSA-II or LSA-III:

(a) LSA-I:
    (i) Uranium and thorium ores and concentrates of such ores, and other ores containing naturally occurring radionuclides.
    (ii) Natural uranium, depleted uranium, natural thorium or their compounds or mixtures, that are unirradiated and in solid or liquid form.
    (iii) Radioactive material for which the A_2 value is unlimited. Fissile material may be included only if excepted as specified in this section in clause 4.6.1.1.

(iv) Other radioactive material in which the activity is distributed throughout and the estimated average specific activity does not exceed 30 times the values for the activity concentration specified in Section 3. Fissile material may be included only if excepted under clause 4.6.1.1

(b) LSA-II:

(i) Water with a tritium concentration of up to 0.8 $TBq.L^{-1}$

(ii) Other material in which the activity is distributed throughout and the estimated average specific activity does not exceed 10^{-4} $A_2.g^{-1}$ for solids and gases, and 10^{-5} $A_2.g^{-1}$ for liquids.

(c) LSA-III: Solids (e.g. consolidated wastes, activated materials), excluding powders, that meet the requirements of clause 4.2.3.1, 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 and ceramic).

(ii) The radioactive material is relatively insoluble, or 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 7 days would not exceed $0.1A_2$.

(iii) The estimated average specific activity of the solid, excluding any shielding material, does not exceed 2×10^{-3} $A_2.g^{-1}$.

4.2.3 Requirement for LSA-III Material

4.2.3.1 LSA-III material shall be a solid of such a nature that if the entire contents of a package were subjected to the leaching Test for LSA-III Material specified in clause 4.2.3.2, the activity in the water would not exceed $0.1A_2$.

4.2.3.2 A solid material sample representing 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 $mS.m^{-1}$ at 20°C. The total activity of the free volume of water shall be measured following the 7 day immersion of the test sample.

4.3 Surface Contaminated Object

4.3.1 Radioactive material may be classified as SCO if the conditions in clauses 4.3.2, 6.8.1 to 6.8.7 are met.

4.3.2 SCO shall be a solid object classified as either SCO-I or SCO-II specified below:

TABLE-IV

CLASSIFICATION OF SURFACE CONTAMINATED OBJECTS

SCO Group	Contamination Level Bq.cm^{-2} Averaged over 300 cm^2 or (the area of the surface if less than 300 cm^2)					
	The Non-fixed Contamination on the Accessible Surface		The Fixed Contamination on the Accessible Surface		The Non-fixed Contamination plus the Fixed Contamination on the Inaccessible Surface	
	for Beta and Gamma Emitters and Low Toxicity Alpha Emitters	for all other Alpha Emitters	for Beta and Gamma Emitters and Low Toxicity Alpha Emitters	for all other Alpha Emitters	for Beta and Gamma Emitters and Low Toxicity Alpha Emitters	for all other Alpha Emitters
SCO-I	4	0.4	4×10^4	4×10^3	4×10^4	4×10^3
SCO-II	400	40	8×10^5	8×10^4	8×10^5	8×10^4

4.4 Special Form Radioactive Material

4.4.1 Classification as Special Form Radioactive Material

Radioactive material may be classified as special form radioactive material only if it meets the applicable requirements specified in clause 4.4.2 below and is approved as special form radioactive material by the Competent Authority.

4.4.2 Requirements for Special Form Radioactive Material

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

4.4.2.2 Special form radioactive material shall be of such a nature or shall be so designed that if it is subjected to the tests specified in clause 4.4.3, it shall meet the following requirements:

(a) It would not break or shatter under the impact, percussion and bending tests specified for special form radioactive material in clauses 4.4.3.2 to 4.4.3.4 and 4.4.3.6(a), as applicable.

(b) It would not melt or disperse in the heat test specified for special form radioactive material in clause 4.4.3.5 or para 4.4.3.6(b), as applicable.

(c) The activity in the water from the leaching tests specified in clauses 4.4.3.7 to 4.4.3.8 for special form radioactive material would not exceed 2 kBq; or alternatively, for sealed sources, the leakage rate for the volumetric leakage assessment test specified in the International Organization for Standardization document ISO 9978: Radiation Protection: Sealed Radioactive Sources - Leakage Test Methods [8], would not exceed the applicable acceptance threshold acceptable to the Regulatory Body.

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

4.4.3 Tests for Special Form Radioactive Material

4.4.3.1 Specimens that comprise or simulate special form radioactive material shall be subjected to the impact test, the percussion test, the bending test and the heat test specified below. A different specimen may be used for each of the tests. Following each test, a leaching assessment or volumetric leakage test shall be performed on the specimen by a method no less sensitive than the methods specified in clause 4.4.3.7 for indispersible solid material or in clause 4.4.3.8 for encapsulated material.

4.4.3.2 ***Impact test***: The specimen shall drop onto the target from a height of 9 m. The target shall be as defined in clause 5.2

4.4.3.3 ***Percussion test***: The specimen shall be placed on a sheet of lead that is supported by a smooth solid surface and struck by the flat face of a mild steel bar so as to cause an impact equivalent to that resulting from a free drop of 1.4 kg through 1 m. The lower part of the bar 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 3.5–4.5 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 bar shall strike the specimen so as to cause maximum damage.

4.4.3.4 ***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 bar. The bar shall strike the specimen so as to cause an impact equivalent to that resulting from a free vertical drop of 1.4 kg through 1 m. The lower part of the bar shall be 25 mm in diameter with the edges rounded off to a radius of 3.0 ± 0.3 mm.

4.4.3.5 ***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 min and shall then be allowed to cool.

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

(a) The impact and the percussion tests prescribed above, provided that the specimens are alternatively subjected to the impact test prescribed in the International Organization for Standardization document ISO 2919: Sealed Radioactive Sources: Classification [9]:

(i) The Class 4 impact test if the mass of the special form radioactive material is less than 200 g;

(ii) The Class 5 impact test if the mass of the special form radioactive material is more than 200 g but less than 500 g.

(b) The heat test prescribed above, provided the specimens are alternatively subjected to the Class 6 temperature test specified in ISO 2919 [9].

4.4.3.7 Leaching and Volumetric Leakage Assessment Methods

For specimens that 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 $mS.m^{-1}$ at 20°C.

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

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

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

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

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

4.4.3.8 For specimens that 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 $mS.m^{-1}$ at 20°C.
   (ii) The water and the specimen shall be heated to a temperature of 50 ± 5°C and maintained at this temperature for 4 h.
   (iii) The activity of the water shall then be determined.
   (iv) The specimen shall then be kept for at least 7 days in still air at not less than 30°C and with a relative humidity of not less than 90%.
   (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 9978: Radiation Protection: Sealed Radioactive Sources — Leakage Test Methods [8].

4.5 Low Dispersible Radioactive Material

4.5.1 Classification of Low Dispersible Radioactive Material

Radioactive material may be classified as low dispersible radioactive material only if it meets the applicable requirements specified in clause 4.5.2, taking into account the

requirements of clause 5.9.3.14 and is approved as low dispersible radioactive material by the Competent Authority.

4.5.2 Requirements for Low Dispersible Radioactive Material

Low dispersible radioactive material shall be such that the total amount of this radioactive material in a package shall meet the following requirements:

(a) The radiation level at 3 m from the unshielded radioactive material does not exceed 10 $mSv.h^{-1}$.

(b) If subjected to the enhanced thermal test (clause 5.9.5.5.2) and the impact test (clause 5.9.5.5.3) specified for Type C packages in this safety code, the airborne release in gaseous and particulate forms of up to 100 μm aerodynamic equivalent diameter would not exceed 100 A_2. A separate specimen may be used for each test.

(c) If subjected to the leaching test for low dispersible radioactive material (clause 4.5.3.2), the activity in the water would not exceed 100 A_2. In the application of this test, the damaging effects of the tests specified in (b) shall be taken into account.

4.5.3 Tests for Low Dispersible Radioactive Material

4.5.3.1 Enhanced Thermal Test and Impact test

A specimen that comprises or simulates low dispersible radioactive material shall be subjected to the enhanced thermal test (clause 5.9.5.5.2) and the impact test (clause 5.9.5.5.3) specified for Type C packages in this safety code. A different specimen may be used for each of the tests. Following each test, the specimen shall be subjected to the leaching test specified below. After each test it shall be determined if the applicable requirements of clause 4.5.2 have been met.

4.5.3.2 Leaching Test for Low Dispersible Radioactive Material

A solid material sample representing 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 $mS.m^{-1}$ at 20°C. The total activity of the free volume of water shall be measured following the 7 day immersion of the test sample.

4.6 Fissile Material

4.6.1 The following provisions shall apply in respect of packages containing fissile material.

4.6.1.1 Fissile material and packages containing fissile material shall be classified under the relevant entry as ‘FISSILE’, in accordance with Table II unless excepted by one of the provisions of subparagraphs (a)–(f) of this clause and transported subject to the applicable requirements specified in clause 6.15.3.3. All provisions apply only to material in packages that meets the requirement that the smallest overall external dimension of the package shall not be less than 10 cm, unless unpackaged material is specifically allowed in the provision:

(a) 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 nuclides are 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.

(b) 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 0.002% of the mass of uranium, and with a minimum nitrogen to uranium atomic ratio (N/U) of 2.

(c) Uranium with a maximum uranium enrichment of 5% by mass of uranium-235 provided:
  (i) There is no more than 3.5 g of uranium-235 per package.
  (ii) The total plutonium and uranium-233 content does not exceed 1% of the mass of uranium-235 per package.
  (iii) Transport of the package is subject to the limit that fissile material in packages classified in accordance with this sub-paragraph shall not be transported in a consignment with more than 45 g of fissile nuclides.

(d) Fissile nuclides with a total mass not greater than 2.0 g per package, provided the package is transported subject to the limit that fissile material in packages classified in accordance with this sub-paragraph shall not be transported in a consignment with more than 15 g of fissile nuclides.

(e) Fissile nuclides with a total mass not greater than 45 g, either packaged or unpackaged, subject to the provison that unpackaged or packaged fissile material classified in accordance with this sub-paragraph shall be transported under exclusive use on a conveyance with no more than 45 g of fissile nuclides.

(f) A fissile material that meets the requirement of clause 4.6.2 and further, only one approved fissile material in packages classified in accordance with this sub-paragraph is allowed per consignment unless multiple materials are authorised in the certificate of approval and in addition, requires the approval of the Competent Authority under this safety code (clause 7.1.2).

4.6.1.2 The contents of packages containing fissile material shall be as specified for the package design, either directly with the provisions of this safety code or in the certificate of approval.

4.6.2 Requirements for Material Excepted from Fissile Classification

A fissile material excepted from classification as 'FISSILE' under clause 4.6.1.1(f) shall be subcritical without the need for accumulation control under the following conditions:

(a) The conditions of clause 5.10.1(a)
(b) The conditions consistent with the assessment provisions stated in clauses 5.10.7 (b) and 5.10.8 (b) for packages
(c) The conditions specified in clause 5.10.6.4(a), if transported by air.

4.7 Uranium Hexafluoride

4.7.1 Uranium hexafluoride shall be assigned to one of the following UN numbers only:

(a) UN 2977, RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, FISSILE
(b) UN 2978, RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, NON-FISSILE OR FISSILE-EXCEPTED
(c) UN 3507, URANIUM HEXAFLUORIDE, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, less than 0.1 kg per package, NON-FISSILE OR FISSILE-EXCEPTED.

4.7.2 The contents of a package containing uranium hexafluoride shall comply with the following requirements:
(a) The mass of uranium hexafluoride shall not be different from that allowed for the package design.
(b) The mass of uranium hexafluoride shall not be greater than a value that would lead to an ullage of less than 5% at the maximum temperature of the package, as specified for the plant systems where the package might be used.
(c) The uranium hexafluoride shall be in solid form and the internal pressure shall not be above atmospheric pressure when presented for transport.

4.8 Special Arrangement

Radioactive material shall be classified as transported under special arrangement when it is intended to be carried in accordance with clause 2.5.

5. CLASSIFICATION, DESIGN AND TEST REQUIREMENTS FOR PACKAGINGS, PACKAGES AND CORRESPONDING ACTIVITY LIMITS

5.1 Demonstration of Compliance with the Performance Standards for Packagings and Preparation of Specimen for Testing

5.1.1 Demonstration of compliance with the performance standards required in this section shall be accomplished by any of the following methods or by a combination thereof:

(a) Performance of tests 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 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 that 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.

5.1.2 All specimens shall be inspected before testing in order to identify and record faults or damage, including the following:

(a) Divergence from the design
(b) Defects in manufacture
(c) Corrosion or other deterioration
(d) Distortion of features.

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

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

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

5.1.6 After each of the applicable tests specified in this section for demonstrating the integrity of the containment system and shielding and assessing criticality safety:

(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 this section for the package under test.

(c) For packages containing fissile material, it shall be determined whether the assumptions and conditions used in the assessments required by clause 5.10 for one or more packages are valid.

5.2 Target for Drop Tests

The target for the drop test specified in respect of impact test for special form radioactive material (clause 4.4.3.2), low dispersibe radioactive material (clause 5.9.5.5.3), free drop test for normal conditions of transport (clause 5.8.4.3), additional free drop test for Type A packages containing liquids and gases [clause 5.8.4.6(a)], mechanical test (clause 5.9.4.3.1) and puncture-tearing test for Type C packages (clause 5.9.5.5.1), 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 damage to the specimen.

5.3 General Requirements for All Packagings and Packages

The consignor shall ensure that all packagings and packages used for transport satisfy the following general requirements:

5.3.1 The package shall be so designed in relation to its mass, volume and shape that it can be easily and safely transported. In addition, the package shall be so designed that it can be properly secured in or on the conveyance during transport.

5.3.2 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 this safety code would not be impaired. The design shall take account of appropriate safety factors to cover snatch lifting.

5.3.3 Attachments and any other features on the outer surface of the package that could be used to lift it shall be designed either to support its mass in accordance with the requirements of clause 5.3.2, or shall be removable or otherwise rendered incapable of being used during transport.

5.3.4 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.

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

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

5.3.7 The package shall be capable of withstanding the effects of any acceleration, vibration or vibration resonance that may arise under routine conditions of 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.

5.3.8 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.

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

5.3.10 The design of the package shall take into account ambient temperatures and pressures that are likely to be encountered in routine conditions of transport.

5.3.11 A package shall be so designed that it provides sufficient shielding to ensure that, under routine conditions of transport and with the maximum radioactive contents that the package is designed to contain, the radiation level at any point on the external surface of the package would not exceed 5 $\mu Sv.h^{-1}$ for excepted packages [clause 5.5.3.1 6.6 (d)], 2 $mSv.h^{-1}$ at the external surface (clause 6.11.2) and a TI of 10.0 (clause 6.11.3) for other packages and overpacks, as applicable, with account taken of the limits on the radiation levels for loading of freight containers and accumulation of packages, overpacks and freight containers, viz., 2 $mSv.h^{-1}$ at any point on, and 0.1 $mSv.h^{-1}$ at 2 m from, the external surface of the conveyance (clause 6.15.2.3) except for consignments transported under exclusive use by road or rail and the limits for consignments under exclusive use specified in clause 6.15.4.3.

5.3.12 For radioactive material having other dangerous properties, the package design shall take into account those properties (clauses 1.3.5 and 6.4).

5.4 Additional Requirements for Packages Transported By Air

5.4.1 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.

5.4.2 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.

5.4.3 Packages containing radioactive material to be transported by air shall be capable of withstanding, without loss or dispersal of radioactive contents from the containment system, an internal pressure that produces a pressure differential of not less than maximum normal operating pressure plus 95 kPa.

