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PART II

Statutory Notification (SRO)

GOVERNMENT OF PAKISTAN
PAKISTAN NUCLEAR REGULATORY AUTHORITY

NOTIFICATION

Islamabad, the 1st January, 2022

S. R. O. 205/2022.—In exercise of the powers conferred by Section 16(2)(a) read with Section 56 of the Pakistan Nuclear Regulatory Authority Ordinance, 2001, the Pakistan Nuclear Regulatory Authority is pleased to make and promulgate the following regulations:

1. **Short title, Extent, Applicability and Commencement.**—(1) These regulations may be called the “Regulations for the Safe Transport of Radioactive Material - (PAK/916) (Rev.1)”.

(2) These regulations extend to the whole of Pakistan.

(3) These regulations shall be applicable to the transport of radioactive material.

(4) These regulations shall come into force at once.

361(1—104)

Price : Rs. 156.00

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2. **Definitions.**—In these regulations, unless there is anything repugnant in the subject or context,

- (a) “ A_1 ” means the activity value of special form radioactive material that is listed in Table 2 or derived in Regulation 26 (1) to 26 (4) of these regulations and is used to determine the activity limits for the requirements of these regulations;
- (b) “ A_2 ” means the activity value of radioactive material, other than special form radioactive material, that is listed in Table 2 or derived in Regulation 26 (1) to 26 (4) of these regulations and is used to determine the activity limits for the requirements of these regulations;
- (c) “*applicant*” means a legal person who applies to the Authority for obtaining an authorization to undertake specified activities under these regulations;
- (d) “*authorization*” means a written permission granted by the Authority to perform specified activities under these regulations;
- (e) “*cargo aircraft*” means any aircraft, other than a passenger aircraft, that carries goods or property;
- (f) “*carrier*” means any person, organization or government undertaking the carriage of radioactive material by any means of transport. The term includes both carriers for hire or reward and carriers on own account;
- (g) “*certificate holder*” means a person holding a valid certificate issued by the Authority;
- (h) “*conditions of transport*” means routine conditions (incident free), normal conditions (minor mishaps) and accident conditions;
- (i) “*confinement system*” means 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;
- (j) “*consignee*” means any person, organization or government that is entitled to take delivery of a consignment;
- (k) “*consignment*” means any package, or load of radioactive material, presented by a consignor for transport;
- (l) “*consignor*” means any person, organization or government which prepares a consignment for transport;

- (m) “*containment system*” means the assembly of components of the packaging specified by the designer as intended to retain the radioactive material during transport;
- (n) “*contamination*” means 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;
- (o) “*conveyance*” means for transport by:
 - (i) road or rail: any vehicle;
 - (ii) water: any vessel, or any hold, compartment, or defined deck area of a vessel; and
 - (iii) air: any aircraft.
- (p) “*Criticality Safety Index (CSI)*” means a number assigned to a package, overpack or freight container containing fissile material that is used to provide control over the accumulation of packages, overpacks or freight containers containing fissile material;
- (q) “*defined deck area*” means the area of the weather deck of a vessel, or of a vehicle deck of a roll-on or roll-off ship or ferry, that is allocated for the stowage of radioactive material;
- (r) “*depleted uranium*” means uranium containing a lesser mass percentage of uranium-235 than 0.72%. It may also include a very small mass percentage of uranium-234;
- (s) “*design*” means the description of fissile material excepted under Regulation 31 (1) (f) of these regulations, 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 documentation;
- (t) “*dose rate*” means the ambient dose equivalent or the directional dose equivalent, as appropriate, per unit time, measured at the point of interest;
- (u) “*enriched uranium*” means uranium containing a greater mass percentage of uranium-235 than 0.72%. It may also include a very small mass percentage of uranium-234;

- (v) “*exclusive use*” means 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 required by these regulations;
- (w) “*fissile material*” means a material containing any of the fissile nuclides, excluding:
 - (i) natural uranium or depleted uranium that is unirradiated;
 - (ii) natural uranium or depleted uranium that has been irradiated in thermal reactors only;
 - (iii) material with fissile nuclides less than a total of 0.25 g; and
 - (iv) any combination of (i), (ii) and (iii) as the case may be.

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

- (x) “*fissile nuclides*” means uranium-233, uranium-235, plutonium-239 and plutonium-241;
- (y) “*fixed contamination*” means contamination other than non-fixed contamination;
- (z) “*freight container*” means an article of transport equipment that is of a permanent character and is 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 readily handled and having fittings for these purposes. The term “freight container” does not include the vehicle. A small freight container has an internal volume of not more than 3 m³ and a large freight container has an internal volume of more than 3 m³;
- (aa) “*IAEA Regulations*” means IAEA Regulations for the Safe Transport of Radioactive Material, 2018 Edition, Specific Safety Requirements No. SSR-6 (Rev.1);
- (bb) “*Intermediate Bulk Container (IBC)*” means a portable packaging that:
 - (i) has a capacity of not more than 3 m³;

- (ii) is designed for mechanical handling; and
 - (iii) is resistant to the stresses produced during handling and transport, as determined by tests.
- (cc) “*licensee*” means the holder of a license issued by the Authority;
- (dd) “*low dispersible radioactive material*” means either a solid radioactive material or a solid radioactive material in a sealed capsule that has limited dispersibility and is not in powder form;
- (ee) “*Low Specific Activity (LSA) material*” means 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 shall not be considered in determining the estimated average specific activity;
- (ff) “*low toxicity alpha emitters*” means 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 ten (10) days;
- (gg) “*management system*” means a set of interrelated or interacting elements for establishing policies and objectives and enabling the objectives to be achieved in an efficient and effective manner;
- (hh) “*maximum normal operating pressure*” means 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;
- (ii) “*multilateral approval*” means an 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;
- (jj) “*natural uranium*” means uranium (which may be chemically separated) containing the naturally occurring distribution of

uranium isotopes (approximately 99.28% uranium-238 and 0.72% uranium-235, by mass). It may also include a very small mass percentage of uranium-234;

- (kk) “*non-fixed contamination*” means contamination that can be removed from a surface during routine conditions of transport;
- (ll) “*overpack*” means 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;
- (mm) “*package*” means the complete product of the packing operation, consisting of the packaging and its contents prepared for transport. The types of package covered by these regulations that are subject to the activity limits and material restrictions of Regulations 33 to 37 and meet the corresponding requirements are:
 - (i) Excepted Package;
 - (ii) Industrial Package Type 1 (Type IP-1);
 - (iii) Industrial Package Type 2 (Type IP-2);
 - (iv) Industrial Package Type 3 (Type IP-3);
 - (v) Type A Package;
 - (vi) Type B(U) Package;
 - (vii) Type B(M) Package; and
 - (viii) Type C Package.

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

- (nn) “*packaging*” means one or more receptacles and any other components or materials necessary for the receptacles to perform the containment and other safety functions;
- (oo) “*passenger aircraft*” means an aircraft that carries any person other than a crew member, a carrier’s employee in an official capacity, an authorized representative of relevant national authority, or a person accompanying a consignment or other cargo;

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- (pp) “*radiation protection program*” means systematic arrangements that are aimed at providing adequate consideration of radiation protection measures;
- (qq) “*radioactive contents*” means the radioactive material together with any contaminated or activated solids, liquids and gases within the packaging;
- (rr) “*radioactive material*” means any material containing radionuclides where both the activity concentration and the total activity in the consignment exceed the values specified in Regulations 25 to 26 of these regulations;
- (ss) “*shipment*” means the specific movement of a consignment from origin to destination;
- (tt) “*special arrangement*” means those provisions, approved by the Authority, under which consignments that do not satisfy all the applicable requirements of these regulations may be transported;
- (uu) “*special form radioactive material*” means either an indispersible solid radioactive material or a sealed capsule containing radioactive material;
- (vv) “*specific activity*” of a radionuclide means the activity per unit mass of that nuclide. The specific activity of a material shall mean the activity per unit mass of the material in which the radionuclides are essentially uniformly distributed;
- (ww) “*Surface Contaminated Object (SCO)*” means a solid object that is not itself radioactive but which has radioactive material distributed on its surface;
- (xx) “*tank*” means 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;
- (yy) “*transit*” means transportation through the territory of Pakistan by any mode of transportation, where the place of initial loading and the final destination are outside Pakistan;

- (zz) “*through or into*” means 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. However, this does not exclude consignments of fissile material carried by air through the territory of Pakistan;
- (aaa) “*Transport Index (TI)*” means a number assigned to a package, overpack or freight container, or to unpackaged LSA-I or SCO-I or SCO-III that is used to provide control over radiation exposure;
- (bbb) “*unilateral approval*” means an approval of a design that is required to be given by the competent authority of the country of origin of the design only;
- (ccc) “*unirradiated thorium*” means thorium containing not more than 10^{-7} g of uranium-233 per gram of thorium-232;
- (ddd) “*unirradiated uranium*” means 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;
- (eee) “*vehicle*” means a road vehicle (including an articulated vehicle, i.e. a tractor and semi-trailer combination), railroad car or railway wagon. Each trailer shall be considered as a separate vehicle; and
- (fff) “*vessel*” means any seagoing vessel or inland waterway craft used for carrying cargo.

3. **Scope.**—(1) These regulations shall apply to the transport of radioactive material by all modes (land, water, air), including transport that is incidental to the use of the radioactive material. For the purpose of these regulations, transport comprises all operations and conditions associated with, and involved in, the movement of radioactive material; these include design, manufacture, maintenance and repair of packaging, and the preparation, consigning, loading, carriage including in-transit storage, transit, shipment after storage, unloading and receipt at the final destination of loads of radioactive material and packages. Graded approach is applied in specifying performance standards in these regulations which are categorized in terms of three general severity levels i.e. routine, normal and accidental conditions.

- (2) These regulations shall not apply to any of 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 activity concentration limit for exempt material values set out in Table 2 or calculated in accordance with Regulation 26 (1) (a) and 26 (2) to 26 (5) of these regulations. For natural materials and ores containing naturally occurring radionuclides that are not in secular equilibrium the calculation of activity concentration shall be performed in accordance with Regulation 26 (3) of these regulations;
 - (g) Non-radioactive solid objects with radioactive substances present on any surface in quantities not exceeding 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.

4. **Interpretation.**—The decision of the Chairman PNRA regarding interpretation of any word or phrase of these regulations shall be final and binding.

GENERAL PROVISIONS AND ADMINISTRATIVE REQUIREMENTS

5. **Non-Compliance.**—(1) If a person contravenes any of the provisions of the Ordinance, the regulations made there under, any of the terms and conditions of the certificate or an authorization, or any of the directives of

the Authority, the Authority may take appropriate enforcement actions against such person, as prescribed in the Pakistan Nuclear Regulatory Authority Enforcement Regulations - (PAK/950).

(2) In the event of non-compliance with any limit prescribed in these regulations applicable to dose rate or contamination, the licensee shall:

- (a) take immediate steps to mitigate the consequences of the non-compliance;
- (b) investigate the non-compliance and its causes, circumstances and consequences; and
- (c) take appropriate action to remedy the causes and circumstances that led to the non-compliance and to prevent the recurrence.

(3) Communication of the non-compliance by the licensee to the Authority, either identified during transport by the carrier or at receipt by the consignee, shall be made within twenty four (24) hours and it shall be immediate whenever an emergency exposure situation has developed or is developing.

(4) The licensee shall submit to the Authority, within thirty (30) days, a written report stating the causes of non-compliance and corrective or preventive actions taken.

6. **Interface.**—(1) Except where otherwise specified, all communications concerning these regulations shall be addressed to the Chairman PNRA or an officer duly authorized on his behalf.

(2) The applicant and certificate holder shall keep the Authority informed of the schedule and progress of its activities during all phases of certification of packaging such as design, manufacturing, testing, repair and maintenance.