5.4.4 Packages shall be designed taking into consideration the requirement that the quantity of radioactive material in a package shall not exceed the relevant limits for the package type specified in this safety code.

5.5 Excepted Package

5.5.1 Classification as an Excepted Package

A package may be classified as an excepted package if it meets one of the following conditions:

(a) It is an empty package having contained radioactive material
(b) It contains instruments or articles not exceeding the activity limits specified in Table-V
(c) It contains articles manufactured of natural uranium, depleted uranium or natural thorium
(d) It contains radioactive material not exceeding the activity limits specified in Table-V
(e) It contains less than 0.1 kg of uranium hexafluoride not exceeding the activity limits specified in column 4 of Table-V.

TABLE-V
ACTIVITY LIMITS FOR EXCEPTED PACKAGES

Physical State	Instrument or Article		Materials
of Contents	**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	$2 \times 10^{-2}\ A_2$	$2 \times 10^{-1}\ A_2$	$2 \times 10^{-2}\ A_2$
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 clauses 3.3.3 to 3.3.5

5.5.2 Restrictions on Contents of an Excepted Packages

5.5.2.1 Radioactive material that is enclosed in or is included as a component part of an instrument or other manufactured article, may be classified under UN 2911, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE — INSTRUMENTS OR ARTICLES, 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 $mSv.h^{-1}$.

(b) Each instrument or article bears the marking 'RADIOACTIVE' on its external surface except for the following:

(i) Radioluminescent timepieces or devices do not require markings.

(ii) Consumer products that have either received regulatory approval or do not individually exceed the activity limit for an exempt consignment in Table-I (column 5) do not require markings, provided that such products are transported in a package that bears the marking 'RADIOACTIVE' on its internal surface in such a manner that a warning of the presence of radioactive material is visible on opening the package.

(iii) Other instruments or articles too small to bear the marking 'RADIOACTIVE' do not require markings, provided that they are transported in a package that bears the marking 'RADIOACTIVE' on its internal surface in such a manner that a warning of the presence of radioactive material is visible on opening the package.

(c) The active material is completely enclosed by non-active components (a device performing the sole function of containing radioactive material shall not be considered to be an instrument or manufactured article).

(d) The limits specified in columns 2 and 3 of Table-V are met for each individual item and package, respectively.

(e) For transport by post, the total activity in each excepted package shall not exceed one tenth of the relevant limits specified in column 3 of Table-V.

5.5.2.2 Radioactive material in forms other than as specified in clause 5.5.2.1 and with an activity not exceeding the limits specified in column 4 of Table-V may be classified under UN 2910, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE — LIMITED QUANTITY OF MATERIAL, provided that:

(a) The package retains its radioactive contents under routine conditions of transport.
(b) The package bears the marking 'RADIOACTIVE' on either:
  (i) an internal surface in such a manner that a warning of the presence of radioactive material is visible on opening the package; or
  (ii) the outside of the package, where it is impractical to mark an internal surface.
(c) For transport by post, the total activity in each excepted package shall not exceed one tenth of the relevant limits specified in column 4 of Table-V.

5.5.2.3 Uranium hexafluoride not exceeding the limits specified in column 4 of Table-V may be classified under UN 3507 URANIUM HEXAFLUORIDE, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, less than 0.1 kg per package, non-fissile or fissile-excepted, provided that:

(a) The mass of uranium hexafluoride in the package is less than 0.1 kg.
(b) The conditions of clauses 4.7.2, 5.5.2.2 (a) and 5.5.2.2 (b) are met.

5.5.2.4 Articles manufactured of natural uranium, depleted uranium or natural thorium and articles in which the sole radioactive material is unirradiated natural uranium, unirradiated depleted uranium or unirradiated natural thorium may be classified under UN 2909, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE — ARTICLES MANUFACTURED FROM NATURAL URANIUM or DEPLETED URANIUM or NATURAL THORIUM, provided that the outer surface of the uranium or thorium is enclosed in an inactive sheath made of metal or some other substantial material.

5.5.2.5 An empty packaging that had previously contained radioactive material may be classified under UN 2908, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE — EMPTY PACKAGING, 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 100 times the levels specified in clause 6.5.1.
(d) Any labels that may have been displayed on it in conformity with the applicable labelling requirements specified in clause 6.13.3.1 are no longer visible.

5.5.3 Requirements for Excepted Package

For the design of an excepted package, the general requirements for all packages (clause 5.3) and, if carried by air, the additional requirements for packages transported by air (clause 5.4).

5.6 Industrial Packages

5.6.1 Requirements for Type IP-1

A Type IP-1 package shall be designed to meet the above-specified general requirements for all packages (clause 5.3) in addition to the requirement that the smallest overall external dimension of the package shall not be less than 10 cm and the additional requirements for packages transported by air (clause 5.4), if carried by air.

5.6.2 Requirements for Type IP-2

A package to be qualified as Type IP-2 shall be designed to meet the requirements for Type IP-1 and, in addition, if it were subjected to the free drop test (clause 5.8.4.3) and the stacking test (clause 5.8.4.4), it would prevent:

(a) Loss or dispersal of the radioactive contents
(b) More than a 20% increase in the maximum radiation level at any external surface of the package.

5.6.3 Requirements for Type IP-3

A package to be qualified as Type IP-3 shall be designed to meet the requirements for Type IP-1 and, in addition, the requirements for Type A packages (clauses 5.8.3.2 to 5.8.3.15), except those for containing liquid and gaseous radioactive material (clauses 5.8.3.16 to 5.8.3.17).

5.6.4 Alternative Requirements for Type IP-2 and Type IP-3

5.6.4.1 Packages may be used as Type IP-2, provided that:

(a) They satisfy the requirements for Type IP-1 (clause 5.6.1).
(b) They are designed to satisfy the requirements prescribed for UN Packing Group I or II in Chapter 6.1 of the United Nations Recommendations on the Transport of Dangerous Goods, Model Regulations [2].
(c) When subjected to the tests required for UN Packing Group I or II, they would prevent.
    (i) Loss or dispersal of the radioactive contents.
    (ii) More than a 20% increase in the maximum radiation level at any external surface of the package.

5.6.4.2 Portable Tanks may also be used as Type IP-2 or Type IP-3, provided that:

(a) They satisfy the requirements for Type IP-1 (clause 5.6.1).
(b) They are designed to satisfy the requirements prescribed in Chapter 6.7 of the United Nations Recommendations on the Transport of Dangerous Goods, Model Regulations [2], or other requirements, at least equivalent, and are capable of withstanding a test pressure of 265 kPa.
(c) They are designed so that any additional shielding that is provided shall be capable of withstanding the static and dynamic stresses resulting from handling and routine conditions of transport and of preventing more than a 20% increase in the maximum radiation level at any external surface of the portable tanks.

5.6.4.3 Tanks, other than portable tanks, may also be used as Type IP-2 or Type IP-3 for transporting LSA-I and LSA-II liquids and gases as prescribed in TableVI, provided that:

(a) They satisfy the requirements for Type IP-1 (clause 5.6.1).
(b) They are designed to satisfy the requirements prescribed in regional or national regulations for the transport of dangerous goods and are capable of withstanding a test pressure of 265 kPa.
(c) They are designed so that any additional shielding that is provided shall be capable of withstanding the static and dynamic stresses resulting from handling and routine conditions of transport and of preventing more than a 20% increase in the maximum radiation level at any external surface of the tanks.

TABLE-VI

INDUSTRIAL PACKAGE REQUIREMENTS FOR LSA MATERIAL AND SCO

Radioactive Contents	**Industrial Package Type**	
	Exclusive Use	**Not Under Exclusive Use**
LSA-I		
Solid[a]	Type IP-1	Type IP-1
Liquid	Type IP-1	Type IP-2
LSA-II		
Solid	Type IP-2	Type IP-2
Liquid and gas	Type IP-2	Type IP-3
LSA-III	Type IP-2	Type IP-3
SCO-I[a]	Type IP-1	Type IP-1
SCO-II	Type IP-2	Type IP-2

[a] Under the conditions specified in clauses 6.7.5 and 6.8.5, LSA-I material and SCO-I may be transported unpackaged.

5.6.4.4 Freight Containers with the characteristics of a permanent enclosure may also be used as Type IP-2 or Type IP-3, provided that:

(a) The radioactive contents are restricted to solid materials.
(b) They satisfy the requirements for Type IP-1 (clause 5.6.1).
(c) They are designed to conform to the International Organization for Standardization document ISO 1496/1: Series 1 Freight Containers: Specifications and Testing — Part 1: General Cargo Containers for General Purposes [11] excluding dimensions and ratings. They shall be designed such that if subjected to the tests prescribed in that document and to the accelerations occurring during routine conditions of transport they would prevent:

(i) loss or dispersal of the radioactive contents; and
(ii) more than a 20% increase in the maximum radiation level at any external surface of the freight containers.

5.6.4.5 Metal IBCs may also be used as Type IP-2 or Type IP-3, provided that:

(a) They satisfy the requirements for Type IP-1(clause 5.6.1).
(b) They are designed to satisfy the requirements prescribed for UN Packing Group I or II in Chapter 6.5 of the United Nations Recommendations on the Transport of Dangerous Goods, Model Regulations [2], and if they were subjected to the tests prescribed in that document, but with the drop test conducted in the most damaging orientation, they would prevent:
(i) loss or dispersal of the radioactive contents; and
(ii) more than a 20% increase in the maximum radiation level at any external surface of the IBC.

5.7 Packages Containing Uranium Hexafluoride

5.7.1 Packages designed to contain uranium hexafluoride shall meet the requirements that pertain to the radioactive and fissile properties of the material prescribed elsewhere in this safety code.

5.7.2 Except as allowed in clause 5.7.3, uranium hexafluoride in quantities of 0.1 kg or more shall meet the requirements specified in clauses 5.7.2.1 to 5.7.2.3.

5.7.2.1 Uranium hexafluoride in quantities of 0.1 kg or more shall be packaged and transported in accordance with the provisions of the International Organization for Standardization document ISO 7195: Packaging of Uranium Hexafluoride (UF_6) for Transport [10].

5.7.2.2 Each package designed to contain 0.1 kg or more of uranium hexafluoride shall be so designed so that it will withstand:

(a) without leakage and without unacceptable stress, as specified in ISO 7195 [10], the structural test as specified in this safety code (The specimen shall be tested hydraulically at an internal pressure of at least 1.38 MPa, but when the test pressure is less than 2.76 MPa, the design shall require multilateral approval. For retesting packaging, any other equivalent non-destructive testing may be applied, subject to multilateral approval), except as allowed in p clause 5.7.3;
(b) without loss or dispersal of the uranium hexafluoride, the free drop test (clause 5.8.4.3) specified for normal conditions of transport in this safety code;
(c) without rupture of the containment system, the thermal test specified in this safety code (clause 5.9.4.3.2), except as allowed in p clause 5.7.3.

5.7.2.3 Packages designed to contain 0.1 kg or more of uranium hexafluoride shall not be provided with pressure relief devices.

5.7.3 Multilateral approval shall be required for the transport of packages, containing 0.1 kg or more of uranium hexafluoride that are designed:

(a) To international or national standards other than ISO 7195 [10], provided an equivalent level of safety is maintained; and/or
(b) To withstand, without leakage and without unacceptable stress, a test pressure of less than 2.76 MPa as specified in the structural test (clause 5.7.4); and/or
(c) To contain 9000 kg or more of uranium hexafluoride and the packages do not meet the requirement of clause 5.7.2.2(c).

In all other respects, the requirements specified in clauses 5.7.1 and 5.7.2 shall be satisfied.

5.7.4 Test for Packaging Designed to Contain Uranium Hexafluoride- Structural Test

Specimens that comprise or simulate packaging designed to contain 0.1 kg or more of uranium hexafluoride shall be tested hydraulically at an internal pressure of at least 1.38 MPa, but when the test pressure is less than 2.76 MPa, the design shall require multilateral approval. For retesting packaging, any other equivalent non-destructive testing may be applied, subject to multilateral approval.

5.8 Type A package

5.8.1 Classification as Type A package

Packages containing radioactive material may be classified as Type A packages provided that the conditions of clause 5.8.2 are met.

5.8.2 Restrictions on the Contents of Type A Packages

5.8.2.1 Type A packages shall not contain activities greater than either of the following:

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

5.8.2.2 For mixtures of radionuclides whose identities and respective activities are known, the following condition shall apply to the radioactive contents of a Type A package:

$$\sum_i \{B(i)/A_1(i)\} + \sum_j \{C(j)/A_2(j)\} \leq 1 \text{…….(4)}$$

where

B(i) is the activity of radionuclide i as special form radioactive material,
$A_1(i)$ is the A_1value for radionuclide i;
C(j) is the activity of radionuclide j as other than special form radioactive material,
$A_2(j)$ is the A_2 value for radionuclide j.

5.8.3 Requirements for Type A Packages

5.8.3.1 Type A packages shall be designed to meet the above-specified general requirements for all packaging and packages (clause 5.3) and, further, the additional requirements for packages transported by air, if carried by air (clause 5.4) and of the clauses 5.8.3.2 to 5.8.3.17 below:

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

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

5.8.3.4 Any tie-down attachments on the package shall be so designed that, under normal and accident conditions of transport, the forces in those attachments shall not impair the ability of the package to meet the requirements of this safety code.

5.8.3.5 The design of the package shall take into account temperatures ranging from –40°C to +70°C for the components of the packaging. Attention shall be given to freezing temperatures for liquids and to the potential degradation of packaging materials within the given temperature range.

5.8.3.6 The design and manufacturing techniques shall be in accordance with national or international standards, or other requirements, acceptable to the Competent Authority.

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

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

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

5.8.3.10 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.

5.8.3.11 The containment system shall retain its radioactive contents under a reduction of ambient pressure to 60 kPa.

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

5.8.3.13 A radiation shield that 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 that is independent of any other packaging structure.

5.8.3.14 A package shall be so designed that if it were subjected to the tests for demonstrating ability to withstand normal conditions of transport specified in this section (clauses 5.8.4.1 to 5.8.4.5), it would prevent:

(a) loss or dispersal of the radioactive contents; or
(b) more than a 20% increase in the maximum radiation level at any external surface of the package.

5.8.3.15 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.

5.8.3.16 A Type A package designed to contain liquid radioactive material shall, in addition:

(a) be adequate to meet the conditions specified in clause 5.8.3.14 (a) if the package is subjected to the tests specified in clause 5.8.4.6; and

(b) either:

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

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

5.8.3.17 A package designed for gases shall prevent loss or dispersal of the radioactive contents if the package were subjected to the tests specified in clause 5.8.4.6. A Type A package designed for tritium gas or for noble gases shall be excepted from this requirement.

5.8.4 Tests for Demonstrating Ability to Withstand Normal Conditions of Transport

5.8.4.1 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 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 2 h if the water spray is applied from four directions simultaneously. No time interval shall elapse, if the water spray is applied from each of the four directions consecutively.

5.8.4.2 ***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 1 h.

5.8.4.3 ***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-VII for the applicable mass. The target shall be as defined in clause 5.2.

(b) 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.

(c) 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.

TABLE-VII

FREE DROP DISTANCE FOR TESTING PACKAGES

TO NORMAL CONDITIONS OF TRANSPORT

Package Mass (kg)	Free Drop Distance (m)
Package mass < 5000	1.2
5 000 ≤Package mass< 10 000	0.9
10 000 ≤Package mass< 15 000	0.6
15 000 ≤Package mass	0.3

5.8.4.4 ***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 maximum weight of the package
(b) The equivalent of 13 kPa 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 typically rest.