7. **General Responsibilities.**—(1) The licensee shall be responsible for compliance of these regulations and shall:

- (a) establish and implement the following documents for activities within the scope of these regulations, as required by applicable licensing regulations i.e. Regulations for the Licensing of Radiation Facility(ies) other than Nuclear Installation(s) - (PAK/908) and Regulations for Licensing of Nuclear Installations in Pakistan - (PAK/909):
 - (i) Radiation Protection Program;
 - (ii) Radiation Emergency Plan;

- (iii) Physical Protection Plan; and
 - (iv) Management System.
- (b) provide training and retraining to persons engaged in transport of radioactive material commensurate with their responsibilities and perform drills or exercises;
 - (c) inform the serial number of each packaging and radioactive material in use having valid design approval certificate issued by the competent authority of the country of origin; and
 - (d) comply with the relevant national applicable requirements relating to security, physical protection, radiation protection, import, export and other dangerous goods if transported with radioactive material.
- (2) For each shipment of radioactive material, the applicant and licensee shall notify the Authority prior to the commencement of the shipment in accordance with the specified format.
- (3) The consignee shall verify the dose rate, contamination levels, marking and labelling in compliance with these regulations upon receipt of consignment.
- (4) The application for acquiring an authorization or certificate shall be accompanied by such fee as prescribed by Regulations on Licensing Fee by Pakistan Nuclear Regulatory Authority - (PAK/900).
- (5) Compliance with the requirements relating to consignor, consignee and carrier, within the country, set in the chapters of these regulations shall also be the responsibility of the licensee.

8. Radioactive Material and Transport Packages Requiring Design Certification.—(1) Any person who intends to design the following radioactive material and packages, within the scope of these regulations, shall seek design approval from the Authority:

- (a) Special form radioactive material;
- (b) Low dispersible radioactive material and associated packages;
- (c) Fissile material excepted under Regulation 31 (1) (f) of these regulations;
- (d) Packages containing 0.1 kg or more of uranium hexafluoride;

- (e) All type of packages containing fissile material unless excepted by Regulations 31 (1), 87 (2) or 87 (3) of these regulations;
- (f) Type B(U) packages;
- (g) Type B(M) packages; and
- (h) Type C packages.

(2) The design for radioactive material and packages mentioned under Regulation 8 (1) (b) to 8 (1) (e) and 8 (1) (g) of these regulations shall require multilateral approval from the Authority, which may be executed through independent certification or validation of certificate in special cases. The design for radioactive material and packages mentioned under Regulation 8 (1) (a), 8 (1) (f) and 8 (1) (h) of these regulations shall require unilateral approval from the Authority.

(3) The licensee shall, on request, make available for inspection by the Authority, documentary evidence of the compliance of design for Excepted, Industrial and Type A packages with all the applicable requirements.

9. Issuance of Design Approval Certificate for Radioactive Material and Packages.—(1) The applicant shall notify in writing to Chairman PNRA of his intention to design package or radioactive material mentioned under Regulation 8 (1) of these regulations.

(2) The applicant shall submit the list of codes and standards to be followed for the design of package or radioactive material to the Authority for approval.

(3) The applicant shall submit an application to the Authority, for obtaining a design approval certificate for design of package or radioactive material, along with the following documents in accordance with the approved codes and standards:

- (a) Safety Analysis Report (SAR); and
- (b) Management System (MS).

(4) Upon approval of SAR and MS, the applicant shall submit the quality plan to the Authority for the manufacturing of relevant prototype revealing all the applicable tests of these regulations required for the qualification and selection of inspection points by the Authority. The manufacturing of prototype shall be done by an authorized manufacturer.

(5) The completion of each test shall form the basis to proceed for the next test.

(6) After completion of qualification tests performed, the applicant shall submit the test completion report along with updated SAR and operating and maintenance manual.

(7) The applicant shall submit three (03) copies of SAR, MS, and test completion report duly signed by the applicant to the Authority.

(8) The Authority may also require the applicant to submit any other relevant document or information at any stage during the certification.

(9) Upon acceptance of the updated submissions and resolution of all safety issues, the Authority may issue a design approval certificate for the radioactive material and transport package to applicant. The certificate may be valid for a period of up to five (05) years.

(10) The Authority may attach such terms and conditions to the certificate as deemed necessary.

10. Revalidation of Design Approval Certificate.—(1) An application for revalidation of a design approval certificate that was certified under these regulations may be made if the technical specifications of the design have not been changed and the application is received by the Authority six (06) months before the expiry date of the certificate. The application shall include the following information:

- (a) A statement confirming that the drawings submitted to the Authority have not been changed;
- (b) A certificate issued by manufacturer confirming that each package or radioactive material has been manufactured in compliance with the drawings previously submitted to the Authority;
- (c) A statement confirming that the operating and maintenance manual previously submitted has not been changed;
- (d) A list of the serial numbers of packaging or radioactive material manufactured and maintained in accordance with the certified design;
- (e) A list of the users of the latest certified design of package or radioactive material; and
- (f) Any other information as deemed necessary by the Authority.

(2) Upon acceptance of above information, the Authority may revalidate design certificate up to another five (05) years or less as the case may be.

11. **Modification in Design.**—(1) Certificate holder intending to incorporate a modification which may lead to changes in the existing design of packaging or radioactive material, shall submit an application to the Authority for modification. The application shall accompany the documents fully describing the desired changes to the terms, conditions or specifications, updated SAR and the reasons for changes along with proper justification.

(2) Upon satisfaction, the Authority may approve design modification. The certificate holder shall implement the modification only after the approval of the design modification from the Authority.

12. **Amendment in Certificate.**—(1) The certificate holder shall submit an application for the amendment in the design approval certificate to the Authority along with the relevant documents and applicable amendment fee as prescribed in Regulations on Licensing Fee by Pakistan Nuclear Regulatory Authority - (PAK/900).

(2) Upon approval of the submissions, the Authority may issue the amended design approval certificate.

13. **Type B(U) Package Approved by Competent Authority of Country of Origin of Design.**—The Authority may allow the use of Type B(U) packages approved by competent authority of the country of origin of design, for a period and conditions as mentioned in the original certificate.

14. **Manufacturing of Radioactive Material and Packages of Certified Design.**—(1) The manufacturing of radioactive material and packages having design approval certificate issued by the Authority under Regulation 8 of these regulations shall be:

- (a) in accordance with the requirements and specifications set out in the design approval certificate;
- (b) from a manufacturer, licensed by the Authority; and
- (c) so that the radioactive material and packages are clearly marked with the certificate number, design number and serial number, as applicable.

(2) The certificate holder shall submit a certificate issued by the manufacturer to the Authority that the design specifications have been fully met during manufacturing.

(3) The certificate holder shall inform the Authority of the serial number of each packaging and radioactive material manufactured to an approved design.

15. Packages Designed for Shipment after Storage.—(1) For packages intended to be used for shipment after storage, the applicant shall:

- (a) state and justify the consideration of ageing mechanisms on the safety analysis and within the proposed operating and maintenance instructions; and
- (b) provide a gap analysis program describing a systematic procedure to consider changes of regulations, changes in technical knowledge and changes of the state of the package design during storage.

16. Authorization for Shipment.—(1) The licensee shall carry out all shipments of radioactive material as per authorization issued under applicable licensing regulations.

(2) The applicant and licensee shall seek multilateral approval of the authority on prescribed application forms and submit radiation protection program, radiation emergency plan, physical protection plan and management system, covering any special precautions or special administrative or operational controls that are to be employed, modes of transport, package information, number and duration of shipments, type of conveyance, proposed routes; as applicable, for:

- (a) shipment involving packages and material requiring multilateral approval for design under these regulations;
- (b) shipment by special use vessels;
- (c) shipments under special arrangements; and application shall include:
 - (i) all the information necessary to satisfy the 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 these regulations had been met;
 - (ii) the reasons, why the shipment cannot be made in full accordance with the applicable requirements; and
 - (iii) 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.

- (d) shipment of Surface Contaminated Objects-III (SCO-III - radioactive material contained in large solid object); and application shall include:
 - (i) a statement of the respects in which, and of the reasons why, the consignment is considered SCO-III;
 - (ii) justification for choosing SCO-III by demonstrating that:
 - i. no suitable packaging currently exists;
 - ii. designing and constructing a packaging or segmenting the object is not practically, technically or economically feasible; and
 - iii. no other viable alternative exists.
 - (iii) a detailed description of the proposed radioactive contents with reference to their physical and chemical states and the nature of the radiation emitted;
 - (iv) a detailed statement of the design of the SCO-III, including complete engineering drawings, schedules of materials and methods of manufacture; and
 - (v) all information necessary to satisfy the Authority, that the requirements of Regulation 44 (4) (e) and 44 (6) of these regulations, if applicable, are satisfied.

(3) Upon acceptance of the above information, the Authority may grant permission for the shipment. The permission may be for single or a planned series of multiple consignments on case to case basis.

17. Calculation Approvals.—(1) The applicant or licensee shall seek multilateral approval of values and limits from the Authority for:

- (a) alternative activity limits for an exempt consignment of instruments or articles as in accordance with Regulation 26 (1) (b) of these regulations; and
- (b) radionuclide values that are not listed in Table 2 of these regulations.

(2) An application for alternative activity limits for an exempt consignment of instruments or articles shall include:

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- (a) an identification and detailed description of the instrument or article, its intended uses and the radionuclides incorporated;
 - (b) the maximum activity of the radionuclides in the instrument or article;
 - (c) maximum external radiation levels arising from the instrument or article;
 - (d) the chemical and physical forms of the radionuclides 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; and
 - (h) dose assessments, 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 subject to.
- (3) An application for approval of the Authority for calculation of radionuclide values that are not listed in Table 2 of these regulations, shall include:
- (a) a description of the nuclear substance, including its name, chemical form and physical state;
 - (b) the calculation of activity concentrations for exempt material and activity limits for exempt consignments including the principles used, assumptions made, scenarios considered and any data or formulae used to determine the value; and
 - (c) a copy of any applicable approval issued by a competent authority of country of origin in accordance with the IAEA Regulations.

18. **Authorization for Transit.**—(1) A person who intends to transit for shipment of radioactive material shall seek authorization from the Authority on prescribed application form along with the following documents:

- (a) Radiation Protection Program;
- (b) Physical Protection Plan;
- (c) Radiation Emergency Plan; and
- (d) Any other information as deemed necessary by the Authority.

(2) Upon acceptance of the above information, the Authority may grant permission for transit of shipment. However, radioactive material falling under Control Lists of Goods, Technologies, Material and Equipment related to Nuclear and Biological Weapons and their Delivery Systems shall also require separate authorization from Strategic Export Control Division (SECDIV).

19. **Applicable Transport Safety and Security Standards.**—(1) For the transport of radioactive material, the applicant or licensee shall conform to the existing PNRA regulations.

(2) In areas where the PNRA Regulations are not available, relevant latest IAEA standards for transport of radioactive material shall be deemed to be applicable. In addition, the applicant or licensee may also follow the relevant latest United States Nuclear Regulatory Commission (USNRC) regulatory documents.

20. **Inspections.**— The Authority may witness or conduct inspection of transport activities to ensure compliance at any stage in accordance with these regulations and other applicable PNRA regulations.

21. **Transitional Arrangements.**—IAEA Regulations shall be followed for use of packages and radioactive material manufactured to the design approved under the 1985 and 1985 (As Amended 1990), 1996 Edition, 1996 Edition (Revised), 1996 (As Amended 2003), 2005, 2009 and 2012 Editions of IAEA Regulations and shall require multilateral approval of the Authority, where applicable.

22. **Record Keeping.**—(1) The licensee and certificate holder shall maintain records and reports related to:

- (a) design, manufacture, maintenance and use throughout the lifetime of the package and radioactive material; and
- (b) all safety trainings of employees involved in transport of radioactive material.

23. Authorization for Vehicle, Vessel or Aircraft Carrying Fissile Material.—(1) The applicant or licensee shall seek permission of the Authority for vehicle, vessel or aircraft intended for the carriage of fissile material.