5.8.4.5 ***Penetration Test*****:** The specimen shall be placed on a rigid, flat, horizontal surface that will not move significantly while the test is being carried out:

(a) A bar 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.

5.8.4.6 Additional Tests for Type A Packages Designed for Liquids and Gases

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 above (clause 5.2).
(b) ***Penetration Test***: The specimen shall be subjected to the test specified in clause 5.8.4.5, except that the height of the drop shall be increased to 1.7 m from the 1 m specified in clause 5.8.4.5 (b).

5.9 Type B(U), Type B(M) or Type C Package

5.9.1 Classification as Type B(U), Type B(M) or Type C Package

Type B(U), Type B(M) and Type C packages shall be classified in accordance with the Competent Authority certificate of approval for the package issued by the country of origin of design.

5.9.2 Restrictions on the contents of Type B(U) or Type B(M) or Type C Package

5.9.2.1 The contents of a Type B(U), Type B(M) or Type C package shall be as specified in the certificate of approval.

5.9.2.2 Type B(U) and Type B(M) packages, if transported by air, shall meet the requirements of clause 5.9.2.1, and shall not contain activities greater than the following:

(a) For low dispersible radioactive material — as authorised for the package design and specified in the certificate of approval
(b) For special form radioactive material — $3000A_1$ or 10^5A_2, whichever is the lower
(c) For all other radioactive material — $3000A_2$.

5.9.3 **Requirements for Type B(U) Packages**

5.9.3.1 Type B(U) packages shall be designed to meet the above-specified general requirements for all packagings and packages (clause 5.3) and, further, the additional requirements for packages transported by air, if carried by air (clause 5.4), and of the clauses 5.8.3.2 to 5.8.3.15 above, except as specified in clause 5.8.3.14, and, in addition, the requirements specified in clauses 5.9.3.2 to 5.9.3.15 below.

5.9.3.2 A package shall be so designed that, under the ambient conditions specified in clauses 5.9.3.5 and 5.9.3.6, heat generated within the package by the radioactive contents shall not, under normal conditions of transport, as demonstrated by the tests for demonstrating ability to withstand normal conditions of transport specified in clause 5.8.4.1 to 5.8.4.5, 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 that may cause one or more of the following:

(a) Alteration of 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
(b) Lessening the efficiency of the packaging through differential thermal expansion, or cracking or melting of the radiation shielding material
(c) Acceleration of corrosion when combined with moisture.

5.9.3.3 A package shall be so designed that, under the ambient condition specified in clause 5.9.3.5, and in the absence of insolation, the temperature of the accessible surfaces of a package shall not exceed 50°C, unless the package is transported under exclusive use.

5.9.3.4 Except as required in clause 5.4.1 for a package transported by air, the maximum temperature of any surface readily accessible during transport of a package under exclusive use shall not exceed 85°C in the absence of insolation under the ambient condition specified in clause 5.9.3.5, taking into account barriers or

screens intended to give protection to persons without the need for the barriers or screens being subject to any test, as appropriate.

5.9.3.5 The ambient temperature shall be assumed to be 38°C.

5.9.3.6 The solar insolation conditions shall be assumed to be as specified in Table-VIII

TABLE-VIII

INSOLATION DATA

Case	Form and Location of Surface	Insolation for 12 h per day ($W.m^{-2}$)
1	Flat surfaces transported horizontally — downward facing	0
2	Flat surfaces transported horizontally — upward facing	800
3	Surfaces transported vertically	200[a]
4	Other downward facing (not horizontal) surfaces	200[a]
5	All other 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.

5.9.3.7 A package that includes thermal protection for the purpose of satisfying the requirements of the thermal test (clause 5.9.4.3.2) shall be so designed that such protection will remain effective if the package is subjected to the tests for demonstrating ability to withstand normal conditions of transport (clauses 5.8.4.1 to 5.8.4.5) and the mechanical test [clauses 5.9.4.3.1 (a) and 5.9.4.3.1 (b) or 5.9.4.3.1 (b) and 5.9.4.3.1 (c)]. Any such protection on the exterior of the package shall not be rendered ineffective by ripping, cutting, skidding, abrading or rough handling.

5.9.3.8 A package shall be so designed that if it were subjected to:

(a) The tests for demonstrating ability to withstand normal conditions of transport specified in clauses 5.8.4.1 to 5.8.4.5, it would restrict the loss of radioactive contents to not more than $10^{-6}A_2$ per hour.

(b) The tests specified in clauses 5.9.4.3, 5.9.4.3.1(b), 5.9.4.3.2 and 5.9.4.3.3 and either the test in:

— clause 5.9.4.3.1(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 $1000A_2$ not as special form radioactive material; or

— clause 5.9.4.3.1(a), for all other packages.

(i) It would retain sufficient shielding to ensure that the radiation level at 1 m from the surface of the package would not exceed 10 $mSv.h^{-1}$ with the maximum radioactive contents that the package is designed to contain.

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

Where mixtures of different radionuclides are present, the provisions of Section 3 shall apply, except that for krypton-85 an effective A_2(i) value equal to $10A_2$ may be used. For case (a), the assessment shall take into account the external contamination limits of clause 6.5.1.

5.9.3.9 A package for radioactive contents with activity greater than 10^5A_2 shall be so designed that if it were subjected to the enhanced water immersion test (clause 5.9.4.3.4), there would be no rupture of the containment system.

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

5.9.3.11 A package shall not include a pressure relief system from the containment system that would allow the release of radioactive material to the environment under the conditions of the tests specified in clauses 5.8.4.1 to 5.8.4.5, 5.9.4.3 and 5.9.4.3.1 to 5.9.4.3.3.

5.9.3.12 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 clauses 5.8.4.1 to 5.8.4.5, 5.9.4.3 and 5.9.4.3.1 to 5.9.4.3.3, the levels of strains in the containment system would not attain values that would adversely affect the package in such a way that it would fail to meet the applicable requirements.

5.9.3.13 A package shall not have a maximum normal operating pressure in excess of a gauge pressure of 700 kPa.

5.9.3.14 A package containing low dispersible radioactive material shall be so designed that any features added to the low dispersible radioactive material that are not part of it, or any internal components of the packaging, shall not adversely affect the performance of the low dispersible radioactive material.

5.9.3.15 A package shall be designed for an ambient temperature range of –40°C to +38°C.

5.9.4 **Requirements For Type B(M) Packages**

5.9.4.1 Type B(M) packages shall meet the requirements for Type B(U) packages specified in clause 5.9.3.1, except that for packages to be transported solely within a specified country or solely between specified countries, conditions other than those given in clauses 5.8.3.5, 5.9.3.4 to 5.9.3.6 and 5.9.3.9 to 5.9.3.15 may be assumed with the approval of the Competent Authorities of these countries. Notwithstanding, the requirements for Type B(U) packages specified in clauses 5.9.3.4 and 5.9.3.9 to 5.9.3.15 shall be met as far as practicable.

5.9.4.2 Intermittent venting of Type B(M) packages may be permitted during transport, provided that the operational controls for venting are acceptable to the Competent Authority.

5.9.4.3 Tests for demonstrating ability to withstand accident conditions of transport

The specimen shall be subjected to the cumulative effects of the mechanical test and the thermal test specified in this section, (clauses 5.9.4.3.1 and 5.9.4.3.2), 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, specified below (clause 5.9.4.3.3) and, if applicable, the enhanced water immersion test (clause 5.9.4.3.4).

5.9.4.3.1 ***Mechanical Test***: The mechanical test consists of three different drop tests.

Each specimen shall be subjected to the applicable drops, as specified in clause 5.9.3.8 or 5.10.8. 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 maximum damage in the thermal test that follows:

(a) **For drop-I**, the specimen shall drop onto the target so as to suffer 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 clause 5.2.

(b) **For drop-II**, the specimen shall drop onto a bar rigidly mounted perpendicularly on the target so as to suffer maximum damage. The height of the drop measured from the intended point of impact of the specimen to the upper surface 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 edge rounded off to a radius of not more than 6 mm. The target on which the bar is mounted shall be as defined in clause 5.2.

(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 × 1 m and shall fall in a horizontal attitude. The lower face of the steel plate shall have its edges and corners rounded off to a radius of not more than 6 mm. 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 clause 5.2.

5.9.4.3.2 ***Thermal Test***: The specimen shall be in thermal equilibrium under conditions of an ambient temperature of 38°C, subject to the solar insolation conditions specified in Table-VIII and subject to the design maximum rate of internal heat generation within the package from the radioactive contents.

Alternatively, any of these parameters are allowed to have different values prior to, and during, the test, provided due account is taken of them in the subsequent assessment of package response. The thermal test shall then consist of (a) followed by (b).

(a) Exposure of a specimen for a period of 30 min to a thermal environment that provides a heat flux at least equivalent to that of a hydrocarbon fuel–air fire in sufficiently quiescent ambient conditions to give a minimum average flame emissivity coefficient of 0.9 and an average temperature of at least 800°C, fully engulfing the specimen, with a surface absorptivity coefficient

of 0.8 or that value that the package may be demonstrated to possess if exposed to the fire specified.

(b) Exposure of the specimen to an ambient temperature of 38°C, subject to the solar insolation conditions specified in Table-VIII and subject to the design maximum rate of internal heat generation within the package by the radioactive contents for a sufficient period to ensure that temperatures in the specimen are everywhere decreasing and/or are approaching initial steady state conditions. Alternatively, any of these parameters are allowed to have different values following cessation of heating, provided due account is taken of them in the subsequent assessment of package response.

During and following the test, the specimen shall not be artificially cooled and any combustion of materials of the specimen shall be permitted to proceed naturally.

5.9.4.3.3 ***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 8 h in the attitude that will lead to maximum damage. For demonstration purposes, an external gauge pressure of at least 150 kPa shall be considered to meet these conditions.

5.9.4.3.4 **Enhanced Water Immersion Test** for Type B(U) and Type B(M) packages containing more than $10^5 A_2$ and Type C packages

The specimen shall be immersed under a head of water of at least 200 m for a period of not less than 1 h. For demonstration purposes, an external gauge pressure of at least 2 MPa shall be considered to meet these conditions.

5.9.5 **Requirements for Type C Packages**

5.9.5.1 Type C packages shall be designed to meet the requirements specified in clauses 5.3.and 5.4 and 5.8.3.2 to 5.8.3.15, except as specified in clause 5.8.3.14), and the requirements specified in clauses 5.9.3.2 to 5.9.3.6, 5.9.3.10 to 5.9.3.15 and 5.9.5.2 to 5.9.5.4.

5.9.5.2 A package shall be capable of meeting the assessment criteria prescribed for tests in clauses 5.9.3.8(b) and 5.9.3.12 after burial in an environment defined by a thermal conductivity of 0.33 W/(m·K) and a temperature of 38°C in the steady state. Initial conditions for the assessment shall assume that any thermal insulation of the package remains intact, the package is at the maximum normal operating pressure and the ambient temperature is 38°C.

5.9.5.3 A package shall be so designed that if it were at the maximum normal operating pressure and subjected to:

(a) The tests specified in clauses 5.8.4.1 to 5.8.4.5, it would restrict the loss of radioactive contents to not more than $10^{-6} A_2$ per hour.

(b) The test sequences in clause 5.9.5.5:

(i) It would retain sufficient shielding to ensure that the radiation level 1 m from the surface of the package would not exceed 10 $mSv.h^{-1}$ with the maximum radioactive contents that the package is designed to contain.

(ii) It would restrict the accumulated loss of radioactive contents in a period of one week to not more than $10A_2$ for krypton-85 and not more than A_2 or all other radionuclides.

Where mixtures of different radionuclides are present, the provisions of clauses 3.3.3 to 3.3.5 shall apply, except that for krypton-85 an effective A_2(i) value equal to $10A_2$ may be used. For case (a), the assessment shall take into account the external contamination limits of clause 6.5.1.

5.9.5.4 A package shall be so designed that there will be no rupture of the containment system following performance of the enhanced water immersion test (clause 5.9.4.3.4).

5.9.5.5 **Tests for Type C Packages**

Specimens shall be subjected to the effects of the following test sequences:

(a) The tests specified in clauses 5.9.4.3.1(a), 5.9.4.3.1(c), 5.9.5.5.1 and 5.9.5.5.2 in this order;
(b) The test specified in clause 5.9.5.5.3

Separate specimens are allowed to be used for the sequence in (a) and for (b).

5.9.5.5.1 ***Puncture–tearing Test***: The specimen shall be subjected to the damaging effects of a vertical solid probe made of mild steel. The orientation of the package specimen and the impact point on the package surface shall be such as to cause maximum damage at the conclusion of the test sequence specified above in clause 5.9.5.5(a):

(a) The specimen, representing a package having a mass of less than 250 kg, shall be placed on a target and subjected to a probe having a mass of 250 kg falling from a height of 3 m above the intended impact point. For this test the probe shall be a 20 cm diameter cylindrical bar with the striking end forming the frustum of a right circular cone with the following dimensions: 30 cm height and 2.5 cm diameter at the top with its edge rounded off to a radius of not more than 6 mm. The target on which the specimen is placed shall be as specified in clause 5.2.
(b) For packages having a mass of 250 kg or more, the base of the probe shall be placed on a target and the specimen dropped onto the probe. The height of the drop, measured from the point of impact with the specimen to the upper surface of the probe, shall be 3 m. The probe for this test shall have the same properties and dimensions as specified in (a), except that the length and mass of the probe shall be such as to cause maximum damage to the specimen. The target on which the base of the probe is placed shall be as specified in clause 5.2.

5.9.5.5.2 ***Enhanced Thermal Test***: The conditions for this test shall be as specified in clause 5.9.4.3.2, except that the exposure to the thermal environment shall be for a period of 60 minutes.

5.9.5.5.3 ***Impact Test***: The specimen shall be subjected to an impact on a target at a velocity of not less than 90 m/s, at such an orientation as to suffer maximum damage. The target shall be as defined in clause 5.2, except that the target surface may be at any orientation as long as the surface is normal to the specimen path.

5.10 **Packages Containing Fissile Material**

5.10.1 Fissile material shall be transported so as to:

(a) Maintain sub-criticality during routine, normal and accident conditions of transport; in particular, the following contingencies shall be considered:
  (i) Leakage of water into or out of packages
  (ii) Loss of efficiency of built-in neutron absorbers or moderators
  (iii) Rearrangement of the contents either within the package or as a result of loss from the package
  (iv) Reduction of spaces within or between packages
  (v) Packages becoming immersed in water or buried in snow
  (vi) Temperature changes.

(b) Meet the requirements:
  (i) Of clause 5.8.3.2, except for unpackaged material when specifically allowed by clause 4.6.1.1(e)
  (ii) Prescribed elsewhere in the provisions of this safety code that pertain to the radioactive properties of the material
  (iii) Of clause 5.8.3.3, unless the material is excepted by clause 4.6.1.1
  (iv) Of clauses 5.10.4 to 5.10.9, unless the material is excepted by clause 4.6.1.1, 5.10.2 or 5.10.3.

5.10.2 Packages containing fissile material that meets the requirements of sub-para. 5.10.2(d) below and one of the provisions of sub-paras 5.10.2(a) to (c) below are excepted from the requirements of clauses 5.10.4 to 5.10.9.

(a) Packages containing fissile material in any form provided that:
  (i) The smallest external dimension of the package is not less than 10 cm.
  (ii) The Criticality Safety Index (CSI) of the package is calculated using the following formula:

$$CSI = 50 \times 5 \times \{[\text{mass of uranium-235 in package (g)}]/Z + [\text{mass of other fissile nuclides in package (g)}]/280\}^{1}$$

  where the values of Z are taken from Table-IX.
  (iii) The CSI of any package does not exceed 10.