(2) Such vehicle, vessel or aircraft containing fissile material shall be transported under exclusive use.

(3) The applicant or licensee shall make available following for approval:

- (a) Vehicle, vessel or aircraft valid fitness certificate from relevant competent authority of the country of registration and acceptable to relevant national authorities that it is fit for the intended purpose and satisfies the relevant technical requirements;
- (b) Technical specifications of the vehicle, vessel or aircraft along with the details of the safety equipment installed;
- (c) Registration information of the vehicle, vessel or aircraft;
- (d) Description of the radioactive material, including the name, the chemical and physical form, the activity or in the case of fissile material, the mass of each radioactive material in a packaging and the total quantity of the activity or mass in the consignment;
- (e) Information about (the name, address and contact number) consignor, consignee and carrier;
- (f) Registration of crew and driver from relevant authorities;
- (g) Physical protection arrangements taken by the applicant are in accordance with Regulations on Physical Protection of Nuclear Material and Nuclear Installations - (PAK/925); and
- (h) Any other information as deemed necessary by the Authority.

ACTIVITY LIMITS AND CLASSIFICATION

24. General Provisions.— Radioactive material shall be assigned to one of the United Nations (UN) numbers as specified in Table 1 in accordance with Regulations 27 to 37 of these regulations.

25. Basic Radionuclide Values.—(1) The following basic values for individual radionuclides are given in Table 2:

- (a) A_1 and A_2 in TBq;
- (b) Activity concentration limits for exempt material in Bq/g; and
- (c) Activity limits for exempt consignments in Bq.

26. **Determination of Basic Radionuclide Values.**—(1) For individual radionuclides:

- (a) that are not listed in Table 2, the determination of the basic radionuclide values referred to in Regulation 25 shall require multilateral approval. For these radionuclides, activity concentrations for exempt material and activity limits for exempt consignments shall be calculated in accordance with the principles/criteria established in the PNRA Regulations on Radiation Protection - (PAK/904) or IAEA General Safety Requirements on Radiation Protection and Safety of Radiation Sources (GSR Part 3). 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 (ICRP), if the chemical forms of each radionuclide under both normal and accident conditions of transport are taken into consideration. Alternatively, the radionuclide values in Table 3 may be used without obtaining approval of the Authority.
- (b) in instruments or articles in which the radioactive material is enclosed in or is included as a component part of the instrument or other manufactured article and which meets Regulation 33 (2) (c) of these regulations, alternative basic radionuclide values to those in Table 2 for the activity limit for an exempt consignment are permitted and shall require multilateral approval. Such alternative activity limits for an exempt consignment shall be calculated in accordance with the principles and criteria set out in the PNRA Regulations on Radiation Protection - (PAK/904) or IAEA General Safety Requirements on Radiation Protection and Safety of Radiation Sources (GSR Part 3).

TABLE 1: EXCERPTS FROM THE 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

Assignment of UN numbers	PROPER SHIPPING NAME and Description ^a
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 ^b
Low Specific Activity 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, SCO-II or SCO-III), 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

Assignment of UN numbers	PROPER SHIPPING NAME and Description ^a
Special Arrangement	
UN 2919	RADIOACTIVE MATERIAL, TRANSPORTED UNDER SPECIAL ARRANGEMENT, non-fissile or fissile-excepted ^b
UN 3331	RADIOACTIVE MATERIAL, TRANSPORTED UNDER SPECIAL ARRANGEMENT, FISSIONABLE
Uranium Hexafluoride	
UN 2977	RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, FISSIONABLE
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 The term "fissile-excepted" refers only to material excepted under Regulation 31 (1) of these regulations.

(2) In the calculations of A_1 and A_2 for a radionuclide not listed in Table 2, a single radioactive decay chain in which the radionuclides are present in their naturally occurring proportions, and in which no progeny nuclide has a half-life either longer than ten (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 progeny nuclide has a half-life either longer than ten (10) days or longer than that of the parent nuclide, the parent and such progeny nuclides shall be considered as mixtures of different nuclides.

(3) For mixtures of radionuclides, the basic radionuclide values referred to in Regulation 25 of these regulations may be determined as follows:

$$X_m = \frac{1}{\sum_i \frac{f(i)}{X(i)}}$$

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 radionuclide i.

X_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.

TABLE 2: BASIC RADIONUCLIDE VALUES

Radionuclide (atomic number)	A_1 (TBq)	A_2 (TBq)	Activity concentration limit for exempt material (Bq/g)	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

Radionuclide (atomic number)	A ₁ (TBq)	A ₂ (TBq)	Activity concentration limit for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
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-135m	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

Radionuclide (atomic number)	A ₁ (TBq)	A ₂ (TBq)	Activity concentration limit for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
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

Radionuclide (atomic number)	A ₁ (TBq)	A ₂ (TBq)	Activity concentration limit for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
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-69	1×10^0	1×10^0	1×10^1	1×10^6
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

Radionuclide (atomic number)	A ₁ (TBq)	A ₂ (TBq)	Activity concentration limit for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
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-193m	4×10^1	4×10^0	1×10^4	1×10^7
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

Radionuclide (atomic number)	A ₁ (TBq)	A ₂ (TBq)	Activity concentration limit for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
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

Radionuclide (atomic number)	A ₁ (TBq)	A ₂ (TBq)	Activity concentration limit for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
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)				

Radionuclide (atomic number)	A ₁ (TBq)	A ₂ (TBq)	Activity concentration limit for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
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 (natural)	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 (natural)	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

Radionuclide (atomic number)	A ₁ (TBq)	A ₂ (TBq)	Activity concentration limit for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
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-83	1×10^0	1×10^0	1×10^1	1×10^6
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-149	8×10^{-1}	8×10^{-1}	1×10^1	1×10^6
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
Tb-161	3×10^1	7×10^{-1}	1×10^3	1×10^6
Technetium (43)				

Radionuclide (atomic number)	A ₁ (TBq)	A ₂ (TBq)	Activity concentration limit for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
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 (natural)	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

Radionuclide (atomic number)	A₁ (TBq)	A₂ (TBq)	Activity concentration limit for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
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

Radionuclide (atomic number)	A ₁ (TBq)	A ₂ (TBq)	Activity concentration limit for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
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) A₁ and/or A₂ values for these parent radionuclides include contributions from their progeny with half-lives less than ten (10) days, as listed in the following:

Mg-28	Al-28
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-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 in the following (the activity to be taken into account is that of parent nuclide only):

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-natural*	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-natural*	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

* In the case of Th-natural, the parent nuclide is Th-232; in the case of U-natural, the parent nuclide is U-238.

- (c) The quantity may be determined from a measurement of the rate of decay or a measurement of the dose rate 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 $\text{UO}_2(\text{NO}_3)_2$ 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.

(4) 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 the formulas in Regulations 26 (3) and 35 (3) of these regulations. Groups may be based on the total alpha activity and the total beta or gamma activity when these are known, using the lowest radionuclide values for the alpha emitters or beta or gamma emitters, respectively.

(5) For individual radionuclides or for mixtures of radionuclides for which relevant data are not available, the values shown in Table 3 shall be used.

TABLE 3: BASIC RADIONUCLIDE VALUES FOR UNKNOWN RADIONUCLIDES OR MIXTURES

Radioactive content	A ₁ (TBq)	A ₂ (TBq)	Activity concentration limit for exempt material (Bq/g)	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

CLASSIFICATION OF MATERIAL

27. **Low Specific Activity Material.**—(1) Radioactive material may only be classified as LSA material if the conditions of Regulations 2 (ee), 27 (2) to 27(4) and 44 (1) to 44 (6) of these regulations are met.

(2) LSA material shall be in one of the following three groups:

(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 A₂ value is unlimited. Fissile material may be included only if excepted under Regulation 31 (1) of these regulations.
- (iv) Other radioactive material in which the activity is distributed throughout and the estimated average specific activity does not exceed thirty (30) times the values for the activity concentration specified in Regulations 25 and 26 of these regulations. Fissile material may be included only if excepted under Regulation 31 (1) of these regulations.

(b) LSA-II:

- (i) Water with a tritium concentration of up to 0.8 TBq/L; and

- (ii) Other material in which the activity is distributed throughout and the estimated average specific activity does not exceed $10^{-4}A_2/g$ for solids and gases, and $10^{-5}A_2/g$ for liquids.
- (c) LSA-III: Solids (e.g. consolidated wastes, activated materials), excluding powders, 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); and
 - (ii) the estimated average specific activity of the solid, excluding any shielding material, does not exceed $2 \times 10^{-3}A_2/g$.
- (3) A single package of non-combustible solid LSA-II or LSA-III material, if carried by air, shall not contain an activity greater than $3000A_2$.
- (4) The radioactive contents in a single package of LSA material shall be so restricted that the dose rate specified in Regulation 44 (1) of these regulations shall not be exceeded, and the activity in a single package shall also be so restricted that the activity limits for a conveyance specified in Regulation 44 (6) of these regulations shall not be exceeded.

28. **Surface Contaminated Object.**—(1) Radioactive material may be classified as SCO if the conditions in Regulations 2 (ww), 28 (2), 28 (3) and 44 (1) to 44 (6) are met.

- (2) SCO shall be in one of the following three groups:
 - (a) SCO-I: A solid object on which:
 - (i) the non-fixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 4 Bq/cm^2 for beta and gamma emitters and low toxicity alpha emitters, or 0.4 Bq/cm^2 for all other alpha emitters;
 - (ii) the fixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed $4 \times 10^4\text{ Bq/cm}^2$ for beta and gamma emitters and low toxicity alpha emitters, or 4000 Bq/cm^2 for all other alpha emitters; and
 - (iii) the non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm^2 (or the area of

the surface if less than 300 cm^2) does not exceed $4 \times 10^4 \text{ Bq/cm}^2$ for beta and gamma emitters and low toxicity alpha emitters, or 4000 Bq/cm^2 for all other alpha emitters.

(b) SCO-II: A solid object on which either the fixed or non-fixed contamination on the surface exceeds the applicable limits specified for SCO-I in (a) above and on which:

- (i) the non-fixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 400 Bq/cm^2 for beta and gamma emitters and low toxicity alpha emitters, or 40 Bq/cm^2 for all other alpha emitters;
- (ii) the fixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed $8 \times 10^5 \text{ Bq/cm}^2$ for beta and gamma emitters and low toxicity alpha emitters, or $8 \times 10^4 \text{ Bq/cm}^2$ for all other alpha emitters; and
- (iii) the non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed $8 \times 10^5 \text{ Bq/cm}^2$ for beta and gamma emitters and low toxicity alpha emitters, or $8 \times 10^4 \text{ Bq/cm}^2$ for all other alpha emitters.

(c) SCO-III: A large solid object which, because of its size, cannot be transported in a type of package described in these regulations and for which:

- (i) all openings are sealed to prevent release of radioactive material during conditions defined in Regulation 44 (4) (e) of these regulations;
- (ii) the inside of the object is as dry as practicable;
- (iii) the non-fixed contamination on the external surfaces does not exceed the limits specified in Regulation 42 (1) of these regulations; and
- (iv) the non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm^2 does not exceed $8 \times 10^5 \text{ Bq/cm}^2$ for beta and gamma emitters and low toxicity alpha emitters, or $8 \times 10^4 \text{ Bq/cm}^2$ for all other alpha emitters.

(3) The radioactive contents in a single package of SCO shall be so restricted that the dose rate specified in Regulation 44 (1) of these regulations

shall not be exceeded, and the activity in a single package shall also be so restricted that the activity limits for a conveyance specified in Regulation 44 (6) of these regulations shall not be exceeded.

29. Special Form Radioactive Material.—Radioactive material may be classified as special form radioactive material only if it meets the requirements of Regulations 8 (1) and 72 of these regulations.

30. Low Dispersible Radioactive Material.—Radioactive material may be classified as low dispersible radioactive material only if it meets the requirements of Regulation 73, taking into account the requirements of Regulations 8 (1) and 84 (14) of these regulations.

31. Fissile Material.—(1) Fissile material and packages containing fissile material shall be classified under the relevant entry as “FISSILE” in accordance with Table 1 unless excepted by one of the below provisions (a) to (f) and transported subject to the requirements of Regulation 63 (3) of these regulations. All provisions apply only to material in packages that meet the requirements of Regulation 83 (2) of these regulations, 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; and
 - (iii) transport of the package is subject to the consignment limit provided in Regulation 63 (3) (c) of these regulations.
- (d) Fissile nuclides with a total mass not greater than 2.0 g per package, provided the package is transported subject to the consignment limit provided in Regulation 63 (3) (d) of these regulations.

- (e) Fissile nuclides with a total mass not greater than 45 g, either packaged or unpackaged, subject to the requirements of Regulation 63 (3) (e) of these regulations.
 - (f) A fissile material that meets the requirements of Regulations 8 (1), 63 (3) (b) and 74 of these regulations.
- (2) The contents of packages containing fissile material shall be as specified for the package design, either directly in these regulations or in the certificate of approval.

32. **Uranium Hexafluoride.**—(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.
- (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.

CLASSIFICATION OF PACKAGES

33. **Classification as Excepted Package.**—(1) 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 4;

- (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 4;
- (e) It contains less than 0.1 kg of uranium hexafluoride not exceeding the activity limits specified in column 4 of Table 4.

TABLE 4: ACTIVITY LIMITS FOR EXCEPTED PACKAGES

Physical state of contents	Instrument or article		Materials
	Item limits ^a	Package limits ^a	Package limits ^a
Solids			
Special form	$10^{-2}A_1$	A_1	$10^{-3}A_1$
Other forms	$10^{-2}A_2$	A_2	$10^{-3}A_2$
Liquids	$10^{-3}A_2$	$10^{-1}A_2$	$10^{-4}A_2$
Gases			
Tritium	$2 \times 10^{-2}A_2$	$2 \times 10^{-1}A_2$	$2 \times 10^{-2}A_2$
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 Regulation 26 (3) to 26 (5).

(2) 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 dose rate at 10 cm from any point on the external surface of any unpackaged instrument or article is not greater than 0.1 mSv/h;
- (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 marks.
 - (ii) Consumer products that have either received regulatory approval in accordance with Regulation 3 (2) (e) of these regulations or do not individually exceed the activity limit for an exempt consignment in Table 2 (column 5) do not require marks, provided that such products are transported in a package that bears the marks “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 marks “RADIOACTIVE” do not require marks, provided that they are transported in a package that bears the marks “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 4 are met for each individual item and each 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 4; and
- (f) if the package contains fissile material, one of the provisions of Regulations 31 (1) (a) to 31 (1) (f) of these regulations shall apply.

(3) Radioactive material in forms other than as specified in Regulation 33 (2) of these regulations and with an activity not exceeding the limits specified in column 4 of Table 4 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 mark “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 4; and

- (d) if the package contains fissile material, one of the provisions of Regulation 31 (1) (a) to 31 (1) (f) of these regulations shall apply.

(4) Uranium hexafluoride not exceeding the limits specified in column 4 of Table 4 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; and
- (b) the conditions of Regulations 32 (2) and 33 (3) (a) to 33 (3) (b) of these regulations are met.

(5) 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.

34. Additional Requirements and Controls for Transport of Empty Packagings.—(1) 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 Regulation 42 (1) of these regulations;
- (d) any labels that may have been displayed on it in conformity with Regulation 51 (1) of these regulations are no longer visible; and
- (e) if the packaging has contained fissile material, one of the provisions of Regulations 31 (1) (a) to 31 (1) (f) of these regulations or one of the provisions for exclusion as defined in fissile material definition shall apply.

35. Classification as Type A package.—(1) Packages containing radioactive material may be classified as Type A packages provided that the conditions of Regulation 35 (2) and 35 (3) of these regulations are met.

(2) Type A packages shall not contain activities greater than either of the following:

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

(3) 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:

$$\sum_i \frac{B(i)}{A_1(i)} + \sum_j \frac{C(j)}{A_2(j)} \leq 1$$

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; and

$A_2(j)$ is the A_2 value for radionuclide j .

36. Classification as Type B(U), Type B(M) or Type C Package.—(1) 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.

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

(3) Type B(U) and Type B(M) packages, if transported by air, shall meet the requirements of Regulation 36 (2) of these regulations and shall not contain activities greater than the following:

- (a) For low dispersible radioactive material — as authorized for the package design as specified in the certificate of approval;

- (b) For special form radioactive material — $3000A_1$ or 10^5A_2 , whichever is the lower; and
- (c) For all other radioactive material — $3000A_2$.

37. **Special Arrangement.**—Radioactive material shall be classified as transported under special arrangement when it is intended to be carried in accordance with Regulation 16 (2) (c) of these regulations.

REQUIREMENTS AND CONTROLS FOR TRANSPORT

38. **Requirements Before the First Shipment.**—(1) Before a packaging is first used to transport radioactive material, it shall be confirmed that it has been manufactured in conformity with the design specifications to ensure compliance with the relevant provisions of these regulations 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) 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 Regulation 87 (1) of these regulations, neutron poisons are specifically included, checks shall be performed to confirm the presence and distribution of those neutron poisons.

39. **Requirements Before Each Shipment.**—(1) Before each shipment of any package, it shall be ensured that the package contains neither:

- (a) radionuclides different from those specified for the package design; nor

- (b) contents in a form, or physical or chemical state, different from those specified for the package design.

(2) Before each shipment of any package, it shall be ensured that all the requirements specified in the relevant provisions of these regulations and in the applicable certificates of approval have been fulfilled. The following requirements shall also be fulfilled, if applicable:

- (a) It shall be ensured that lifting attachments that do not meet the requirements of Regulation 75 (2) of these regulations have been removed or otherwise rendered incapable of being used for lifting the package, in accordance with Regulation 75 (3) of these regulations.
- (b) Each Type B(U), Type B(M) and Type C package 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.
- (c) 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 Regulations 84 (8) and 86 (3) were made.
- (d) For packages containing fissile material, the measurement specified in Regulation 88 (2) (b) and the tests to demonstrate closure of each package as specified in Regulation 90 (1) of these regulations shall be performed.
- (e) 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 these regulations and in the applicable certificates of approval have been fulfilled.

40. **Transport of Other Goods.**—(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.

(2) Freight containers, IBCs, tanks, as well as other packagings 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/cm² for beta and gamma emitters and low toxicity alpha emitters and 0.04 Bq/cm² for all other alpha emitters.

(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 cognizant transport organizations, as well as IAEA Regulations.

41. 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 IAEA Regulations.

42. Requirements and Controls for Contamination and for Leaking Packages.—(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/cm² for beta and gamma emitters and low toxicity alpha emitters; and
- (b) 0.4 Bq/cm² for all other alpha emitters.

These limits are applicable when averaged over any area of 300 cm² of any part of the surface.

(2) Except as provided in Regulation 42 (7) of these regulations, the level of non-fixed contamination on the external and internal surfaces of overpacks, freight containers and conveyances shall not exceed the limits specified in Regulation 42 (1) of these regulations. This requirement does not apply to the internal surfaces of freight containers being used as packaging, either loaded or empty.

(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 dose rate 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 public, property and the environment, in accordance with provisions established by the Authority, shall be taken to overcome and minimize the consequences of such leakage or damage.

(4) Packages that are damaged or leaking radioactive contents in excess of allowable limits for normal conditions of transport may be removed to an acceptable interim location under supervision, but shall not be shipped until repaired or reconditioned and decontaminated.

(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) Except as provided in Regulation 42 (7) of these regulations, any conveyance, or equipment or part thereof that has become contaminated above the limits specified in Regulation 42 (1) of these regulations in the course of the transport of radioactive material, or that shows a dose rate in excess of 5 $\mu\text{Sv/h}$ 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 Regulation 42 (1) of these regulations.
- (b) The dose rate resulting from the fixed contamination shall not exceed 5 $\mu\text{Sv/h}$ at the surface.

(7) A freight container or conveyance dedicated to the transport of unpackaged radioactive material under exclusive use shall be excepted from the requirements of Regulations 42 (2) and 42 (6) of these regulations solely with regard to its internal surfaces and only for as long as it remains under that specific exclusive use.

43. Requirements and Controls for Transport of Excepted Packages.—(1) Excepted packages shall be subject only to the following requirements:

- (a) The requirements specified in Regulations 39 (2), 40 (1), 40 (2), 41, 42 (1) to 42 (6), 43 (2), 49, 50 (1) to 50 (3), 55, 56 introductory sentence, 56 (1) (a, k, m), 56 (1) (j) (i, ii), 57 (4) to 57 (7), 58 (2), 58 (3), 60, 62 (1), 63 (3), 68 and 69 of these regulations;

- (b) The requirements for excepted packages specified in Regulation 77 of these regulations; and
- (c) The requirements specified in Regulation 67 of these regulations, if transported by post.

All relevant provisions of the other chapters shall apply to excepted packages.

(2) The dose rate at any point on the external surface of an excepted package shall not exceed 5 μ Sv/h.

44. Requirements and Controls for Transport of LSA Material and SCO in Industrial Packages or Unpackaged.—(1) The quantity of LSA material or 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 dose rate at 3 m from the unshielded material or object or collection of objects does not exceed 10 mSv/h.

(2) For LSA material and SCO that are or contain fissile material that is not excepted under Regulation 31 (1) of these regulations, the applicable requirements of Regulations 63 (1) and 63 (2) of these regulations shall be met.

(3) For LSA material and SCO that are or contain fissile material, the applicable requirements of Regulation 87 (1) of these regulations shall be met.

(4) LSA material and SCO in groups LSA-I, SCO-I and SCO-III 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 ten (10) times the applicable level specified in Regulation 2 (n) of these regulations.
- (c) For SCO-I where it is suspected that non-fixed contamination exists on inaccessible surfaces in excess of the values specified in clause 28 (2) (a) (i), 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 Regulation 31 (1) (e) of these regulations.
- (e) For SCO-III;
 - (i) Transport shall be under exclusive use by road, rail, inland waterway or sea.
 - (ii) Stacking shall not be permitted.
 - (iii) All activities associated with the shipment, including radiation protection, emergency response and any special precautions or special administrative or operational controls that are to be employed during transport shall demonstrate that the overall level of safety in transport is at least equivalent to that which would be provided if the requirements of Regulation 83 (14) (only for the test specified in Regulation 104 (6), preceded by the tests specified in Regulations 104 (2) and 104 (3)) of these regulations had been met.
 - (iv) The requirements of Regulation 79 of these regulations for a Type IP-2 package shall be satisfied, except that the maximum damage referred to in Regulation 104 (4) may be determined based on provisions in the transport plan, and the requirements of Regulation 104 (5) of these regulations are not applicable.
 - (v) The object and any shielding are secured to the conveyance in accordance with Regulation 75 (1) of these regulations.
 - (vi) The shipment shall be subject to multilateral approval.
- (5) LSA material and SCO, except as otherwise specified in Regulation 44 (4) of these regulations, shall be packaged in accordance with Table 5.
- (6) The total activity in a single hold or compartment of an inland waterway craft, or in another conveyance, for carriage of LSA material or SCO in a Type IP-1, Type IP-2, Type IP-3 package or unpackaged, shall not exceed the limits shown in Table 6. For SCO-III, the limits in the Table 6 may be exceeded provided that the transport plan contains precautions which are to be employed during transport to obtain an overall level of safety at least equivalent to that which would be provided if the limits had been applied.