(b) Packages containing fissile material in any form provided that:
  (i) The smallest external dimension of the package is not less than 30 cm.
  (ii) The package, after being subjected to the tests specified in clauses 5.8.4.1 to 5.8.4.5:

  — Retains its fissile material contents
  — Preserves the minimum overall outside dimensions of the package to at least 30 cm
  — Prevents the entry of a 10 cm cube.

  (iii) The CSI of the package is calculated using the following formula:

$$CSI = 50 \times 2 \times \{[\text{mass of uranium-235 in package (g)}]/Z + [\text{mass of other fissile nuclides in package (g)}] / 280\}$$

  where the values of Z are taken from Table IX.

[1]Plutonium may be of any isotopic composition provided that the amount of plutonium-241 is less than that of plutonium-240 in the package.

(iv) The CSI of any package does not exceed 10.

(c) Packages containing fissile material in any form provided that:

(i) The smallest external dimension of the package is not less than 10 cm.

(ii) The package, after being subjected to the tests specified in clauses 5.8.4.1 to 5.8.4.5:

— Retains its fissile material contents

— Preserves the minimum overall outside dimensions of the package to at least 10 cm

— Prevents the entry of a 10 cm cube.

(iii) The CSI of the package is calculated using the following formula:

$$CSI = 50 \times 2 \times \{[\text{mass of uranium-235 in package (g)}]/450 + [\text{mass of other fissile nuclides in package (g)}]/280\}$$

(iv) The maximum mass of fissile nuclides in any package does not exceed 15 g.

(d) The total mass of beryllium, hydrogenous material enriched in deuterium, graphite and other allotropic forms of carbon in an individual package shall not be greater than the mass of fissile nuclides in the package except where their total concentration does not exceed 1 g in any 1000 g of material.

Beryllium incorporated in copper alloys up to 4% by weight of the alloy does not need to be considered.

TABLE -IX

VALUES OF Z FOR CALCULATION OF CSI ACCORDING TO CLAUSE 5.10.2

Enrichment[a]	**Z**
Uranium enriched up to 1.5 %	2200
Uranium enriched up to 5 %	850
Uranium enriched up to 10 %	660
Uranium enriched up to 20 %	580
Uranium enriched up to 100 %	450

[a] If a package contains uranium with varying enrichments of U-235, then the value corresponding to the highest enrichment value shall be used for Z.

5.10.3 Packages containing not more than 1000 g of plutonium are excepted from the application of clauses 5.10.4 to 5.10.9 provided that:

(a) Not more than 20% of the plutonium by mass is fissile nuclides.

(b) The CSI of the package is calculated using the following formula:
CSI = 50 × 2 × [mass of plutonium (g)/1000]

(c) If uranium is present with the plutonium, the mass of uranium shall be no more than 1% of the mass of the plutonium.

5.10.4 Contents Specification for Assessments of Package Designs Containing Fissile Material

5.10.4.1 Where the chemical or physical form, isotopic composition, mass or concentration, moderation ratio or density, or geometric configuration is not known, the assessments of clauses 5.10.6 to 5.10.8 shall be performed assuming that each parameter that is not known has the value that gives the maximum neutron multiplication consistent with the known conditions and parameters in these assessments.

5.10.4.2 For irradiated nuclear fuel, the assessments of clauses 5.10.6 to 5.10.8 shall be based on an isotopic composition demonstrated to provide either:

(a) The maximum neutron multiplication during the irradiation history; or

(b) A conservative estimate of the neutron multiplication for the package assessments. After irradiation but prior to shipment, a measurement shall be performed to confirm the conservatism of the isotopic composition.

5.10.5 Geometry and Temperature Requirements

5.10.5.1 The package, after being subjected to the tests specified in clauses 5.8.4.1 to 5.8.4.5, shall:

(a) Preserve the minimum overall outside dimensions of the package to at least 10 cm

(b) Prevent the entry of a 10 cm cube.

5.10.5.2 The package shall be designed for an ambient temperature range of –40°C to +38°C unless the Competent Authority specifies otherwise in the certificate of approval for the package design.

5.10.6 Assessment of an Individual Package in Isolation

5.10.6.1 For a package 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 error, absence of leakage may be assumed in respect of those void spaces. Special features shall include either of the following:

(a) Multiple high standard water barriers, not less than two of which would remain watertight if the package were subject to the tests prescribed in clause 5.10.8(b), a high degree of quality control in the manufacture, maintenance and repair of packaging, and tests to demonstrate the closure of each package before each shipment; or

(b) For packages containing uranium hexafluoride only, with a maximum uranium enrichment of 5 mass per cent uranium-235:

(i) Packages where, following the tests prescribed in clause 5.10.8(b), there is no physical contact between the valve and any other component of the packaging other than at its original point of attachment and where, in addition, following the thermal test prescribed in clause 5.9.4.3.2, the valves remain leak-tight

(ii) A high degree of quality control in the manufacture, maintenance and repair of packaging, coupled with tests to demonstrate closure of each package before each shipment.

5.10.6.2 It shall be assumed that the confinement system is closely reflected by at least 20 cm of water or such greater reflection as may additionally be provided by the surrounding material of the packaging. However, when it can be demonstrated that the confinement system remains within the packaging following the tests prescribed in clause 5.10.8(b), close reflection of the package by at least 20 cm of water may be assumed in clause 5.10.6.3(c).

5.10.6.3 The package shall be subcritical under the conditions of clauses 5.10.6.1 and 5.10.6.2 and with the package conditions that result in the maximum neutron multiplication consistent with:

(a) Routine conditions of transport (incident free)
(b) The tests specified in clause5.10.7(b)
(c) The tests specified in clause 5.10.8(b).

5.10.6.4 For packages to be transported by air:

(a) The package shall be subcritical under conditions consistent with the Type C package tests specified in clause 5.9.5.5, assuming reflection by at least 20 cm of water but no water in-leakage.
(b) In the assessment of clause 5.10.6.3, allowance shall not be made for special features of clause 5.10.6.1, unless, following the Type C package tests specified in clause 5.9.5.5, and subsequently, with the water in-leakage test (clause 5.10.10.3), leakage of water into or out of the void spaces is prevented.

5.10.7 Assessment of Package Arrays under Normal Conditions of Transport

A number N shall be derived, such that five times N packages shall be subcritical for the arrangement and package conditions that provide the maximum neutron multiplication consistent with the following:

(a) There shall not be anything between the packages, and the package arrangement shall be reflected on all sides by at least 20 cm of water.
(b) The state of the packages shall be their assessed or demonstrated condition if they had been subjected to the tests specified in clauses 5.8.4.1 to 5.8.4.5.

5.10.8 Assessment of Package Arrays under Accident Conditions of Transport

A number N shall be derived, such that two times N packages shall be subcritical for the arrangement and package conditions that provide the maximum neutron multiplication consistent with the following:

(a) Hydrogenous moderation between the packages and the package arrangement reflected on all sides by at least 20 cm of water.

(b) The tests for demonstrating ability to withstand normal conditions of transport specified in clauses 5.8.4.1 to 5.8.4.5 followed by whichever of the following is the more limiting:

(i) The mechanical test specified in clause 5.9.4.3.1(b) and either 5.9.4.3.1(c) for packages having a mass not greater than 500 kg and an overall density not greater than 1000 $kg.m^{-3}$ based on the external dimensions or clause 5.9.4.3.1(a) for all other packages, followed by the thermal test specified in clause 5.9.4.3.2, and completed by the water leakage tests for packages containing fissile material specified in clause 5.10.10; or

(ii) The water immersion test (clause 5.9.4.3.3).

(c) Where any part of the fissile material escapes from the containment system following the tests specified in sub-para. (b) above, it shall be assumed that fissile material escapes from each package in the array and that all of the fissile material shall be arranged in the configuration and moderation that results in the maximum neutron multiplication with close reflection by at least 20 cm of water.

5.10.9 Determination of Criticality Safety Index for Packages

The CSI for packages containing fissile material shall be obtained by dividing the number 50 by the smaller of the two values of N derived in clauses 5.10.7 and 5.10.8 (i.e. CSI = 50/N). The value of the CSI may be zero, provided that an unlimited number of packages are subcritical (i.e. N is effectively equal to infinity in both cases).

5.10.10 Water Leakage Test for Packages Containing Fissile Material

5.10.10.1 Packages for which water in-leakage or out-leakage to the extent that results in greatest reactivity has been assumed for purposes of assessment under clauses 5.10.6 to 5.10.8 shall be excepted from the test.

5.10.10.2 Before the specimen is subjected to the water leakage test specified below, it shall be subjected to the tests in clause 5.9.4.3.1(b) and either 5.9.4.3.1(a) or (c), as required by clause 5.10.8 and the thermal test (clause 5.9.4.3.2).

5.10.10.3 The specimen shall be immersed under a head of water of at least 0.9 m for a period of not less than 8 h and in the attitude for which maximum leakage is expected.

6. REQUIREMENTS AS TO CONTROLS FOR TRANSPORT

6.1 Requirements before the First Shipment

Before a packaging is first used for transport of radioactive material, it shall be confirmed by the consignor that it has been manufactured in conformity with the design specifications to ensure compliance with the relevant provisions of this safety code and any applicable certificate of approval. The following requirements shall also be fulfilled, if applicable:

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

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

(c) Each Type B(U), Type B(M) and Type C package incorporating the approved radioactive content and activity or equivalent thermal load shall be held until equilibrium conditions have been approached closely enough to demonstrate compliance with the requirements for temperature and pressure, unless an exemption from these requirements has received unilateral approval.

(d) For each packaging intended to contain fissile material, it shall be ensured that the effectiveness of the criticality safety features is within the limits applicable to or specified for the design, and in particular where, in order to comply with the requirements of clause 5.10.1, neutron poisons are specifically included, checks shall be performed to confirm the presence and distribution of those neutron poisons.

6.2 Requirements before Each Shipment

Before each shipment of any package, it shall be ensured by the consignor that:

(a) the package contains neither:
  (i) radionuclides different from those specified for the package design, nor
  (ii) contents in a form, or physical or chemical state, different from those specified for the package design,

(b) all the requirements specified in the relevant provisions of this safety code, and in the applicable certificates of approval have been fulfilled, and the following requirements, if applicable, are also fulfilled:
  (i) It shall be ensured that lifting attachments that do not meet the requirements of clause 5.3.2 have been removed or otherwise rendered incapable of being used for lifting the package, in accordance with clause 5.3.3.
  (ii) For each Type B(U), Type B(M) and Type C package, it shall be ensured by inspection and/or appropriate tests that all closures, valve 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 clauses 5.9.3.8 and 5.9.5.3 were made.

(iii) For packages containing fissile material, the measurement specified in clause 5.10.4.2 (b) and the tests to demonstrate closure of each package as specified in clause 5.10.6.1 shall be performed.

For packages requiring leak-tightness, compliance with the relevant requirements of this safety code shall be demonstrated as may be specified by the Competent Authority.

6.3 Transport of Other Goods

6.3.1 A package shall not contain any items other than those that are necessary for the use of the radioactive material. The interaction between these items and the package, under the conditions of transport applicable to the design, shall not reduce the safety of the package.

6.3.2 Freight containers, IBCs, tanks, as well as other packaging and overpacks, used for the transport of radioactive material shall not be used for the storage or transport of other goods unless decontaminated below the level of 0.4 $Bq.cm^{-2}$ for beta and gamma emitters and low toxicity alpha emitters and 0.04 $Bq.cm^{-2}$ for all other alpha emitters.

6.3.3 Consignments shall be segregated from other dangerous goods during transport 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 cognisant transport organisations, as well as the provisions of this safety code.

6.4 Other Dangerous Properties of Contents

In addition to the radioactive and fissile 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 the provisions of this safety code.

6.5 Requirements and Controls for Contamination and for Leaking Packages

6.5.1 The non-fixed contamination on the external surfaces of any package shall be kept as low as practicable and, under routine conditions of transport, shall not exceed the following limits:

(a) 4 $Bq.cm^{-2}$ for beta and gamma emitters and low toxicity alpha emitters
(b) 0.4 $Bq.cm^{-2}$ for all other alpha emitters.

These limits are applicable when averaged over any area of 300 cm^2 of any part of the surface.

6.5.2 The level of non-fixed contamination on the external and internal surfaces of overpacks, freight containers, tanks, IBCs and conveyances shall not exceed the above limits (clause 6.5.1), except as provided in clause 6.5.7.

6.5.3 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 assessment shall include the package, the conveyance, the adjacent loading and unloading areas and, if necessary, all other material that has been carried in the conveyance. When necessary, additional steps for the protection of persons, property and the environment, in accordance with provisions established by the relevant Competent Authority, shall be taken to overcome and minimize the consequences of such leakage or damage.

6.5.4 Packages that are damaged or leaking radioactive contents in excess of allowable limits for normal conditions of transport shall be removed, under supervision, to an interim location permitted by the Competent Authority but shall not be forwarded until repaired or reconditioned and decontaminated.

6.5.5 A conveyance and equipment used regularly for the transport 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 transported.

6.5.6 Except as provided in clause 6.5.7, any conveyance, or equipment or part thereof that has become contaminated above the limits specified in clause 6.5.1 in the course of the transport of radioactive material, or that shows a radiation level in excess of 5 $\mu Sv.h^{-1}$ at the surface, shall be decontaminated as soon as possible by a qualified person and shall not be reused unless the following conditions are fulfilled:

(a) The non-fixed contamination shall not exceed the limits specified in para. 6.5.1.
(b) The radiation level resulting from the fixed contamination shall not exceed 5 $\mu Sv.h^{-1}$ at the surface.

6.5.7 A freight container, tank, IBC or conveyance dedicated to the transport of unpackaged radioactive material under exclusive use shall be excepted from the requirements of clauses 6.5.2 and 6.5.6 solely with regard to its internal surfaces and only for as long as it remains under that specific exclusive use.

6.6 Requirements and Controls for the Transport of Excepted Packages

Excepted packages shall be subject to the following provisions:

(a) The requirements specified in clauses 6.2 and 6.3.1, 6.3.2 , 6.4, 6.5.1 to 6.5.6, 6.13.1, 6.13.2.1 to 6.13.2.3, 6.14.1, the introductory sentence of 6.14.2, 6.14.2 (a), 6.14.2 (k), 6.14.3.4 to 6.14.3.7, 6.14.4.2, 6.14.4.3, 6.14.6, 6.15.2.1, 6.16, 6.17;
(b) The design requirements for excepted packages specified in clause 5.5.3.2;
(c) The requirements specified in clauses 6.15.7.1 and 6.15.7.2, if transported by post.
(d) The radiation level at any point on the external surface of an excepted package shall not exceed 5 μSv/h.

All relevant provisions of the other sections shall apply to excepted packages. If the excepted package contains fissile material, one of the fissile exceptions provided by clause 4.6.1.1 shall apply.

6.7 Requirements and Controls for Transport of LSA Material in Industrial Packages or Unpackaged

6.7.1 The radioactive contents in a single package of LSA material 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 $mSv.h^{-1}$ and the activity in a single package shall also be

so restricted that the activity limits for a conveyance specified in Table-X shall not be exceeded.

TABLE-X

CONVEYANCE ACTIVITY LIMITS FOR LSA MATERIAL AND SCO IN INDUSTRIAL PACKAGES OR UNPACKAGED

Nature of Material	Activity Limit for Conveyances other than by Inland Waterway	Activity Limit for a Hold or Compartment of an Inland Waterway Craft
LSA-I	No limit	No limit
LSA-II and LSA-III non-combustible solids	No limit	$100A_2$
LSA-II and LSA-III combustible solids, and all liquids and gases	$100A_2$	$10A_2$
SCO	$100A_2$	$10A_2$

6.7.2 A single package of non-combustible solid LSA-II or LSA-III material, if carried by air, shall not contain an activity greater than $3000A_2$.