45. Determination of Transport Index.—(1) The TI for a package, overpack or freight container, or for unpackaged LSA-I, SCO-I or SCO-III, shall be the number derived in accordance with the following procedure:

- (a) Determine the maximum dose rate in units of millisieverts per hour (mSv/h) at a distance of 1 m from the external surfaces of the package, overpack, freight container or unpackaged LSA-I, SCO-I or SCO-III. 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 dose rate at any point 1 m from the external surface of the load may be taken as:
- (i) 0.4 mSv/h for ores and physical concentrates of uranium and thorium;
 - (ii) 0.3 mSv/h for chemical concentrates of thorium; and
 - (iii) 0.02 mSv/h for chemical concentrates of uranium, other than uranium hexafluoride.
- (b) For tanks, freight containers and unpackaged LSA-I, SCO-I or SCO-III, the value determined in Regulation 45 (1) (a) of these regulations shall be multiplied by the appropriate factor from Table 7.
- (c) The value obtained in Regulation 45 (1) (a) and (b) of these regulations 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 and the resulting number is the TI value (without unit).

(2) The TI for each rigid overpack, freight container or conveyance shall be determined as either the sum of the TIs of all the packages contained therein. For a shipment from a single consignor, the consignor may determine the TI by direct measurement of dose rate.

(3) The TI for non-rigid overpack shall be determined only as the sum of the TIs of all the packages within the overpack.

TABLE 5: INDUSTRIAL PACKAGE REQUIREMENTS FOR LSA MATERIAL, SCO-I AND SCO-II

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

Radioactive contents	Industrial package type	
	Exclusive use	Not under exclusive use
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 Regulation 44 (4) of these regulations, LSA-I material and SCO-I may be transported unpackaged.

**TABLE 6: CONVEYANCE ACTIVITY LIMITS
FOR LSA MATERIAL AND SCO IN INDUSTRIAL
PACKAGES OR UNPACKAGED**

Nature of material	Activity limit for conveyances other than inland waterway craft	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 ^a	100A ₂	10A ₂

^a For SCO-III see Regulation 44 (6) of these regulations.

**TABLE 7: MULTIPLICATION FACTORS FOR TANKS,
FREIGHT CONTAINERS AND UNPACKAGED LSA-I, SCO-I
AND SCO-III**

Size of load ^a	Multiplication factor
size of load $\leq 1 \text{ m}^2$	1
$1 \text{ m}^2 < \text{size of load} \leq 5 \text{ m}^2$	2
$5 \text{ m}^2 < \text{size of load} \leq 20 \text{ m}^2$	3
$20 \text{ m}^2 < \text{size of load}$	10

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

46. Determination of Criticality Safety Index for Consignments, Freight Containers and Overpacks.—The 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.

47. Limits on Transport Index, Criticality Safety Index and Dose Rates for Packages and Overpacks.—(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.

(2) Except for packages or overpacks transported under exclusive use by rail or by road under the conditions specified in Regulation 64 (3) (a), or under exclusive use and special arrangement by vessel or by air under the conditions specified in Regulation 65 (1) or 66 (3) of these regulations, respectively, the maximum dose rate at any point on the external surface of a package or overpack shall not exceed 2 mSv/h.

(3) The maximum dose rate at any point on the external surface of a package or overpack under exclusive use shall not exceed 10 mSv/h.

48. Categories.—(1) 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 8 and with the following requirements:

- (a) For a package, overpack or freight container, the TI and the surface dose rate conditions shall be taken into account in determining which category is appropriate. Where the TI satisfies the condition for one category but the surface dose rate 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 procedures specified in Regulation 45 of these regulations.
- (c) If the surface dose rate is greater than 2 mSv/h, the package or overpack shall be transported under exclusive use and under the provisions of Regulations 65 (1), 66 (3), 64 (3) (a) of these regulations, as appropriate.
- (d) A package transported under a special arrangement shall be assigned to category III-YELLOW except under the provisions of Regulation 49 of these regulations.
- (e) An overpack or freight container that contains packages transported under special arrangement shall be assigned to category III-YELLOW except under the provisions of Regulation 49 of these regulations.

TABLE 8: CATEGORIES OF PACKAGES, OVERPACKS AND FREIGHT CONTAINERS

Conditions		Category
TI	Maximum dose rate at any point on external surface	
0 ^a	Not more than 0.005 mSv/h	I-WHITE
More than 0 but not more than 1 ^a	More than 0.005 mSv/h but not more than 0.5 mSv/h	II-YELLOW
More than 1 but not more than 10	More than 0.5 mSv/h but not more than 2 mSv/h	III-YELLOW
More than 10	More than 2 mSv/h but not more than 10 mSv/h	III-YELLOW ^b

^a If the measured TI is not greater than 0.05, the value quoted may be zero in accordance with Regulation 45 (1) (c) of these regulations.

^b Shall also be transported under exclusive use except for freight containers (see Table 10).

49. Marking, Labelling and Placarding.—For each package or overpack, the UN number and proper shipping name shall be determined (see Table 1). In all cases of international transport of packages requiring competent authority 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, categorization, labelling and marking shall be in accordance with the certificate of the country of origin of design.

50. Marking.—(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 marks of all the packages within the overpack are clearly visible.

(2) Each package shall be legibly and durably marked on the outside with the UN marks as specified in Table 9. Additionally, each overpack shall be legibly and durably marked with the word “OVERPACK” and the UN marks as specified in Table 9 unless all the marks of the packages within the overpack are clearly visible.

(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.

TABLE 9: 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 Regulation 67 (2) of these regulations

^a See Table 1 for listing of UN numbers and proper shipping names.

(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"; and
- (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) of the country of origin of design 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.

(5) Each package that conforms to a design approved under one or more of Regulations 8 (1) (d) to 8 (1) (h) and 21 of these regulations 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 of the country of origin;

- (b) A serial number to identify uniquely each packaging that conforms to that design; and
 - (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) Each package that conforms to a Type B(U), Type B(M) or Type C package design shall have the outside of the outermost receptacle, that 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.
- (7) Any mark on the package made in accordance with the requirements of Regulation 50 (4) (a) and (b) and 50 (5) (c) of these regulations relating to the package type that does not relate to the UN number and proper shipping name assigned to the consignment shall be removed or covered.
- (8) Where LSA-I or SCO-I material is contained in receptacles or wrapping materials and is transported under exclusive use, as permitted by Regulation 44 (4) of these regulations, the outer surface of these receptacles or wrapping materials may bear the mark “RADIOACTIVE LSA-I” or “RADIOACTIVE SCO-I”, as appropriate.

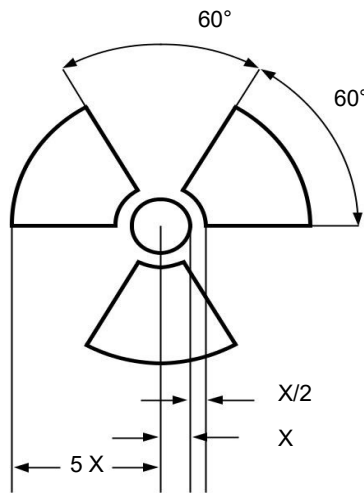


Fig. 1. Basic trefoil symbol with proportions based on a central circle of radius X . The minimum allowable size of X shall be 4 mm.

51. **Labelling.**—(1) Each package, overpack and freight container shall bear the labels conforming to the applicable models in Figs 2–4, except as allowed under the alternative provisions of Regulation 54 (1) of these regulations 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 Regulation 31 (1) of these regulations, 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 Regulation 41 of these regulations.

(2) The labels conforming to the applicable models in Figs 2–4 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 2–4. The labels shall not cover the marks specified in Regulation 50 (1) to 50 (6).

52. Labelling for Radioactive Contents.—(1) Each label conforming to the applicable models in Figs 2–4 shall be completed with the following information:

(a) Contents:

- (i) Except for LSA-I material, the names of the radionuclides as taken from Table 2, 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 names of the radionuclides. 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.

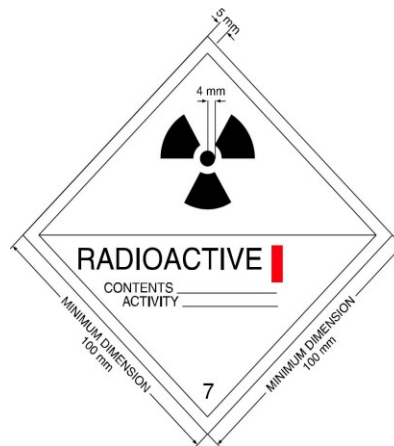


Fig. 2. Category I-WHITE label. The minimum width of the line inside the edge forming the diamond shall be 2 mm. The background colour of the label shall be

white, the colour of the trefoil and the printing shall be black, and the colour of the category bar shall be red.

- (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.



Fig. 3. Category II-YELLOW label. The minimum width of the line inside the edge forming the diamond shall be 2 mm. 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.

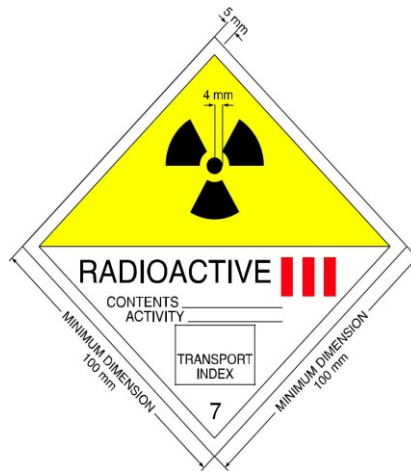


Fig. 4. Category III-YELLOW label. The minimum width of the line inside the edge forming the diamond shall be 2 mm. The background colour of the upper

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.

- (c) For overpacks and freight containers, the “contents” and “activity” entries on the label shall bear the information required in Regulation 52 (1) (a) and (b) of these regulations, 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 Regulation 45 (1) to 45 (3) of these regulations (except for Category I-WHITE).

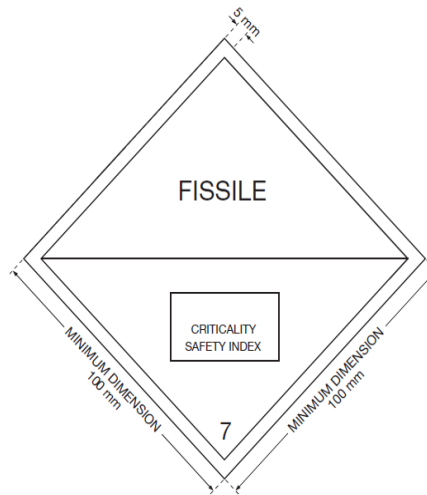


Fig. 5. CSI label. The minimum width of the line inside the edge forming the diamond shall be 2 mm. The background colour of the label shall be white, and the colour of the printing shall be black.

53. Labelling for Criticality Safety.—(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 of the country of origin of design or as specified in Regulations 87 (2) and 87 (3) of these regulations.

(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.

54. Placarding.—(1) Large freight containers carrying unpackaged LSA-I materials or SCO-I or 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 2–4, except having the minimum size shown in Fig. 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 1) 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 shown in Fig. 6, on all four sides of the freight container or tank.

55. Consignor's Responsibilities.—Except as otherwise provided in these regulations, no person may offer radioactive material for transport unless it is properly marked, labelled, placarded, described and certified on a transport document, and otherwise in a condition for transport as required by these regulations.

56. Particulars of Consignment.—(1) 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 Regulations 24 to 49, preceded by the letters “UN”.
- (b) The proper shipping name, as specified in accordance with the provisions of Regulations 24 to 49 of these regulations.
- (c) The UN dangerous goods class number “7”.
- (d) The subsidiary hazard class or division numbers corresponding to the subsidiary hazard labels 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.



Fig. 6. Placard. Except as permitted by Regulation 64 (1), minimum dimensions shall be as shown; when different dimensions are used, the relative proportions must 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.

- (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.