6.7.3 For LSA material that are or contain fissile material that is not excepted under clause 4.6.1.1, the applicable requirements of clauses 6.15.3.1 and 6.15.3.2 shall be met.

6.7.4 For LSA material that are or contain fissile material, the applicable requirements of clause 5.10.1 shall be met.

6.7.5 LSA-I may be transported, unpackaged, under the following conditions:

(a) All unpackaged material other than ores containing only naturally occurring radionuclide's shall be transported in such a manner that under routine conditions of transport there will be no escape of the radioactive contents from the conveyance nor will there be any loss of shielding.

(b) Unpackaged fissile material shall meet the requirement of clause 4.6.1.1(e).

6.7.6 LSA materials, except as otherwise specified in clause 6.7.5, shall be packaged in accordance with Table-VI.

6.7.7 The total activity in a single hold or compartment of an inland waterway craft, or in another conveyance, for carriage of LSA material in a Type IP-1, Type IP-2, Type IP-3 package or unpackaged, shall not exceed the limits shown in Table-X.

6.8 Requirements and Controls for Transport of SCO in Industrial Packages or Unpackaged

6.8.1 The activity in a single package shall also be so restricted that the activity limits for a conveyance specified in Table X shall not be exceeded.

6.8.2 The quantity of SCO in a single Type IP-1, Type IP-2, Type IP-3 package, or object or collection of objects, whichever is appropriate, shall be so restricted that the external radiation level at 3 m from the unshielded material or object or collection of objects does not exceed 10 $mSv.h^{-1}$.

6.8.3 For SCO that contain fissile material that is not excepted under clause 4.6.1.1, the applicable requirements of clauses 6.15.3.1 and 6.15.3.2 shall be met.

6.8.4 For SCO that are or contain fissile material, the applicable requirements of clause 5.10.1 shall be met.

6.8.5 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 routine conditions of transport there will be no escape of the radioactive contents from the conveyance nor will there be any loss of shielding.
(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 10 times the applicable level specified in the definition of contamination.
(c) For SCO-I where it is suspected that non-fixed contamination exists on inaccessible surfaces in excess of the values specified in clause 4.3.2, measures shall be taken to ensure that the radioactive material is not released into the conveyance.
(d) Unpackaged fissile material shall meet the requirement of clause 4.6.1.1(e).

6.8.6 SCO, except as otherwise specified in clause 6.8.5, shall be packaged in accordance with Table-VI.

6.8.7 The total activity in a single hold or compartment of an inland waterway craft, or in another conveyance, for carriage of SCO in a Type IP-1, Type IP-2, Type IP-3 package or unpackaged, shall not exceed the limits shown in Table-X.

6.9 Determination of Transport Index (TI)

6.9.1 The TI for a package, overpack or 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 in units of millisieverts per hour ($mSv.h^{-1}$) at a distance of 1 m from the external surfaces of the package, overpack, freight container or unpackaged LSA-I and SCO-I. The value determined shall be multiplied by 100 and the resulting number is the TI. For uranium and thorium ores and their concentrates, the maximum radiation level at any point 1 m from the external surface of the load may be taken as:
(i) 0.4 $mSv.h^{-1}$ for ores and physical concentrates of uranium and thorium,
(ii) 0.3 $mSv.h^{-1}$ for chemical concentrates of thorium, and
(iii) 0.02 $mSv.h^{-1}$ for chemical concentrates of uranium, other than uranium hexafluoride.

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

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

TABLE-XI

MULTIPLICATION FACTORS FOR TANKS, FREIGHT CONTAINERS, AND UNPACKAGED LSA-I AND SCO-I

Size of Load[a]	Multiplication Factor
size of load $\leq 1\ m^2$	1
$1\ m^2 <$ size of load $\leq 5\ m^2$	2
$5\ m^2 <$ size of load $\leq 20\ m^2$	3
$20\ m^2 <$ size of load	10

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

6.9.2 The TI for each overpack, freight container or conveyance shall be determined as either the sum of the TIs of all the packages contained, or by direct measurement of radiation level, except in the case of non-rigid overpacks, for which the TI shall be determined only as the sum of the TIs of all the packages.

6.10 Determination of Criticality Safety Index for Consignments, Freight Containers and Overpacks

The criticality safety index (CSI) for each overpack or freight container shall be determined as the sum of the CSIs of all the packages contained. The same procedure shall be followed for determining the total sum of the CSIs in a consignment or aboard a conveyance.

6.11 Limits on Transport Index, Criticality Safety Index and Radiation Levels for Packages and Overpacks

6.11.1 Except for consignments under exclusive use, the TI of any package or overpack shall not exceed 10, nor shall the CSI of any package or overpack exceed 50.

6.11.2 Except for packages or overpacks transported under exclusive use by rail or by road under the conditions specified in clause 6.15.4.3 (a), or under exclusive use and special arrangement by vessel or by air under the conditions specified in clause 6.15.5.1 or 6.15.6.3, respectively, the maximum radiation level at any point on the external surface of a package or overpack shall not exceed 2 $mSv.h^{-1}$.

6.11.3 The maximum radiation level at any point on the external surface of a package or overpack under exclusive use shall not exceed 10 $mSv.h^{-1}$.

6.12 Categories

Packages, overpacks and freight containers shall be assigned to either category I-WHITE, II-YELLOW or III-YELLOW in accordance with the conditions specified in Table XII and with the following requirements:

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

(b) The TI shall be determined following the provisions specified in clause 6.9.

(c) If the surface radiation level is greater than 2 $mSv.h^{-1}$, the package or overpack shall be transported under exclusive use and under the provisions of clauses 6.15.4.3 (a), 6.15.5.1 or 6.15.6.3, as appropriate.

(d) A package transported under a special arrangement shall be assigned to category III-YELLOW except that, in the case of international transport, the categorization shall be in accordance with the approval certificate issued by the Competent Authority of the country of origin of the design of the package.

(e) An overpack or freight container that contains packages transported under special arrangement shall be assigned to category III-YELLOW except that, in the case of international transport, the categorisation shall be in accordance with the approval certificate issued by the Competent Authority of the country of origin of the design of the package.

TABLE-XII

CATEGORIES OF PACKAGES, OVERPACKS AND FREIGHT CONTAINERS

Conditions		**Category**
TI	Maximum radiation level at any point on external surface	
0[a]	Not more than 0.005 $mSv.h^{-1}$	I-WHITE
More than 0 but not more than 1[a]	More than 0.005 $mSv.h^{-1}$ but not more than 0.5 $mSv.h^{-1}$	II-YELLOW
More than 1 but not more than 10	More than 0.5 $mSv.h^{-1}$ but not more than 2 $mSv.h^{-1}$	III-YELLOW
More than 10	More than 2 $mSv.h^{-1}$ but not more than 10 $mSv.h^{-1}$	III-YELLOW [b]

[a] If the measured TI is not greater than 0.05, the value quoted may be zero in accordance with clause 6.9.1(c).

[b] Shall also be transported under exclusive use except for freight containers.

6.13 Marking, Labelling and Placarding

6.13.1 For each package or overpack, the applicable UN number and proper shipping name shall be appropriately determined. In all cases of international transport of packages requiring Competent Authority's approval of design or shipment, for which different approval types apply in the different countries concerned by the shipment. The UN number, proper shipping name, categorisation, labelling and marking shall be in accordance with the certificate of the country of origin of design.

6.13.2 Marking

6.13.2.1 Each package shall be legibly and durably marked on the outside of the packaging with an identification of either the consignor or consignee, or both. Each overpack shall be legibly and durably marked on the outside of the overpack with an identification of either the consignor or consignee, or both, unless these markings of all the packages within the overpack are clearly visible.

6.13.2.2 Each package shall be legibly and durably marked on the outside with the UN marking as specified in Table-XIII. Additionally, each overpack shall be legibly and durably marked with the word 'OVERPACK' and the UN marking as specified in Table-XIII unless all the markings of the packages within the overpack are clearly visible.

6.13.2.3 Each package of gross mass exceeding 50 kg shall have its permissible gross mass legibly and durably marked on the outside of the packaging.

6.13.2.4 Each package that conforms to:

(a) An IP-1, IP-2 or IP-3 design shall be legibly and durably marked on the outside of the packaging with 'TYPE IP-1', 'TYPE IP-2' or 'TYPE IP-3', as appropriate.

(b) A Type A package design shall be legibly and durably marked on the outside of the packaging with 'TYPE A'.

(c) An IP-2, IP-3 or a Type A package design shall be legibly and durably marked on the outside of the packaging with the international vehicle registration code (VRI Code) IND for India or of the country of origin of design, if other than India, and either the name of the manufacturer or other identification of the packaging specified by the Competent Authority of the country of origin of design.

TABLE-XIII
UN MARKING FOR PACKAGES AND OVERPACKS

Item	UN Marking[a]
Package (other than an excepted package)	UN number, preceded by the letters 'UN', and the proper shipping name
Excepted package (other than those in consignments accepted for international movement by post)	UN number, preceded by the letters 'UN'
Overpack (other than an overpack containing only excepted packages)	UN number, preceded by the letters 'UN' for each applicable UN number in the overpack, followed by the proper shipping name in the case of a non-excepted package
Overpack containing only excepted packages (other than consignments accepted for international movement by post)	UN number, preceded by the letters 'UN' for each applicable UN number in the overpack
Consignment accepted for international movement by post	The requirement of clause 6.15.7.2

[a] See Table-II for listing of UN number and proper shipping name.

6.13.2.5 Each package that conforms to a design approved under one or more provisions of this safety code (clauses 7.4.1, 7.4.2.1, 7.4.2.2, 7.4.3.1, 7.4.3.2, 7.4.4.1 and 7.4.4.2) and under provisions for transitional arrangements (clause 7.6.2.1) shall be legibly and durably marked on the outside of the packaging with the following information:

(a) The identification mark allocated to that design by the Competent Authority

(b) A serial number to identify uniquely each packaging that conforms to that design

(c) 'TYPE B(U)', 'TYPE B(M)' or 'TYPE C', in the case of a Type B(U),Type B(M) or Type C package design.

6.13.2.6 Each package that conforms to a Type B(U), Type B(M) or Type C package design shall have on the outside of the outermost receptacle, that it 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.

6.13.2.7 Where LSA-I or SCO-I material is contained in receptacles or wrapping materials and is transported under exclusive use, as permitted by clauses 6.7.5 and 6.8.5, the outer surface of these receptacles or wrapping materials may bear the marking 'RADIOACTIVE LSA-I' or 'RADIOACTIVE SCO-I', as appropriate.

6.13.3 Labelling

6.13.3.1 Each package, overpack and freight container shall bear the labels conforming to the applicable models in Figs 2 to 4, except as allowed under the alternative provisions of clause 6.13.6.1 for large freight containers and tanks, according to the appropriate category. In addition, each package, overpack and freight container containing fissile material, other than fissile material excepted under the provisions of clause 4.6.1.1, shall bear labels conforming to the model in Fig. 5. Any labels that do not relate to the contents shall be removed or covered. For radioactive material having other dangerous properties, see clause 6.4.

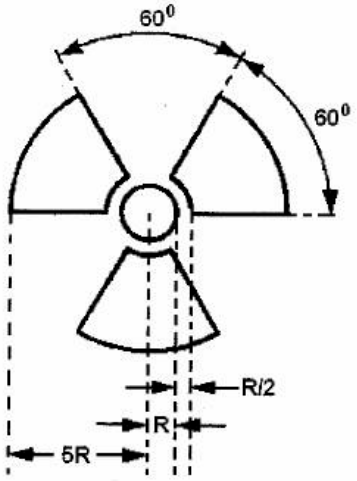

Fig. 1.
Radiation Symbol for Radioactive Sources

Fig. 1 shows the basic trefoil symbol with proportions based on a central circle of radius R. The minimum allowable size of R shall be 4 mm.

6.13.3.2 The labels conforming to the applicable models in Figs 2 to 4 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. The labels conforming to the model in Fig. 5, where applicable, shall be affixed adjacent to the labels conforming to the applicable models in Figs 2 to 4. The labels shall not cover the markings specified above in this section (clauses 6.13.2.1 to 6.13.2.6).

6.13.4 Labelling for Radioactive Contents

Each label conforming to the applicable models in Figs 2 to 4 shall be completed with the following information:

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.

(a) Contents:

(i) Except for LSA-I material, the name(s) of the radionuclide(s) 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 following the name(s) of the radionuclide(s). The terms 'LSA-II', 'LSA-III', 'SCO-I' and 'SCO-II' shall be used for this purpose.

(ii) For LSA-I material, 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) with the appropriate SI prefix symbol. For fissile material, the total mass of fissile nuclides in units of grams (g), or multiples thereof, may be used in place of activity.

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

(d) TI: The number determined in accordance with the provisions of clause 6.9 (no TI entry is required for Category I-WHITE).

FIG. 3. CATEGORY II-YELLOW LABEL. THE BACKGROUND COLOUR OF THE UPPER HALF OF THE LABEL SHALL BE YELLOW AND 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.

FIG. 4. CATEGORY III-YELLOW LABEL. THE BACKGROUND COLOUR OF THE UPPER HALF OF THE LABELSHALL BE YELLOW AND 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.

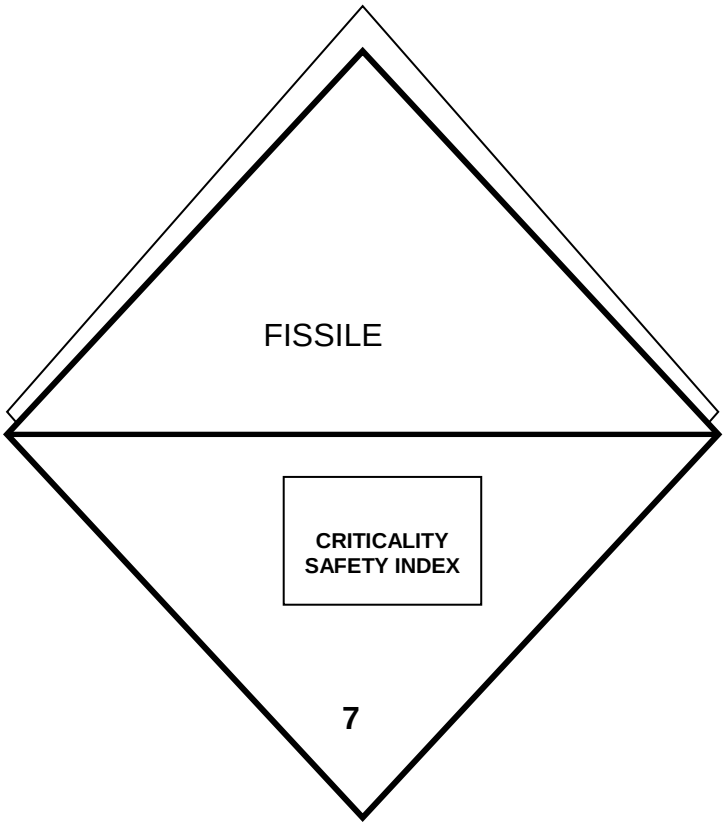

FIG. 5. CSI LABEL. THE BACKGROUND COLOUR OF THE LABEL SHALL BE WHITE, THE COLOUR OF THE PRINTING SHALL BE BLACK.

6.13.5 Labelling for Criticality Safety

6.13.5.1 Each label conforming to the model in Fig. 5 shall be completed with the CSI as stated in the certificate of approval applicable in the countries through or into which the consignment is transported and issued by the Competent Authority or as specified in clauses 5.10.2 or 5.10.3.

6.13.5.2 For overpacks and freight containers, the label conforming to the model in Fig. 5 shall bear the sum of the CSIs of all the packages contained therein.

6.13.6 Placarding

6.13.6.1 Large freight containers carrying packages other than excepted packages, and tanks shall bear four placards that conform to the model given in Fig. 6. The placards shall be affixed in a vertical orientation to each side wall and to each end wall of the large freight container or tank. Any placards that do not relate to the contents shall be removed. Instead of using both labels and placards, it is permitted, as an alternative, to use enlarged labels only, where appropriate, as shown in Figs 2 to 4, except having the minimum size shown in Fig. 6.

6.13.6.2 Where the consignment in the freight container or tank is unpackaged LSA-I or SCO-I or where a consignment in a freight container is required to be shipped under exclusive use and is packaged radioactive material with a single UN number, the appropriate UN number for the consignment (see Table-II) 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. 6 and against the white background; or

(b) On the placard shown in Fig. 7.

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

6.14 Forwarding a Consignment for Transport

6.14.1 Except as otherwise provided in this safety code, the consignor shall ensure that when a radioactive material is forwarded for transport it is properly marked, labelled, placarded, described and certified on a transport document, and otherwise in a condition for transport as required by the provisions of this safety code.

6.14.2 Particulars of Consignment

The consignor shall include in the transport documents with each consignment the identification of the consignor and consignee, including their names and addresses, and the following information, as applicable, in the order given:

(a) The UN number assigned to the material as specified in accordance with the provisions of this safety code, preceded by the letters 'UN' (clauses 3.1 and 6.13.1).

FIG. 6. PLACARD. EXCEPT AS PERMITTED BY CLAUSE 6.15.4.1, MINIMUM DIMENSIONS SHALL BE AS SHOWN; WHEN DIFFERENT DIMENSIONS ARE USED, THE RELATIVE PROPORTIONS SHALL BE MAINTAINED. THE NUMBER '7' SHALL NOT BE LESS THAN 25 mm HIGH. THE BACKGROUND COLOUR OF THE UPPER HALF OF THE PLACARD SHALL BE YELLOW AND 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 UN NUMBER FOR THE CONSIGNMENT.

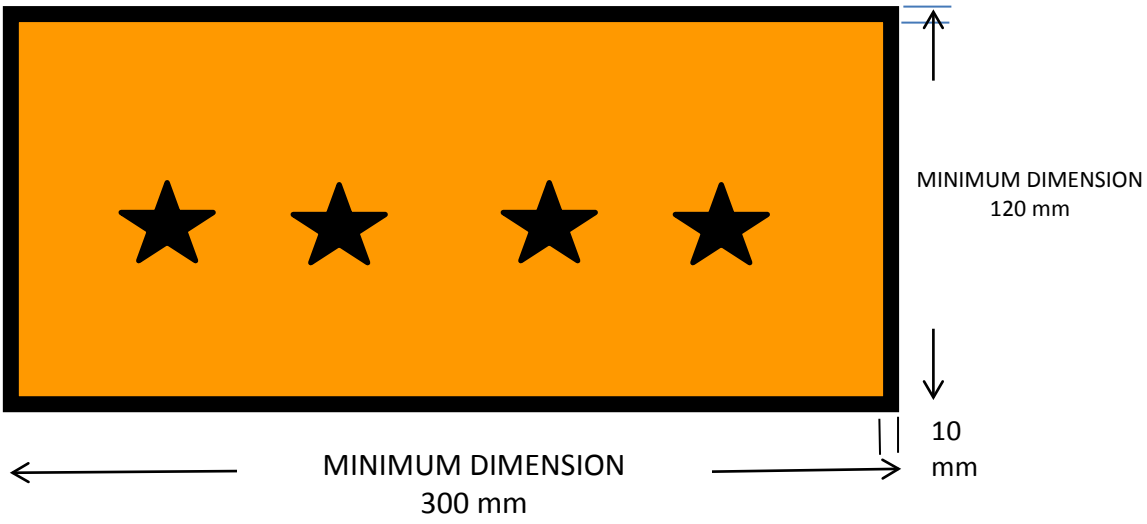

FIG. 7. PLACARD FOR SEPARATE DISPLAY OF UN NUMBER. THE BACKGROUND COLOUR OF THE PLACARD SHALL BE ORANGE AND THE BORDER AND UN NUMBER SHALL BE BLACK. THE SYMBOL '**' DENOTES THE SPACE IN WHICH THE APPROPRIATE UN NUMBER FOR RADIOACTIVE MATERIAL, AS SPECIFIED IN TABLE II, SHALL BE DISPLAYED.**

(b) The proper shipping name, as specified in accordance with the provisions of clauses 3.1 and 6.13.1.
(c) The UN class number '7'.
(d) The subsidiary hazard class or division number(s) corresponding to the subsidiary risk label(s) required to be applied, when assigned, shall be entered following the primary hazard class or division and shall be enclosed in parentheses.
(e) The name or symbol of each radionuclide or, for mixtures of radionuclides, an appropriate general description or a list of the most restrictive nuclides.
(f) A description of the physical and chemical form of the material, or a notation that the material is special form radioactive material or low dispersible radioactive material. A generic chemical description is acceptable for chemical form.
(g) The maximum activity of the radioactive contents during transport expressed in units of becquerels (Bq) with the appropriate SI prefix symbol. For fissile material, the mass of fissile material (or mass of each fissile nuclide for mixtures, when appropriate) in units of grams (g), or appropriate multiples thereof, may be used in place of activity.
(h) The category of the package, i.e. I-WHITE, II-YELLOW, III-YELLOW.
(i) The TI (for categories II-YELLOW and III-YELLOW only).
(j) For fissile material:
    (i) Shipped under one exception of subparagraphs 4.6.1.1(a) to (f), reference to that clause
    (ii) Shipped under clause 4.6.1.1(c) to (e), the total mass of fissile nuclides
    (iii) Contained in a package for which one of clauses 5.10.2(a) to (c) or 5.10.3 is applied, reference to that clause
    (iv) The CSI, where applicable.

(k) The identification mark for each Competent Authority certificate of approval (special form radioactive material, low dispersible radioactive material, fissile material excepted under clause 4.6.1.1 (f), special arrangement, package design or shipment) applicable to the consignment.

(l) For consignments of more than one package, the information contained in sub-paras (a) to (k) above, shall be given for each package. For packages in an overpack, freight container or conveyance, a detailed statement of the contents of each package within the overpack, freight container or conveyance and, where appropriate, of each overpack, freight container or conveyance shall be included. If packages are to be removed from the overpack, freight container or conveyance at a point of intermediate unloading, appropriate transport documents shall be made available.

(m) Where a consignment is required to be shipped under exclusive use, the statement 'EXCLUSIVE USE SHIPMENT'.

(n) For LSA-II, LSA-III, SCO-I and SCO-II, the total activity of the consignment as a multiple of A_2. For radioactive material for which the A_2 value is unlimited, the multiple of A_2 shall be zero.

6.14.3 Consignor's Certification or Declaration

6.14.3.1 The consignor shall include in the transport documents a certification or declaration in the following terms:

'I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name and are classified, packaged, marked and labelled/placarded, and are in all respects in proper condition for transport in accordance with the applicable international and national governmental regulations.'

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

6.14.3.3 The declaration shall be signed and dated by the consignor. Facsimile signatures are acceptable where applicable laws and regulations recognise the legal validity of facsimile signatures.

6.14.3.4 If the dangerous goods documentation is presented to the carrier by means of electronic data processing (EDP) or electronic data interchange (EDI) transmission techniques, the signature(s) may be replaced by the name(s) (in capitals) of the person authorised to sign.

6.14.3.5 When radioactive material, other than when carried in tanks, is packed or loaded into any freight container or vehicle that will be transported by sea, the consignor shall obtain from those responsible for packing the container or vehicle a container/vehicle packing certificate specifying the container/vehicle identification number(s) and certifying that the operation has been carried out in accordance with the applicable conditions of the IMDG Code [3].

6.14.3.6 The information required in the transport documents and the container/vehicle packing certificate may be incorporated into a single document, if not, the documents shall be attached one to the other. If the information is incorporated into a single document, the document shall include a signed declaration such as:

'It is declared that the packing of the goods into the container/vehicle has been carried out in accordance with the applicable provisions'. This declaration shall be dated and the person signing it shall be identified on the document. Facsimile signatures are acceptable where applicable laws and regulations recognise the legal validity of facsimile signatures.

6.14.3.7 The declaration shall be made on the same transport document that contains the particulars of consignment listed in clause 6.14.2.

6.14.4 Information for Carriers

6.14.4.1 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 requirements for loading, stowage, carriage, handling and unloading of the package, overpack or freight container, including any special stowage provisions for the safe dissipation of heat, (clause 6.15.2.2) 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
(d) Action to be taken by the carrier in the event of non-compliance with any limit specified in this safety code applicable to radiation level or contamination observed during transport.

6.14.4.2 The consignor shall retain a copy of each of the transport documents containing the information specified in clauses 6.14.2, 6.14.3.1, 6.14.3.5, 6.14.3.6 and 6.14.4.1, as applicable, for a minimum period of three months. When the documents are kept electronically, the consignor shall be able to reproduce them in a printed form.

6.14.4.3 The consignor shall make the applicable Competent Authority's certificates available to the carrier(s) before loading and unloading.

6.14.5 Notification of Competent Authorities

6.14.5.1 Before the first shipment of any package requiring Competent Authority's approval, the consignor shall ensure that copies of each applicable Competent Authority's certificate applying to that package design have been submitted to the Competent Authority and in the case of international transport, to the relevant 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 Competent Authority.

6.14.5.2 For each shipment listed in (a), (b), (c) or (d) below, the consignor shall notify the Competent Authority and the Competent Authority of each country through or into which the consignment is to be transported. For international transport, this notification shall be in the hands of each Competent Authority prior to the commencement of the shipment at least 7 days in advance. For transport within India, this notification shall be in the hands of the Competent Authority prior to the commencement of the shipment at least 3 days in advance.

(a) Type C packages containing radioactive material with an activity greater than $3000A_1$ or $3000A_2$, as appropriate, or 1000 TBq, whichever is the lower
(b) Type B(U) packages containing radioactive material with an activity greater than $3000A_1$ or $3000A_2$, as appropriate, or 1000 TBq, whichever is the lower
(c) Type B(M) packages
(d) Shipments under special arrangement.

6.14.5.3 The consignment notification shall include:

(a) Sufficient information to enable the identification of the package or packages, including all applicable certificate numbers and identification marks.
(b) Information on the date of shipment, the expected date of arrival and the proposed routing.
(c) The name(s) of the radioactive material(s) or nuclide(s).
(d) Descriptions of the physical and chemical forms of the radioactive material, or whether it is special form radioactive material or low dispersible radioactive material.
(e) The maximum activity of the radioactive contents during transport expressed in units of becquerels (Bq) with the appropriate SI prefix symbol. For fissile material, the mass of fissile material (or the mass of each fissile nuclide for a mixture, when appropriate) in units of grams (g), or multiples thereof, may be used in place of activity.

6.14.5.4 The consignor is not required to send a separate notification if the required information has been included in the application for approval of shipment (clause 7.8.3).

6.14.6 Possession of Certificates and Instructions

The consignor shall have in his/her possession a copy of each certificate required under Section 7 of this safety code 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.

6.15 Transport and Storage in Transit

6.15.1 Segregation during Transport and Storage in Transit

6.15.1.1 Packages, overpacks and freight containers containing radioactive material and unpackaged radioactive material shall be segregated during transport and during storage in transit:

(a) From workers in regularly occupied working areas by distances calculated using a dose criterion of 5 mSv in a year and conservative model parameters
(b) From members of the public in areas where the public has regular access by distances calculated using a dose criterion of 1 mSv in a year and conservative model parameters
(c) From undeveloped photographic film by distances calculated using a radiation exposure criterion for undeveloped photographic film due to the transport of radioactive material of 0.1 mSv per consignment of such film

(d) From other dangerous goods in accordance with clause 6.3.3.

6.15.1.2 Category I- WHITE, Category II-YELLOW or III-YELLOW packages or overpacks shall not be carried in compartments occupied by passengers, except those exclusively reserved for couriers specially authorised to accompany such packages or overpacks.

6.15.2 Stowage during Transport and Storage in Transit

6.15.2.1 Consignments shall be securely stowed.

6.15.2.2 Provided that its average surface heat flux does not exceed 15 $W.m^{-2}$ and that the immediate surrounding cargo is not in sacks or bags, a package or overpack may be carried or stored among packaged general cargo without any special stowage provisions except as may be specifically required by the Competent Authority in an applicable certificate of approval.

6.15.2.3 Loading of freight containers and accumulation of packages, overpacks and freight containers shall be controlled as follows:

(a) Except under the condition of exclusive use, and for consignments of LSA-I material, the total number of packages, overpacks and freight containers aboard a single conveyance shall be so limited that the sum of the TIs aboard the conveyance does not exceed the values shown in Table-XIII.
(b) The radiation level under routine conditions of transport shall not exceed 2 $mSv.h^{-1}$ at any point on, and 0.1 $mSv.h^{-1}$ at 2 m from, the external surface of the conveyance, except for consignments transported under exclusive use by road or rail, for which the radiation limits around the vehicle are set forth in this section in clauses 6.15.4.3(b) and 6.15.4.3(c).
(c) The sum of the CSIs in a freight container and aboard a conveyance shall not exceed the values shown in Table-XV.

6.15.2.4 Any package or overpack having a TI greater than 10, or any consignment having a CSI greater than 50, shall be transported only under exclusive use.

6.15.3 Additional Requirements relating to Transport and Storage in Transit of Fissile Material

6.15.3.1 Any group of packages, overpacks and freight containers containing fissile material stored in transit in any one storage area shall be so limited that the sum of the CSIs in the group does not exceed 50. Each group shall be stored so as to maintain a spacing of at least 6 m from other such groups.

6.15.3.2 Where the sum of the CSIs on board a conveyance or in a freight container exceeds 50, as permitted in Table-XV, storage shall be such as to maintain a spacing of at least 6 m from other groups of packages, overpacks or freight containers containing fissile material or other conveyances carrying radioactive material.

6.15.3.3 Fissile material meeting one of the provisions (a) to (f) of clause 4.6.1.1 shall meet the following requirements:

(a) Only one of the provisions (a) to (f) of clause 4.6.1.1 is allowed per consignment.

(b) Only one approved fissile material in packages classified in accordance with clause 4.6.1.1(f) is allowed per consignment unless multiple materials are authorized in the certificate of approval.

(c) Fissile material in packages classified in accordance with clause 4.6.1.1 (c) shall be transported in a consignment with no more than 45 g of fissile nuclides.

(d) Fissile material in packages classified in accordance with clause 4.6.1.1(d) shall be transported in a consignment with no more than 15 g of fissile nuclides.

(e) Unpackaged or packaged fissile material classified in accordance with clause 4.6.1.1(e) shall be transported under exclusive use on a conveyance with no more than 45 g of fissile nuclides.

TABLE-XIV

TRANSPORT INDEX LIMITS FOR FREIGHT CONTAINERS AND CONVEYANCES NOT UNDER EXCLUSIVE USE

Type of Freight Container or Conveyance	**Limit on Sum of TIs in a Freight Container or Aboard a Conveyance**
Freight container — Small	50
Freight container — Large	50
Vehicle	50
Aircraft:	
Passenger	50
Cargo	200
Inland waterway craft	50
Seagoing vessel[a]:	
(i) Hold, compartment or defined deck area:	
Packages, overpacks, small freight containers	50
Large freight containers	200
(ii) Total vessel:	
Packages, overpacks, small freight containers	200
Large freight containers	No limit

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[a] Packages or overpacks carried in or on a vehicle which are in accordance with the provisions of clause 6.15.4.3 may be transported by vessels provided that they are not removed from the vehicle at any time while on board the vessel.