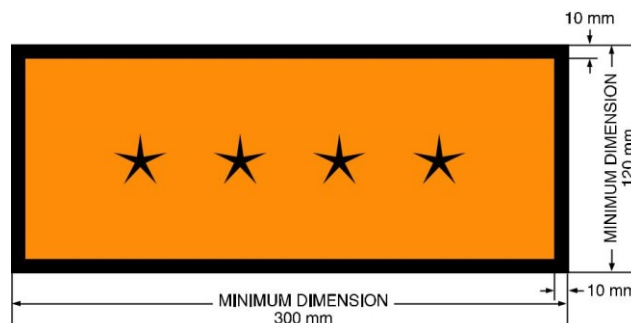


Fig. 7. Placard for separate display of UN number. The background colour of the placard shall be orange and the border and UN number shall be black. The symbol “****” denotes the space in which the appropriate UN number for radioactive material, as specified in Table 1, shall be displayed.

- (h) The category of the package, overpack or freight container, as assigned per Regulation 48 i.e. I-WHITE, II-YELLOW, III-YELLOW.
- (i) The TI as determined per Regulation 45 (1) to 45 (3) of these regulations (except for Category-I WHITE).
- (j) For fissile material:
 - i shipped under one exception of Regulation 31 (1) (a) to 31 (1) (f) of these regulations, reference to that Regulation;
 - ii shipped under Regulation 31 (1) (c) to 31 (1) (e) of these regulations, the total mass of fissile nuclides;
 - iii contained in a package for which one of Regulation 87 (2) (a) to 87 (2) (c) or Regulation 87 (3) of these regulations is applied, reference to that Regulation; and
 - 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 Regulation 31 (1) of these regulations, special arrangement, package design or shipment) applicable to the consignment.
- (l) For consignments of more than one package, the information contained in Regulation 56 (1) (a) to 56 (1) (k) 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, SCO-II and SCO-III, 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.

57. Consignor's Certification or Declaration.—(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 or placarded, and are in all respects in proper condition for transport in accordance with the applicable international and national regulations.”

(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.

(3) The declaration shall be signed and dated by the consignor. Facsimile signatures are acceptable where applicable laws and regulations recognize the legal validity of facsimile signatures.

(4) If the dangerous goods documentation is presented to the carrier by means of electronic data processing or electronic data interchange transmission techniques, the signatures may be replaced by the names (in capitals) of the person authorized to sign.

(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, those responsible for packing the container or vehicle shall provide a container or vehicle packing certificate specifying the container or vehicle identification numbers and certifying that the operation has been carried out in accordance with the applicable conditions of the International Maritime Dangerous Goods (IMDG) Code.

(6) The information required in the transport documents and the container or vehicle packing certificate may be incorporated into a single document, if not, the documents shall be attached. 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 or 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 recognize the legal validity of facsimile signatures.

(7) The declaration shall be made on the same transport document that contains the particulars of consignment listed in Regulation 56.

58. Information for Carriers.—(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 (see Regulation 62 (2) of these regulations), or a statement that no such requirements are necessary;
- (b) Restrictions on the mode of transport or conveyance and any necessary routing instructions; and
- (c) Emergency arrangements appropriate to the consignment.

(2) The consignor shall retain a copy of each of the transport documents containing the information specified in Regulations 56, 57 (1), 57 (5), 57 (6) and 58 (1) of these regulations, as applicable, for a minimum period of three (3) months. When the documents are kept electronically, the consignor shall be able to reproduce them in a printed form.

(3) The applicable competent authority certificates need not necessarily accompany the consignment. The consignor shall make the applicable certificates available to the carrier(s) before loading and unloading.

59. Specific Notification to Competent Authorities.—(1) Before the first shipment of any package requiring approval of competent authority, the consignor shall ensure that copies of each applicable competent authority certificate applying to that package design have been submitted to the competent authority of the country of origin of the shipment and to the competent authority of each country through or into which the consignment is to be transported. The consignor is not required to await an acknowledgement from the competent authority, nor is the competent authority required to make such acknowledgement of receipt of the certificate.

(2) For each shipment listed in (a), (b), (c) or (d) below, the consignor shall notify the competent authority of the country of origin of the shipment and the competent authority of each country through or into which the consignment is to be transported. This notification shall be in the possession of each competent authority prior to the commencement of the shipment, and preferably at least seven (7) days in advance of the shipment. The shipment that require consignor notification include:

- (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; and
 - (d) Shipments under special arrangement.
- (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 names of the radioactive materials or nuclides.
 - (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.
- (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.

60. Possession of Certificates and Instructions.—The consignor shall have in his or her possession a copy of each certificate required under these regulations and a copy of the instructions with regard to the proper closing of the package and other preparations for shipment before making any shipment under the terms of the certificates.

TRANSPORT AND STORAGE IN TRANSIT

61. Segregation during Transport and Storage in Transit.—(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; and
- (d) From other dangerous goods in accordance with Regulation 40 (3) of these regulations.

(2) 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 authorized to accompany such packages or overpacks.

62. Stowage during Transport and Storage in Transit.—(1) Consignments shall be securely stowed.

(2) Provided that its average surface heat flux does not exceed 15W/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.

(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 limited so that the sum of the TIs aboard the conveyance does not exceed the values shown in Table 10.

(b) The dose rate under routine conditions of transport shall not exceed 2 mSv/h at any point on the external surface of the vehicle or freight container, and 0.1 mSv/h at 2 m from the external surface of the vehicle or freight container except for consignments transported under exclusive use by road or rail, for which the radiation limits around the vehicle are set forth in Regulation 64 (3) (b) to 64 (3) (c) of these regulations.

(c) The sum of the CSIs in a freight container and aboard a conveyance shall not exceed the values shown in Table 11.

(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.

TABLE 10: 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 freight container	50
Large freight container	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

^a Packages or overpacks carried in or on a vehicle that are in accordance with the provisions of Regulation 64 (3) of these regulations may be transported by vessels provided that they are not removed from the vehicle at any time while on board the vessel.

63. Additional Requirements Relating to Transport and Storage in Transit of Fissile Material.—(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.

(2) Where the sum of the CSIs on board a conveyance or in a freight container exceeds 50, as permitted in Table 11, storage shall be such as to maintain a spacing of at least 6m from other groups of packages, overpacks or freight containers containing fissile material or other conveyances carrying radioactive material.

(3) Fissile material meeting one of the Regulation 31 (1) (a) to 31 (1) (f) of these regulations shall meet the following requirements:

- (a) Only one of the Regulation 31 (1) (a) to 31 (1) (f) of these regulations is allowed per consignment.
- (b) Only one approved fissile material in packages classified in accordance with Regulation 31 (1) (f) of these regulations is allowed per consignment unless multiple materials are authorized in the certificate of approval.
- (c) Fissile material in packages classified in accordance with Regulation 31 (1) (c) of these regulations shall be transported in a consignment with no more than 45 g of fissile nuclides.
- (d) Fissile material in packages classified in accordance with Regulation 31 (1) (d) of these regulations 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 Regulation 31 (1) (e) of these regulations shall be transported under exclusive use on a conveyance with no more than 45 g of fissile nuclides.

TABLE 11: CSI 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 freight container	50	Not applicable

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
Large freight container	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 that are in accordance with the provisions of Regulation 64 (3) of these regulations 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 as to maintain a spacing of at least 6 m from other groups.

^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 as to maintain a spacing of at least 6 m from other groups. The intervening space between groups may be occupied by other cargo in accordance with Regulation 40(3) of these regulations.

64. Additional Requirements Relating to Transport by Rail and by Road.—(1) Vehicles carrying packages, overpacks or freight containers labelled with any of the labels shown in Figs 2–5, or carrying unpacked LSA-I material, SCO-I or SCO-III shall display the placard shown in Fig. 6 on each of:

- (a) the two external lateral walls in the case of a rail vehicle; and
- (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.

(2) Where the consignment in or on the vehicle is unpackaged LSA-I material or SCO-I or SCO-III 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 (see Table 1) 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 Regulation 42 (2) (b) of these regulations 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.

(3) For consignments under exclusive use, the dose rate shall not exceed:

- (a) 10 mSv/h at any point on the external surface of any package or overpack, and may only exceed 2 mSv/h provided that:
 - (i) the vehicle is equipped with an enclosure that, during routine conditions of transport, prevents the access of unauthorized 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; and
 - (iii) there is no loading or unloading during the shipment.
- (b) 2 mSv/h at any point on the outer surfaces of the vehicle, including the upper and lower surfaces, or, in the case of an open vehicle, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load, and on the lower external surface of the vehicle.

- (c) 0.1 mSv/h at any point 2 m from the vertical planes represented by the outer lateral surfaces of the vehicle, or, if the load is transported in an open vehicle, at any point 2 m from the vertical planes projected from the outer edges of the vehicle.

(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.

65. Additional Requirements Relating to Transport by Vessels.—

(1) Packages or overpacks having a surface dose rate greater than 2 mSv/h, unless being carried in or on a vehicle under exclusive use in accordance with Table 10, footnote (a), shall not be transported by vessel except under special arrangement.

(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 specified in Regulation 62 (3) of these regulations provided that the following conditions are met:

- (a) A radiation protection program 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.

66. Additional Requirements Relating to Transport by Air.—(1)

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

(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.

(3) Packages or overpacks having a surface dose rate greater than 2 mSv/h shall not be transported by air except by special arrangement.

67. Additional Requirements Relating to Transport by Post.—(1) A consignment that conforms to the requirements of Regulation 43 (1) of these regulations, in which the activity of the radioactive contents does not exceed one tenth of the limits prescribed in Table 4, and that does not contain uranium hexafluoride, may be accepted for domestic movement by national postal authority (Pakistan Post), subject to such additional requirements as postal authority may prescribe.

(2) A consignment that conforms to the requirements of Regulation 43 (1) of these regulations, in which the activity of the radioactive contents does not exceed one tenth of the limits prescribed in Table 4, 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) The consignment shall be deposited with the postal service only by consignors authorized by the national authority.
- (b) The consignment shall be dispatched by the quickest route, normally by air.
- (c) The consignment 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) The consignment 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.

68. 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 be restored to its original condition by the licensee.

69. Undeliverable Consignments.— Where a consignment is undeliverable, it shall be placed in a safe location and the Authority shall be informed as soon as possible and a request made for instructions on further action.

70. Retention and Availability of Transport Documents by Carriers.—(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 these regulations are provided; or
- (b) the information applicable to the consignment is provided in electronic form.

(2) The information applicable to the consignment shall accompany the consignment to its 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.

(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 the consignment's final destination. The information shall be able to be produced without delay in a printed form.

(4) The carrier shall retain a copy of the transport document and additional information and documentation, as specified in these regulations, for a minimum period of three (3) months.

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

REQUIREMENTS FOR RADIOACTIVE MATERIAL, PACKAGINGS AND PACKAGES

71. Requirements for LSA-III Material.—The Authority may specify requirements for LSA-III material, if required.

72. Requirements for Special Form Radioactive Material.—(1) Special form radioactive material shall have at least one dimension of not less than 5 mm.

(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 Regulations 96 to 98 of these regulations, it shall meet the following requirements:

- (a) It would not break or shatter under the impact, percussion and bending tests in Regulation 97 (1) to 97 (3) and 97 (5) (a) of these regulations, as applicable.
- (b) It would not melt or disperse in the heat test in Regulation 97 (4) or 97 (5) (a), as applicable.

- (c) The activity in the water from the leaching tests specified in Regulation 98 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: Radiation Protection — Sealed Radioactive Sources — Leakage Test Methods (ISO 9978), would not exceed the applicable acceptance threshold acceptable to the Authority.

(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.

73. Requirements for Low Dispersible Radioactive Material.—(1) 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 dose rate at 3 m from the unshielded radioactive material does not exceed 10 mSv/h.
- (b) If subjected to the tests specified in Regulation 109 (3) and 109 (4) of these regulations, the airborne release in gaseous and particulate forms of up to 100 μm aerodynamic equivalent diameter would not exceed 100A₂. A separate specimen may be used for each test.
- (c) If subjected to the test specified in Regulation 95 of these regulations, the activity in the water would not exceed 100A₂. In the application of this test, the damaging effects of the tests specified in (b) shall be taken into account.