6.15.4 Additional Requirements relating to Transport by Rail and by Road

6.15.4.1 Rail and road vehicles carrying packages, overpacks or freight containers labelled with any of the labels shown in Figs 2 to 5, or carrying consignments under exclusive use, shall display the placard shown in Fig. 6 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 large tanks or freight containers, the placards on the tanks or freight containers shall suffice. In the case of vehicles that have insufficient area to allow the fixing of larger placards, the dimensions of the placard described in Fig. 6 may be reduced to 100 mm. Any placards that do not relate to the contents shall be removed.

TABLE-XV

CRITICALITY SAFETY INDEX LIMITS FOR FREIGHT CONTAINERS AND CONVEYANCES CONTAINING FISSILE MATERIAL

Type of Freight Container or Conveyance	**Limit on sum of CSIs in a Freight Container or Aboard a Conveyance**	
	Not under Exclusive Use	**Under Exclusive Use**
Freight container — Small	50	Not applicable
Freight container — Large	50	100
Vehicle	50	100
Aircraft:		
Passenger	50	Not applicable
Cargo	50	100
Inland waterway craft	50	100
Seagoing vessel[a]:		
(i) Hold, compartment or defined deck area:		
Packages, overpacks,		
Small freight containers	50	100
Large freight containers	50	100
(ii) Total vessel:		
Packages, overpacks,		
small freight containers	200[b]	200[c]
Large freight containers	No limit[b]	No limit[c]

[a] Packages or overpacks carried in or on a vehicle which are in accordance with the provisions of clause 6.15.4.3 may be transported by vessels provided that they are not

removed from the vehicle at any time while on board the vessel. In this case the entries under the heading 'under exclusive use' apply.

[b] The consignment shall be so handled and stowed that the sum of CSIs in any 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.

[c] The consignment shall be so handled and stowed that the sum of CSIs in any group does not exceed 100, and that each group is handled and stowed so that the groups are separated from each other by at least 6 m. The intervening space between groups may be occupied by other cargo in accordance with clause 6.3.3.

6.15.4.2 Where the consignment in or on the vehicle is unpackaged LSA-I material or SCO-I or where a consignment is required to be shipped under exclusive use and is packaged radioactive material with a single UN number, the appropriate UN number 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. 6, against the white background; or
(b) On the placard shown in Fig. 7.

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

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

(a) 10 $mSv.h^{-1}$ at any point on the external surface of any package or overpack, and may only exceed 2 $mSv.h^{-1}$ provided that:
  (i) The vehicle is equipped with an enclosure that, during routine conditions of transport, prevents the access of unauthorised persons to the interior of the enclosure.
  (ii) Provisions are made to secure the package or overpack so that its position within the vehicle enclosure remains fixed during routine conditions of transport.
  (iii) There is no loading or unloading during the shipment.
(b) 2 $mSv.h^{-1}$ 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.
(c) 0.1 $mSv.h^{-1}$ 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.

6.15.4.4 In the case of road vehicles, no persons other than the driver and assistants shall be permitted in vehicles carrying packages, overpacks or freight containers bearing category II-YELLOW or III-YELLOW labels.

6.15.5 Additional Requirements relating to Transport by Vessels

6.15.5.1 Packages or overpacks having a surface radiation level greater than 2 $mSv.h^{-1}$, unless being carried in or on a vehicle under exclusive use in accordance with

Table-XIV, footnote (a), shall not be transported by vessel except under special arrangement.

6.15.5.2 The transport of consignments by means of a special use vessel that, 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 for control of loading of freight containers and accumulation of packages, overpacks and freight containers, specified in this section (clause 6.15.2.3) provided that the following conditions are met:

(a) A radiation protection programme for the shipment 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.
(c) The loading, carriage and unloading of the consignments shall be supervised by persons qualified in the transport of radioactive material.

6.15.6 Additional Requirements relating to Transport by Air

6.15.6.1 Type B(M) packages and consignments under exclusive use shall not be transported on passenger aircraft.

6.15.6.2 Vented Type B(M) packages, packages that 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.

6.15.6.3 Packages or overpacks having a surface radiation level greater than 2 $mSv.h^{-1}$ shall not be transported by air except by special arrangement.

6.15.7 Additional Requirements relating to Transport by Post

6.15.7.1 A consignment that conforms to the requirements for excepted packages (clause 6.6), in which the activity of the radioactive contents does not exceed one tenth of the limits prescribed in Table-V, and that does not contain uranium hexafluoride, may be accepted for domestic movement by national postal authorities, subject to such additional requirements as those authorities may prescribe.

6.15.7.2 A consignment that conforms to the requirements for excepted packages (clause 6.6), in which the activity of the radioactive contents does not exceed one tenth of the limits prescribed in Table-V, and that does not contain uranium hexafluoride, 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 Competent 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.

(e) The name and address of the consignor and the contents of the consignment shall be indicated on the internal packaging.

6.16 Customs Operations

Customs operations involving the inspection 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.

6.17 Undeliverable Consignments

Where a consignment is undeliverable, it 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.

6.18 Retention and Availability of Transport Documents by Carriers

6.18.1 A carrier shall not accept a consignment for transport unless:

(a) A copy of the transport document and other documents or information as required by the provisions of this safety code are provided; or

(b) The information applicable to the consignment is provided in electronic form.

6.18.2 The information applicable to the consignment shall accompany the consignment to final destination. This information may be on the transport document or may be on another document. This information shall be given to the consignee when the consignment is delivered.

6.18.3 When the information applicable to the consignment is given to the carrier in electronic form, the information shall be available to the carrier at all times during transport to final destination. The information shall be able to be produced without delay as a paper document.

6.18.4 The carrier shall retain a copy of the transport document and additional information and documentation, as specified in the provisions of this safety code, for a minimum period of three months.

6.18.5 When the documents are kept electronically or in a computer system, the carrier shall be capable of reproducing them in a printed form.

7. APPROVAL AND ADMINISTRATIVE REQUIREMENTS

7.1 General

7.1.1 For package designs where it is not required that a certificate of approval be obtained from the Competent Authority, the consignor shall, on request, make available for inspection by the competent authority, documentary evidence of the compliance of the package design with all the applicable requirements.

7.1.2 Except that Registration shall be required in respect of Type A packagings designed for transporting radioactive material other than fissile material, Competent Authority's approval shall be required for the following:

(a) Designs for:
  (i) Special form radioactive material (clauses 7.2 and 7.6.4)
  (ii) Low dispersible radioactive material (clause 7.2)
  (iii) Fissile material excepted under clause 4.6.1.1(f) (clause 7.3)
  (iv) Packages containing 0.1 kg or more of uranium hexafluoride (clause 7.4.1)
  (v) Packages containing fissile material, unless excepted by clause 4.6.1.1, 5.10.2 or 5.10.3 (clauses 7.4.4 and 7.6.2.1)
  (vi) Type B(U) packages and Type B(M) packages (clauses 7.4.2 to 7.4.3 and 7.6.2.1)
  (vii) Type C packages (clause 7.4.2).
(b) Special arrangements (clause 7.9.1).
(c) Certain shipments (clause 7.8).
(d) Radiation protection programme for special use vessels [clause 6.15.5.2(a)].
(e) Calculation of radionuclide values that are not listed in Table-I [clause 3.3.1(a)].
(f) Calculation of alternative activity limits for an exempt consignment of instruments or articles [clause 3.3.1b)].

The certificates of approval for the package design and the shipment may be combined into a single certificate.

7.2 Approval of Special Form Radioactive Material and Low Dispersible Radioactive Material

The design for special form radioactive material shall require unilateral approval. The design for low dispersible radioactive material shall require multilateral approval. In both the cases, an application for approval shall include:

(a) A detailed description of the radioactive material or, if a capsule, the contents; particular reference shall be made to both physical and chemical states.
(b) A detailed statement of the design of any capsule to be used.
(c) A statement of the tests that have been carried out 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 or low dispersible radioactive material meets the applicable requirements of the provisions of this safety code.
(d) A specification of the applicable management system, as required in clause 2.3.1.
(e) Any proposed pre-shipment actions for use in the consignment of special form radioactive material or low dispersible radioactive material.

7.3 Approval of Material Excepted from Fissile Classification

The design for a fissile material excepted from 'FISSILE' classification in accordance with Table II, under para.4.6.1.1(f) shall require multilateral approval.

An application for approval shall include:

(a) A detailed description of the material; particular reference shall be made to both physical and chemical states.
(b) A statement of the tests that have been carried out and their results, or evidence based on calculative methods, to show that the material is capable of meeting the requirements specified in clause 4.6.2.
(c) A specification of the applicable management system as required in clause 2.3.1.
(d) A statement of specific actions to be taken prior to shipment.

7.4 Approval of Package Designs

7.4.1 Approval of Package Designs to contain Uranium Hexafluoride

The approval of designs for packages containing 0.1 kg or more of uranium hexafluoride requires that:

(a) Each design that meets the requirements of clause 5.7.3 shall require multilateral approval.
(b) Each design that meets the requirements of clauses 5.7.1 and 5.7.2 shall require unilateral approval by the Competent Authority of the country of origin of the design, unless multilateral approval is otherwise required by the provisions of this safety code.
(c) The application for approval shall include all information necessary to satisfy the Competent Authority that the design meets the requirements of clauses 5.7.1, 5.7.2 and 5.7.2.1 and a specification of the applicable management system, as required in clause 2.3.1.

7.4.2 Approval of Type B(U) and Type C Package Designs

7.4.2.1 Each Type B(U) and Type C package design shall require unilateral approval, except that:

(a) A package design for fissile material, which is also subject to clause 7.4.4 ~~and,~~ shall require multilateral approval.
(b) A Type B(U) package design for low dispersible radioactive material shall require multilateral approval.

7.4.2.2 An application for approval shall include:

(a) A detailed description of the proposed radioactive contents with 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 manufacture
(c) A statement of the tests that have been carried out 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 gauge, a specification of the materials of manufacture of the containment system, the samples to be taken and the tests to be made
(f) Where the proposed radioactive contents are irradiated nuclear fuel, the applicant shall state and justify any assumption in the safety analysis relating to the characteristics of the fuel and describe any pre-shipment measurement required by clause 5.10.4.2 (b)
(g) Any special stowage provisions necessary to ensure the safe dissipation of heat from the package considering the various modes of transport to be used and the type of conveyance or freight container
(h) A reproducible illustration, not larger than 21 cm × 30 cm, showing the make-up of the package
(i) A specification of the applicable management system as required in clause 2.3.1.

7.4.3 Approval of Type B(M) Package Designs

7.4.3.1 Each Type B(M) package design, including those for fissile material which are also subject to clause 7.4.4, and those for low dispersible radioactive material, shall require multilateral approval.

7.4.3.2 An application for approval of a Type B(M) package design shall include, in addition to the information required in clause 7.4.2.2 for Type B(U) packages:

(a) A list of the requirements specified in clauses 5.8.3.5, 5.9.3.4 to 5.9.3.6, 5.9.3.9 and 5.9.3.10 to 5.9.3.15 with which the package does not conform
(b) Any proposed supplementary operational controls to be applied during transport not regularly provided for in the provisions of this safety code, but which are necessary to ensure the safety of the package or to compensate for the deficiencies listed in (a)
(c) A statement relative to any restrictions on the mode of transport and to any special loading, carriage, unloading or handling procedures
(d) A statement of the range of ambient conditions (temperature, solar insolation) that are expected to be encountered during transport and which have been taken into account in the design.

7.4.4 Approval of Package Designs to Contain Fissile Material

7.4.4.1 Each package design for fissile material that is not excepted by any of the clauses 4.6.1.1 (a) to (f), 5.10.2 and 5.10.3 shall require multilateral approval.

7.4.4.2 An application for approval shall include all information necessary to satisfy the Competent Authority that the design meets the requirements of clause 5.10.1 and a specification of the applicable management system, as required in clause 2.3.1.

7.5 Approval of Alternative Activity Limits for an Exempt Consignment of Instruments or Articles

Alternative activity limits for an exempt consignment of instruments or articles in accordance with clause 3.3.1 (b) shall require multilateral approval. An application for approval shall include:

(a) An identification and detailed description of the instrument or article, its intended uses and the radionuclide(s) incorporated
(b) The maximum activity of the radionuclide(s) in the instrument or article

(c) Maximum external radiation levels arising from the instrument or article
(d) The chemical and physical forms of the radionuclide(s) contained in the instrument or article
(e) Details of the construction and design of the instrument or article, particularly as related to the containment and shielding of the radionuclide in routine, normal and accident conditions of transport
(f) The applicable management system, including the quality testing and verification procedures to be applied to radioactive sources, components and finished products to ensure that the maximum specified activity of radioactive material or the maximum radiation levels specified for the instrument or article are not exceeded, and that the instruments or articles are constructed according to the design specifications
(g) The maximum number of instruments or articles expected to be shipped per consignment and annually
(h) Dose assessments in accordance with the principles and methodologies recommended by the Competent Authority, including individual doses to transport workers and members of the public and, if appropriate, collective doses arising from routine, normal and accident conditions of transport, based on representative transport scenarios that the consignments are subjected to.

7.6 Transitional Arrangements

7.6.1 Packages not requiring Competent Authority's Approval of Design under the 1985 and 1985 (As Amended 1990) Editions of the IAEA Regulations for the Safe Transport of Radioactive Material

7.6.1.1 Packages not requiring Competent Authority's approval of design (excepted packages, Type IP-1, Type IP-2, Type IP-3 and Type A packages) shall meet the requirements of this safety code in full:

7.6.1.2 Packages that meet the requirements of the 1985 or 1985 (As Amended 1990) Editions of the IAEA Regulations for the Safe Transport of Radioactive Material:

(a) May continue in transport provided that they were prepared for transport prior to 31 December 2003 and are subject to the requirements of clause 7.6.3, if applicable;
(b) May continue to be used, provided that:
  (i) They were not designed to contain uranium hexafluoride.
  (ii) The applicable requirements of clause 2.3.1 of this safety code are applied.
  (iii) The activity limits and classification specified in this safety code are applied.
  (iv) The requirements and controls for transport specified in this safety code are applied.
  (v) The packaging was not manufactured or modified after December 31, 2003.

7.6.2 Packages approved under the 1973, 1973 (As Amended), 1985 and 1985(As Amended 1990) Editions of the IAEA Regulations for the Safe Transport of Radioactive Material

7.6.2.1 Packages requiring Competent Authority's approval of the design shall meet the requirements of this safety code in full unless the following conditions are met:

(a) The packagings were manufactured to a package design approved by the Competent Authority under the provisions of the 1973 or 1973 (As Amended) or the 1985 or 1985 (As Amended 1990) Editions of IAEA Regulations for the Safe Transport of Radioactive Material.
(b) The package design is subject to multilateral approval.
(c) The applicable requirements of clause 2.3.1 of this safety code are applied.
(d) The activity limits and classification specified in this safety code are applied.
(e) The requirements and controls for transport specified in this safety code are applied.
(f) For a package containing fissile material and transported by air, the requirement of clause 5.10.6.4 is met.
(g) For packages that meet the requirements of the 1973 or 1973 (As Amended) Editions of the IAEA Regulations for the Safe Transport of Radioactive Material:
    (i) The packages retain sufficient shielding to ensure that the radiation level at 1 m from the surface of the package would not exceed 10 $mSv.h^{-1}$ in the accident conditions of transport defined in the 1973 Revised or 1973 Revised (As Amended) Editions of the IAEA Regulations for the Safe Transport of Radioactive Material with the maximum radioactive contents which the package is authorized to contain.
    (ii) The packages do not utilize continuous venting.
    (iii) A serial number in accordance with the provision of clause 6.13.2.5 is assigned to and marked on the outside of each packaging.

7.6.2.2 No new manufacture of packagings to a package design meeting the provisions of the 1973, 1973 (As Amended), 1985 and 1985 (As Amended 1990) Editions of the IAEA Regulations for the Safe Transport of Radioactive Material shall be commenced.

7.6.3 Packages excepted from the requirements for fissile material under the 2009 Edition of the IAEA Regulations for the Safe Transport of Radioactive Material

Packages containing fissile material that is excepted from classification as 'FISSILE' according to clause 4.6.1.1 (a) (i) or (iii) of the 2009 Edition of the IAEA Regulations for the Safe Transport of Radioactive Material prepared for transport before December 31, 2014 may continue in transport and may continue to be classified as non-fissile or fissile-excepted except that the consignment limits in Table IV of the 2009 Edition of the IAEA Regulations for the Safe Transport of Radioactive Material shall apply to the conveyance. The consignment shall be transported under exclusive use.

7.6.4 Special form Radioactive Material Approved under the 1973, 1973(As Amended), 1985 and 1985 (As Amended 1990) Editions of the IAEA Regulations for the Safe Transport of Radioactive Material

Special form radioactive material manufactured to a design that had received unilateral approval by the Competent Authority under the 1973, 1973 (As Amended), 1985 or 1985 (As Amended 1990) Editions of the IAEA Regulations

for the Safe Transport of Radioactive Material may continue to be used when in compliance with the mandatory management system in accordance with the applicable requirements of clause 2.3.1. No new manufacture of such special form radioactive material shall be commenced.

7.7 Notification and Registration of Serial Numbers

The Competent Authority shall be informed of the serial number of each packaging manufactured to a design approved under clauses 7.4.2.1, 7.4.3.1, 7.4.4.1 and 7.6.2.1.

7.8 Approval of Shipments

7.8.1 Multilateral approval shall be required for:

(a) The shipment of Type B(M) packages not conforming with the requirements of clause 5.8.3.5 or designed to allow controlled intermittent venting.
(b) The shipment of Type B(M) packages containing radioactive material with an activity greater than $3000A_1$ or $3000A_2$, as appropriate, or 1000 TBq, whichever is the lower.
(c) The shipment of packages containing fissile material if the sum of the CSIs of the packages in a single freight container or in a single conveyance exceeds 50. Excluded from this requirement shall be shipments by seagoing vessels, if the sum of the CSIs does not exceed 50 for any hold, compartment or defined deck area and the distance of 6 m between groups of packages or overpacks, as required in Table XV , is met.
(d) Radiation protection programmes for shipments by special use vessels in accordance with clause 6.15.5.2(a).

7.8.2 Competent Authority may authorise transport through or into its country without shipment approval, by a specific provision in its design approval.

7.8.3 An application for approval of shipment 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
(c) The details of how the precautions and administrative or operational controls, referred to in the certificates of approval for the package design, if applicable, are to be put into effect.

7.9 Approval of Shipments under Special Arrangement

7.9.1 Each consignment transported under special arrangement shall require multilateral approval.

7.9.2 An application for approval of shipments 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 provisions of this safety code had been met.

The application shall also include:

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

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

7.10 Responsibilities of the Designer and the Consignor

7.10.1 It is the responsibility of the designer of radioactive material and designer of package, consignor or their authorised representatives to apply for the necessary approval certificate from the Competent Authority.

7.10.2 The designer and the consignor shall ensure that if the period of validity of such certificates lapses, application for renewal be submitted to the Competent Authority sufficiently in advance, so that domestic and international transport of radioactive material is undertaken with valid certificates only. The approval certificates, as applicable, issued by the Competent Authority conform to the international recommendations.

7.10.3 It is the responsibility of the consignor to ensure that:

(a) the consignee of a radioactive consignment is duly authorised by the Competent Authority if the consignment is imported to India or by the relevant authority if the consignment is being exported from India, to receive the same;

(b) multilateral approval is obtained, as necessary;

(c) the carrier and cargo personnel are adequately instructed, through appropriate and effective means, about their responsibilities as to safe handling of package, accumulation of packages and segregation of packages from workers, public, undeveloped photographic films and other dangerous goods (clause 6.15.1.1) in conveyance and storage-in transit, emergency response actions [clause 2.2 (a)] during transport of storage-in transit and training of personnel (clause 2.6.1) and intimation of non-compliance (clause 2.4) as prescribed in this safety code; and

(d) the consignor shall, prior to the dispatch of the shipment, inform the consignee and confirm that that the consignee is prepared to receive the consignment.

ANNEXURE-I

SUMMARY OF APPROVAL AND PRIOR NOTIFICATION REQUIREMENTS

(Part 1)

Class of Package Or Material	Competent Authority's Approval Required		Consignor Required to Notify Country of Origin and Countries En route[a] of each Shipment
	Country of Origin	Countries En route[a]	
Excepted package[b ,c]	No	No	No
LSA material[c,d,e] and SCO[c,e] – Type IP-1, – Type IP-2 or – Type IP-3	No	No	No
Type A[c,d,e]	No	No	No

Footnotes

[a] Countries through or into which (but not over which) the consignment is transported.

[b] For international transport by post, the *consignment* shall be deposited with the postal service only by *consignors* authorised by the national authority.

[c] If the *radioactive contents* are *fissile material* excepted under para. 4.6.1.1(f) of this safety code, *multilateral approval* shall be required (see clause 7.3 of this safety code).

[d] If the radioactive contents are uranium hexafluoride in quantities of 0.1 kg or more, the approval requirements for packages containing it shall additionally apply (see clauses 7.1.2 and 7.4.1).

[e] If the *radioactive contents* are *fissile material* that is not excepted from the requirements for *packages* containing *fissile material*, then the *approval* requirements in clauses 7.4.4.1 and 7.8.1 of this safety code shall additionally apply.

ANNEXURE-I

SUMMARY OF APPROVAL AND PRIOR NOTIFICATION REQUIREMENTS

(Part 2)

Class of Package or Material	Competent Authority's Approval Required		Consignor Required to Notify Country of Origin and Countries En route[a] of each Shipment
	Country of Origin	Countries En route[a]	
Type B(U)[b,c,d] -Package design - Shipment	Yes No	No[e] No	(see Notes 1 and 2)
Type B(M)[b,c,e] -Package design - Shipment	Yes (see Note 3)	Yes (see Note 3)	Yes (see Note 1)
Type C[b,c,d] – Package design – Shipment	Yes No	No No	(see Notes 1 and 2)

Footnotes

[a] Countries through or into which (but not over which) the consignment is transported.

[b] If the radioactive contents are fissile material that is not excepted from the requirements for packages containing fissile material, then the approval requirements in clauses 7.4.4.1 and 7.8.1 shall additionally apply.

[c] If the radioactive contents are uranium hexafluoride in quantities of 0.1 kg or more, the approval requirements for packages containing it shall additionally apply (see clauses 7.1.2 and 7.4.1).

[d] If the radioactive contents are fissile material excepted under clause 4.6.1.1(f) of this safety code, multilateral approval shall be required (see clause 7.3 of this safety code).

[e] If the radioactive contents are low dispersible radioactive material and the package is to be shipped by air, multilateral approval of the package design is required [see clause 7.4.2.1(b)].

Note 1: Before the first shipment of any package requiring Competent Authority's approval of the design, the consignor shall ensure that a copy of the approval certificate for that design has been submitted to the Competent Authority of each country (see clause 6.14.5.1).

Note 2: Notification required if the radioactive contents exceed $3 \times 10^3 A_1$, or $3 \times 10^3 A_2$, or 1000 TBq, whichever is the lower (see clause 6.14.5.2).

Note 3: Multilateral approval of shipment required if the radioactive contents exceed $3 \times 10^3 A_1$, or $3 \times 10^3 A_2$, or 1000 TBq, whichever is the lower, or if controlled intermittent venting is allowed (see clause 7.8.1).

ANNEXURE-I

SUMMARY OF APPROVAL AND PRIOR NOTIFICATION REQUIREMENTS

(Part 3)

Class of Package Or Material	**Competent Authority's Approval Required**		**Consignor Required to Notify Country of Origin and Countries En route[a] of each Shipment**
	Country of Origin	**Countries En route[a]**	
Packages for Fissile material			
- Package design	Yes[b]	Yes[b]	
- Shipment			
Σ CSI $\leq$ 50	No[c]	No[c]	(see Notes 1 and 2)
Σ CSI > 50	Yes	Yes	(see Notes 1 and 2)
Packages containing 0.1 kg or more of uranium hexafluoride[d]			
- Package design	Yes	Yes for H(M) /No for H(U)[d]	
- Shipment	No[c]	No[c]	(see Notes 1 and 2)

Footnotes

[a] Countries through or into which (but not over which) the consignment is transported.

[b] Designs of packages containing fissile material may also require approval in respect of one of the other items in Annexure-I.

[c] Shipments may, however, require approval in respect of one of the other items in Annexure- I.

[d] If the *radioactive contents* are *fissile material* excepted under clause 4.6.1.1(f) of the Regulations, *multilateral approval* shall be required (see clause 7.1.2 & 7.4.1 of this safety code).

Note 1: The multilateral approval requirement for fissile packages and some uranium hexafluoride packages automatically satisfies the requirement in clause 6.14.5.1.

Note 2: Notification required if the radioactive contents exceed $3 \times 10^3 A_1$, or $3 \times 10^3 A_2$, or 1000 TBq, whichever is the lower (see clause 6.14.5.2).

ANNEXURE- I

SUMMARY OF APPROVAL AND PRIOR NOTIFICATION REQUIREMENTS

(Part 4)

Class of Package Or Material	**Competent Authority's Approval Required**		**Consignor Required to Notify Country of Origin and Countries En route[a] of each Shipment**
	Country of Origin	**Countries En route[a]**	
Special form radioactive material			
– Design	Yes	Yes	No
– Shipment	(see Note 1)	(see Note 1)	(see Note 1)
Low dispersible radioactive material			
– Design	Yes	Yes	No
– Shipment	(see Note 1)	(see Note 1)	(see Note 1)
Special arrangement			
– Shipment	Yes	Yes	Yes
Type B (U) packages for which design is approved under			
1973 Regulations	Yes	Yes	(see Note 2)
1985 Regulations	Yes	Yes	(see Note 2)
Fissile material excepted from 'FISSILE' classification, in accordance with clause 4.6.2	Yes	Yes	No
Exempt consignment of instruments or articles	Yes	Yes	No

Footnotes

[a] Countries through or into which (but not over which) the consignment is transported.

Note 1: See approval and prior notification requirements for applicable package.

Note 2: Before the first shipment of any package requiring Competent Authority's approval of the design, the consignor shall ensure that a copy of the approval certificate for that design has been submitted to the Competent Authority of each country (see clause 6.14.5.1).

ANNEXURE-II

SUMMARY OF CONSIGNMENTS REQUIRING EXCLUSIVE USE

The following consignments are required to be shipped under exclusive use:

(a) Unpackaged LSA-I material and SCO-I (see clauses 6.7.5 and 6.8.5)

(b) Liquid LSA-I material in a Type IP-1 package (see clauses 6.7.6 and 6.8.6 and Table- VI)

(c) Gaseous and/or liquid LSA-II material in a Type IP-2 package (see clauses 6.7.6 and 6.8.6, and Table-VI)

(d) LSA-III material in a Type IP-2 package (see clauses 6.7.6 and 6.8.6, and Table-VI)

(e) Packages or overpacks having an individual TI greater than 10 or a consignment CSI greater than 50 (see clauses 6.11.1 and 6.15.2.4)

(f) Packages or overpacks having the maximum radiation level at any point on the external surfaces that exceed 2 $mSv.h^{-1}$ (see clause 6.11.2)

(g) Loaded conveyance or large freight containers with a total sum of TI exceeding the values given in Table-XIII [see clause 6.15.2.3(a)]

(h) Loaded conveyances or large freight containers with a total sum of CSI exceeding the values given in Table- XV for 'not under exclusive use' (see clause 6.15.3.2)

(i) Type B(U), Type B(M) or Type C package whose temperature of accessible surfaces exceeds 50°C when subject to an ambient temperature of 38°C in the absence of insolation (see clause 5.9.3.3)

(j) Up to 45 g of fissile nuclides on a conveyance, either packaged or unpackaged, in accordance with the provisions of clauses 4.6.1.1(e) and 6.7.5(b), 6.8.5(d)

(k) Packages containing fissile material classified as non-fissile or fissile-excepted under clause 4.6.1.1(a) (i) or (iii) of the 2009 Edition of the IAEA Regulations for the Safe Transport of Radioactive Material (clause 7.6.3).

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LIST OF PARTICIPANTS

Initial draft prepared by:

Dr. A.N. Nandakumar (Consultant)	:	AERB (Former)

COMMITTEE ON SAFE TRANSPORT OF RADIOACTIVE MATERIAL (COSTRAM)

Date(s) of meeting	:	May 12 & 13, 2014

Chairman and Members of COSTRAM:

Shri. R.G. Agarwal (Chairman)	:	BARC (Former)
Shri S. Vedamoorthy	:	NPCIL (Former)
Shri R.P. Hans	:	BARC
Dr. A.N. Nandakumar	:	AERB (Former)
Shri S.P. Srivastava	:	BARC
Shri B.S. Manjunath	:	BARC
Shri Vishnu Verma	:	BARC
Shri Kailash Agarwal	:	BARC
Shri V.R. Bhave	:	BRIT
Dr. S.V. Prabhu	:	IIT, Bombay
Shri R.K. Singh (Member Secretary)	:	AERB

STANDING COMMITTEE FOR REVIEW AND REVISION OF AERB RADIATION SAFETY DOCUMENTS (SC-RRR-SD)

Date of meeting : July 24, 2014

Chairman and Members of SCRRRSD:

Shri A.R. Sundararajan (Chairman)	:	AERB (Former)
Dr. D.N. Sharma	:	BARC (Former)
Dr. B.C. Bhatt	:	BARC (Former)
Shri P.K. Nema	:	BARC (Former)
Dr. M.G.R. Rajan	:	BARC
Shri D.A.R. Babu	:	BARC
Dr. A.U. Sonawane	:	AERB
Shri V. Mohan	:	AERB
Dr. (Smt.) Jain Reji George	:	BRIT
Smt. V. Anuradha	:	AERB
Shri R.K. Chaturvedi (Member Secretary)	:	AERB

ADVISORY COMMITTEE ON RADIOLOGICAL SAFETY (ACRS)

Date of meeting	:	February 3, 2015

Chairman and Members of ACRS:

Dr. U.C. Mishra (Chairman)	:	BARC (Former)
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Dr. S.K. Srivastava	:	Tata Memorial Hospital, Mumbai
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LIST OF SAFETY CODES AND GUIDES FOR REGULATION OF TRANSPORT OF RADIOACTIVE MATERIAL

Safety Series No.	Title
AERB/NRF-TS/SC-1(Rev.1)	Safe Transport of Radioactive Material
AERB/SC/G	Regulation of Nuclear and Radiation Facilities
AERB/NRF-TS/SG-1(Rev. 1)	Transport and Storage of Radioactive Consignments and Emergency Preparedness for Transport Accidents involving Radioactive Material
AERB/NRF-TS/SG-10	Security in Transport of Radioactive Material

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