74. Requirements for Material Excepted from Fissile Classification.—(1) A fissile material excepted from classification as “FISSILE” under Regulation 31 (1) (f) of these regulations shall be subcritical without the need for accumulation control under the following conditions:

- (a) The conditions of Regulation 87 (1) (a) of these regulations;
- (b) The conditions consistent with the assessment provisions stated in Regulations 91 (1) (b) and 92 (1) (b) of these regulations for packages; and
- (c) The conditions specified in Regulation 90 (4) (a) of these regulations, if transported by air.

75. General Requirements for All Packagings and Packages.—(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.

(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 these regulations would not be impaired. The design shall take account of appropriate safety factors to cover snatch lifting.

(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 Regulation 75 (2) of these regulations or shall be removable or otherwise rendered incapable of being used during transport.

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

(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.

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

(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.

(8) The design of the package shall take into account ageing mechanisms.

(9) 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.

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

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

(12) 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 dose rate at any point on the external surface of the package would not exceed the values specified in Regulations 43 (2), 47 (2) and 47 (3), as applicable, with account taken of Regulations 62 (3) (b) and 64 (3) of these regulations.

(13) For radioactive material having other dangerous properties, the package design shall take into account those properties (see Regulation 7 (1) (d) and 41 of these regulations).

76. Additional Requirements for Packages Transported by Air.—

(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.

(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.

(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.

77. Requirements for Excepted Packages.—An excepted package shall be designed to meet the requirements specified in Regulation 75 and, in addition, the requirements of Regulation 83 (2) if it contains fissile material allowed by one of the provisions of Regulation 31 (1) (a) to 31 (1) (f) of these regulations, and requirements of Regulation 76 of these regulations if carried by air.

78. Requirements for Type IP-1.—A Type IP-1 package shall be designed to meet the requirements specified in Regulation 75 and 83 (2) of these regulations and, in addition, the requirements of Regulation 76 of these regulations if carried by air.

79. Requirements for Type IP-2.—(1) A package to be qualified as Type IP-2 shall be designed to meet the requirements for Type IP-1 as specified in Regulation 78 and, in addition, if it were subjected to the tests specified in Regulation 104 (4) and 104 (5) of these regulations, it would prevent:

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

80. **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 as specified in Regulation 78 and, in addition, the requirements specified in Regulation 83 (2) to 83 (15) of these regulations.

81. **Alternative Requirements for Type IP-2 and Type IP-3.**—(1) Packages may be used as Type IP-2, provided that:

- (a) they satisfy the requirements for Type IP-1 specified in Regulation 78 of these regulations;
- (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; and
- (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; and
 - (ii) more than a 20% increase in the maximum dose rate at any external surface of the package.

(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 specified in Regulation 78 of these regulations;
- (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, or other requirements, at least equivalent, and are capable of withstanding a test pressure of 265 kPa; and
- (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 dose rate at any external surface of the portable tanks.

(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 as prescribed in Table 5, provided that:

- (a) they satisfy the requirements for Type IP-1 specified in Regulation 78 of these regulations;
 - (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; and
 - (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 dose rate at any external surface of the tanks.
- (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 specified in Regulation 78 of these regulations; and
 - (c) they are designed to conform to the International Organization for Standardization document ISO: Series 1 Freight Containers — Specifications and Testing — Part 1: General Cargo Containers for General Purposes (ISO-1496-1) 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 dose rate at any external surface of the freight containers.
- (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 specified in Regulation 78 of these regulations; and
 - (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, 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 dose rate at any external surface of the IBC.

82. Requirements for Packages Containing Uranium Hexafluoride.—(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 these regulations. Except as allowed in Regulation 82 (4) of these regulations, uranium hexafluoride in quantities of 0.1 kg or more shall also be packaged and transported in accordance with the provisions of the International Organization for Standardization document Nuclear Energy - Packaging of Uranium Hexafluoride (UF₆) for Transport (ISO 7195) and the requirements of Regulation 82 (2) and 82 (3) of these regulations.

(2) Each package designed to contain 0.1 kg or more of uranium hexafluoride shall be so designed that the package will meet the following requirements:

- (a) Withstand, without leakage and without unacceptable stress, as specified in ISO 7195, the structural test as specified in Regulation 103, except as allowed in Regulation 82 (4) of these regulations;
- (b) Withstand, without loss or dispersal of the uranium hexafluoride, the free drop test specified in Regulation 104 (4) of these regulations; and
- (c) Withstand, without rupture of the containment system, the thermal test specified in Regulation 106 (3), except as allowed in Regulation 82 (4) of these regulations.

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

(4) Subject to multilateral approval, packages designed to contain 0.1 kg or more of uranium hexafluoride may be transported if the packages are designed:

- (a) to international or national standards other than ISO 7195, 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 Regulation 103 of these regulations; and/or

- (c) To contain 9000 kg or more of uranium hexafluoride and the packages do not meet the requirement of Regulation 82 (2) (c) of these regulations.

In all other respects, the requirements specified in Regulation 82 (1) to 82 (3) of these regulations shall be satisfied.

83. Requirements for Type A Packages.—(1) Type A packages shall be designed to meet the requirements specified in Regulation 75 and, in addition, the requirements of Regulation 76 if carried by air, and of Regulation 83 (2) to 83 (17) of these regulations.

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

(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.

(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 these regulations.

(5) The design of the package shall take into account temperatures ranging from -40°C to $+70^{\circ}\text{C}$ 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.

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

(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.

(8) Special form radioactive material may be considered as a component of the containment system.

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

(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.

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

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

(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.

(14) A package shall be so designed that if it were subjected to the tests specified in Regulation 104 of these regulations, it would prevent:

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

(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.

(16) A Type A package designed to contain liquid radioactive material shall, in addition:

- (a) Be adequate to meet the conditions specified in Regulation 83 (14)
 - (a) if the package is subjected to the tests specified in Regulation 105 of these regulations; 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.

(17) A Type A package designed for gases shall prevent loss or dispersal of the radioactive contents if the package were subjected to the tests specified in Regulation 105 of these regulations, except for a Type A package designed for tritium gas or noble gases.

84. Requirements for Type B(U) Packages.—(1) Type B(U) packages shall be designed to meet the requirements specified in Regulation 75, the requirements specified in Regulation 76 if carried by air, and in Regulation 83 (2) to 83 (15), except as specified in Regulation 83 (14) (a), and, in addition, the requirements of Regulation 84 (2) to 84 (15) of these regulations.

(2) A package shall be so designed that, under the ambient conditions specified in Regulation 84 (5) and 84 (6) of these regulations, heat generated within the package by the radioactive contents shall not, under normal conditions of transport, as demonstrated by the tests in Regulation 104 of these regulations, 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 of 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.

(3) A package shall be so designed that, under the ambient condition specified in Regulation 84 (5) of these regulations 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.

(4) Except as required in Regulation 76 (1) of these regulations 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 Regulation 84 (5) of these regulations. Account may be taken of barriers or screens intended to give protection to persons without the need for the barriers or screens being subject to any test.

- (5) The ambient temperature shall be assumed to be 38°C.

(6) The solar insolation conditions shall be assumed to be as specified in Table 12.

(7) A package that includes thermal protection for the purpose of satisfying the requirements of the thermal test specified in Regulation 106 (3) shall be so designed that such protection will remain effective if the package is subjected to the tests specified in Regulation 104 and Regulation 106 (2) (a) and (b) or 106 (2) (b) and (c) of these regulations, as appropriate. Any such protection on the exterior of the package shall not be rendered ineffective by ripping, cutting, skidding, abrading or rough handling.

(8) A package shall be so designed that if it were subjected to:

- (a) the tests specified in Regulation 104 of these regulations, it would restrict the loss of radioactive contents to not more than $10^{-6} A_2$ per hour.
- (b) the tests specified in Regulation 106 (1), 106 (3), 106 (4) and 106 (2) (b) of these regulations and either the test in:

— Regulation 106 (2) (c) of these regulations, 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

— Regulation 106 (2) (a) of these regulations, for all other packages.

- (i) It would retain sufficient shielding to ensure that the dose rate at 1 m from the surface of the package would not exceed 10 mSv/h 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.

TABLE 12: 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

Case	Form and location of surface	Insolation for 12 h per day (W/m ²)
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 neighboring objects neglected.

Where mixtures of different radionuclides are present, the provisions of Regulation 26 (3) to 26 (5) of these regulations 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 non-fixed contamination limits of Regulation 42 (1) of these regulations.

(9) A package for radioactive contents with activity greater than $10^5 A_2$ shall be so designed that if it were subjected to the enhanced water immersion test specified in Regulation 107 of these regulations, there would be no rupture of the containment system.

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

(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 Regulations 104 and 106 of these regulations.

(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 Regulations 104 and 106 of these regulations, 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.

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

(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.

(15) A package shall be designed for an ambient temperature range of -40°C to $+38^\circ\text{C}$.

85. Requirements for Type B(M) Packages.—(1) Type B(M) packages shall meet the requirements for Type B(U) packages specified in Regulation 84 (1), except that for packages to be transported solely within a specified country or solely between specified countries, conditions other than those given in Regulations 83 (5), 84 (4) to 84 (6), 84 (9) to 84 (15) of these regulations may be assumed with the approval of the competent authorities of these countries. The requirements for Type B(U) packages specified in Regulation 84 (4) and 84 (9) to 84 (15) of these regulations shall be met as far as practicable.

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

86. Requirements for Type C Packages.—(1) Type C packages shall be designed to meet the requirements specified in Regulations 75 to 76 and 83 (2) to 83 (15), except as specified in Regulation 83 (14) (a), and the requirements specified in Regulations 84 (2) to 84 (6), 84 (10) to 84 (15) and 86 (2) to 86 (4) of these regulations.

(2) A package shall be capable of meeting the assessment criteria prescribed for tests in Regulation 84 (8) (b) and 84 (12) of these regulations after burial in an environment defined by a thermal conductivity of $0.33 \text{ W/(m}\cdot\text{K)}$ 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 .

(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 Regulation 104 of these regulations, it would restrict the loss of radioactive contents to not more than $10^{-6}A_2$ per hour.
- (b) the test sequences in Regulation 109 (1) of these regulations:
 - (i) It would retain sufficient shielding to ensure that the dose rate at 1 m from the surface of the package would not exceed 10 mSv/h 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 Regulation 26 (3) to 26 (5) of these regulations 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 Regulation 42 (1) of these regulations.

(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 specified in Regulation 107 of these regulations.

87. Requirements for Packages Containing Fissile Material.—(1)
Fissile material shall be transported so as to:

- (a) maintain subcriticality 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; and
 - (vi) Temperature changes.
- (b) meet the requirements:
 - (i) of Regulation 83 (2) except for unpackaged material when specifically allowed by Regulation 31 (1) (e) of these regulations;
 - (ii) prescribed elsewhere in these regulations that pertain to the radioactive properties of the material;
 - (iii) of Regulation 83 (3) unless the material is excepted by Regulation 31 (1) of these regulations; and
 - (iv) of Regulations 88 to 93, unless the material is excepted by Regulations 31 (1), 87 (2) or 87 (3) of these regulations.

(2) Packages containing fissile material that meets the requirements of Regulation 87 (2) (d) and one of the provisions of Regulation 87 (2) (a) to (c) are excepted from the requirements of Regulations 88 to 93 of these regulations.

(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 CSI of the package is calculated using the following formula:

$$CSI = 50 \times 5 \times \{[mass\ of\ uranium-235\ in\ package\ (g)]/Z$$

$$+ [mass\ of\ other\ fissile\ nuclides^1\ in\ package\ (g)]/280\}$$
 where the values of Z are taken from Table 13; and

(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 Regulation 104 of these regulations:
 - Retains its fissile material contents;
 - Preserves the minimum overall outside dimensions of the package to at least 30 cm; and
 - Prevents the entry of a 10 cm cube.

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

$$CSI = 50 \times 2 \times \{[mass\ of\ uranium-235\ in\ package\ (g)]/Z$$

$$+ [mass\ of\ other\ fissile\ nuclides^1\ in\ package\ (g)] / 280\}$$

where the values of Z are taken from Table 13; and

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

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

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*.

- (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 Regulation 104 of these regulations:
 - Retains its fissile material contents;
 - Preserves the minimum overall outside dimensions of the package to at least 10 cm; and
 - Prevents the entry of a 10 cm cube.
- (iii) the CSI of the package is calculated using the following formula:

$$CSI = 50 \times 2 \times \{[mass\ of\ uranium-235\ in\ package\ (g)]/450 + [mass\ of\ other\ fissile\ nuclides^1\ in\ package\ (g)]/280\}$$
- (iv) the total 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 the total concentration of these materials 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 13: VALUES OF Z FOR CALCULATION OF CSI
IN ACCORDANCE WITH REGULATION 87 (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 uranium-235, then the value corresponding to the highest enrichment shall be used for Z.

(3) Packages containing not more than 1000 g of plutonium are excepted from the application of Regulation 88 to 93 of these regulations 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:
$$CSI = 50 \times 2 \times [mass\ of\ plutonium\ (g)/1000]$$
- (c) if uranium is present with the plutonium, the mass of uranium shall be no more than 1% of the mass of the plutonium.

88. Contents Specification for Assessments of Package Designs Containing Fissile Material.—(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 Regulations 90 to 92 of these regulations 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.

(2) For irradiated nuclear fuel, the assessments of Regulations 90 to 92 of these regulations 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.

89. Geometry and Temperature Requirements.—(1) The package, after being subjected to the tests specified in Regulation 104 of these regulations, shall:

- (a) preserve the minimum overall outside dimensions of the package to at least 10 cm; and
- (b) prevent the entry of a 10 cm cube.

(2) The package shall be designed for an ambient temperature range of -40°C to $+38^{\circ}\text{C}$ unless specified in the certificate of approval for the package design.

90. Assessment of an Individual Package in Isolation.—(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 Regulation 92 (1) (b) of these regulations, a high degree of quality control in the manufacture, maintenance and repair of packagings, 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 Regulation 92 (1) (b) of these regulations, there is no physical contact between the valve or the plug and any other component of the packaging other than at its original point of attachment and where, in addition, following the test prescribed in Regulation 106 (3) of these regulations, the valves or the plugs remain leak tight;
 - (ii) A high degree of quality control in the manufacture, maintenance and repair of packagings, coupled with tests to demonstrate closure of each package before each shipment.
- (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 Regulation 92 (1) (b), close reflection of the package by at least 20 cm of water may be assumed in Regulation 90 (3) (c) of these regulations.
- (3) The package shall be subcritical under the conditions of Regulations 90 (1) and 90 (2) of these regulations 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 Regulation 91 (1) (b) of these regulations; and
 - (c) the tests specified in Regulation 92 (1) (b) of these regulations.
- (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 Regulation 109 (4) of these regulations, assuming reflection by at least 20 cm of water but no water in-leakage.

- (b) In the assessment of Regulation 90 (3), use of special features as specified in Regulation 90 (1) is allowed provided that the leakage of water into or out of void spaces is prevented when the package is submitted to the Type C package tests specified in Regulation 109 (1) followed by the water leakage test specified in Regulation 108 (3) of these regulations.

91. Assessment of Package Arrays Under Normal Conditions of Transport.—(1) 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 Regulation 104 of these regulations.

92. Assessment of Package Arrays Under Accident Conditions of Transport.—(1) 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 specified in Regulation 104 of these regulations followed by whichever of the following is the more limiting:
 - (i) The tests specified in Regulation 106 (2) (b) and either Regulation 106 (2) (c) for packages having a mass not greater than 500 kg and an overall density not greater than 1000 kg/m³ based on the external dimensions or Regulation 106 (2) (a) for all other packages, followed by the test specified in Regulation 106 (3) and completed by the tests specified in Regulation 108 of these regulations; or
 - (ii) The test specified in Regulation 106 (4) of these regulations.
- (c) Where any part of the fissile material escapes from the containment system following the tests specified in Regulation 92 (1) (b) of these regulations, 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.

93. 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 Regulations 91 and 92 of these regulations (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).

TEST PROCEDURES

94. Demonstration of Compliance.—(1) Demonstration of compliance with the performance standards required in Regulations 72 to 93 of these regulations shall be accomplished by any of the following methods listed below or by a combination thereof:

- (a) Performance of tests with specimens representing 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.

(2) 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 Regulations 72 to 93 of these regulations.

95. Leaching Test for Low Dispersible Radioactive Material.—A solid material sample representing the entire contents of the package shall be immersed for seven (07) 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 seven (07) 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 at 20°C. The total activity of the free volume of water shall be measured following the seven (07) day immersion of the test sample.

96. Tests for Special Form Radioactive Material - General.—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 in Regulation 97 (1) to 97 (4) of these regulations. 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 given in Regulation 98 (1) for indispensable solid material or in Regulation 98 (2) of these regulations for encapsulated material.

97. Test Methods.—(1) Impact test: The specimen shall drop onto the target from a height of 9 m. The target shall be as defined in Regulation 102 of these regulations.

(2) 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 from a height of 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.

(3) 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 from a height of 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) 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.

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

- (a) the tests prescribed in Regulations 97 (1) and 97 (2) of these regulations, provided that the specimens are alternatively subjected to the impact test prescribed in the International Organization for Standardization — Radiological Protection: Sealed Radioactive Sources — General Requirements and Classification (ISO 2919):
 - (i) The Class 4 impact test if the mass of the special form radioactive material is less than 200 g; and
 - (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 test prescribed in Regulation 97 (4) of these regulations, provided the specimens are alternatively subjected to the Class 6 temperature test specified in ISO 2919.

98. Leaching and Volumetric Leakage Assessment Methods.—(1)
For specimens that comprise or simulate indispersible solid material, a leaching assessment shall be performed as follows:

- (a) The specimen shall be immersed for seven (07) 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 seven (07) 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 at 20°C.
- (b) The water and the specimen shall then be heated to a temperature of $50 \pm 5^{\circ}\text{C}$ 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 seven (07) 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 and the specimen shall be heated to $50 \pm 5^{\circ}\text{C}$ and maintained at this temperature for 4 h.
- (f) The activity of the water shall then be determined.

(2) 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 at 20°C.
 - (ii) The water and the specimen shall then be heated to a temperature of $50 \pm 5^\circ\text{C}$ 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 seven (07) 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: Radiation Protection — Sealed Radioactive Sources — Leakage Test Methods (ISO 9978) provided that they are acceptable to the competent authority of the country of origin.

99. Tests for Low Dispersible Radioactive Material.—A specimen that comprises or simulates low dispersible radioactive material shall be subjected to the enhanced thermal test specified in Regulation 109 (3) and the impact test specified in Regulation 109 (4) of these regulations. A different specimen may be used for each of the tests. Following each test, the specimen shall be subjected to the leach test specified in Regulation 95 of these regulations. After each test it shall be determined if the applicable requirements of Regulation 73 of these regulations have been met.

100. Tests for Packages - Preparation of a Specimen for Testing.—
(1) 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; and

- (d) Distortion of features.
- (2) The containment system of the package shall be clearly specified.
- (3) 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.

101. Testing the Integrity of the Containment System and Shielding and Assessing Criticality Safety.—(1) After each test or group of tests or sequence of the applicable tests, as appropriate, specified in Regulations 103 to 109 of these regulations:

- (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 Regulations 72 to 93 of these regulations 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 Regulation 87 to 93 of these regulations for one or more packages are valid.

102. Target for Drop Tests.—The target for the drop test specified in Regulations 97 (1), 104 (4), 106 (2) and 109 (2) and 105 (1) (a) of these regulations 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.

103. Test for Packagings Designed to Contain Uranium Hexafluoride.—Specimens that comprise or simulate packagings 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 packagings, any other equivalent non-destructive testing may be applied, subject to multilateral approval.

104. Tests for Demonstrating Ability to Withstand Normal Conditions of Transport.—(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 requirements of Regulation 104 (2) of these regulations are fulfilled.

(2) 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, however, if the water spray is applied from each of the four directions consecutively.

(3) 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.

(4) 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 the 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 14 for the applicable mass. The target shall be as defined in Regulation 103 of these regulations.
- (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.

(5) 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.

TABLE 14: FREE DROP DISTANCE FOR TESTING PACKAGES TO NORMAL CONDITIONS OF TRANSPORT

Package mass (kg)	Free drop distance (m)
package mass < 5000	1.2
5000 ≤ package mass < 10000	0.9
10000 ≤ package mass < 15000	0.6
15000 ≤ package mass	0.3

(6) 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 the 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.

105. Additional Tests for Type A Packages Designed for Liquids and Gases.—(1) A specimen, or separate specimens, shall be subjected to each of the following tests unless it can be demonstrated that one test is more severe for the specimen in question than the other, in which case one specimen shall be subjected to the more severe test:

- (a) Free drop test: The specimen shall drop onto the target so as to suffer the maximum damage in respect of containment. The height of the drop measured from the lowest part of the specimen to the upper surface of the target, shall be 9 m. The target shall be as defined in Regulation 102 of these regulations.
- (b) Penetration test: The specimen shall be subjected to the test specified in Regulation 104 (6), except that the height of the drop shall be increased to 1.7 m from the 1 m specified in Regulation 104 (6) (b) of these regulations.

106. Tests for Demonstrating Ability to Withstand Accident Conditions of Transport.—(1) The specimen shall be subjected to the cumulative effects of the tests specified in Regulation 106 (2) and 106 (3) of these regulations, in that order. Following these tests, either this specimen or a separate specimen shall be subjected to the effects of the water immersion tests,

as specified in Regulation 106 (4) and, if applicable, Regulation 107 of these regulations.

(2) Mechanical test: The mechanical test consists of three different drop tests. Each specimen shall be subjected to the applicable drops, as specified in Regulation 84 (8) or 92 of these regulations. 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 Regulation 102 of these regulations.
- (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 cross 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 described in Regulation 102 of these regulations.
- (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 $1 \text{ m} \times 1 \text{ m}$ 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 Regulation 102 of these regulations.

(3) 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 12 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 12 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 decreasing in all parts of the specimen 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.

(4) 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.

107. 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.

108. Water Leakage Test for Packages Containing Fissile Material.—(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 Regulations 90 to 92 shall be excepted from the water leakage test.

(2) Before the specimen is subjected to the water leakage test specified below, it shall be subjected to the tests in Regulation 106 (2) (b) and either 106 (2) (a) or 106 (2) (c), as required by Regulation 92 and the test specified in Regulation 106 (3) of these regulations.

(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.

109. Tests for Type C Packages.—(1) Specimens shall be subjected to the effects of the following test sequences:

- (a) The tests specified in Regulation 106 (2) (a), 106 (2) (c), 109 (2) and 109 (3) of these regulations, in this order;
- (b) The test specified in Regulation 109 (4) of these regulations.

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

(2) 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 in Regulation 109 (1) (a) of these regulations:

- (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 Regulation 102 of these regulations.
- (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 Regulation 102 of these regulations.

(3) Enhanced thermal test: The conditions for this test shall be as specified in Regulation 106 (3) of these regulations, except that the exposure to the thermal environment shall be for a period of 60 min.

(4) Impact test: The specimen shall be subject 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 Regulation 102 of these regulations, except that the target surface may be at any orientation as long as the surface is normal to the specimen path.

110. **Repeal.**—The "Regulations for the Safe Transport of Radioactive Material - PAK/916" notified *vide* S.R.O. 333(I)/2007 dated April 20, 2007 are hereby repealed.

[Ref: PNRA-PPD-02(16)/17.]

NAVEED MAQBUL,
Member (Corporate).