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CPR Part 4

REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIAL IN THE PHILIPPINES

TABLE OF CONTENTS

		Page
I. GENERAL PROVISIONS		
Section 1.	Purpose	1
Section 2.	Scope	1
Section 3.	Definitions	2
Section 4.	Interpretation	6
Section 5.	Communication	6
Section 6.	Specific Regulatory Exemptions	6
Section 7.	Transport Regulations Addressed by Other National Modal Agencies	6
Section 8.	Authorization to Transport Radioactive Material	6
II. ADMINISTRATIVE REQUIREMENTS		
Section 9.	Radiation Protection Program for Transport of Radioactive Material	7
Section 10.	Transport Documents	7
Section 11.	Permit to Transport	8
Section 12.	Management System	9
Section 13.	Emergency Response	9
Section 14.	Non-compliance	9
Section 15.	Special Arrangement	9
Section 16.	Training	10
Section 17.	Retraining	11
Section 18.	Information for Carriers	11
III. ACTIVITY LIMITS AND CLASSIFICATIONS		
Section 19.	Assignment of UN Numbers	11
Section 20.	Determination of Basic Radionuclide Values	11
Section 21.	Classification of Material	13
Section 22.	Classification of Packages	15
IV. TECHNICAL REQUIREMENTS AND CONTROLS FOR TRANSPORT		
Section 23	Requirements Before the First Shipment	18
Section 24.	Requirements Before Each Shipment	18
Section 25.	Consignor's Responsibilities	19
Section 26.	General Requirements for Packaging and Packages	20

Section 27.	Requirements and Controls for Contamination and for Leaking Packages	21
Section 28.	Requirements and Controls for Transport of Packages	21
Section 29.	Determination of Transport Index (TI)	23
Section 30.	Limits on TI and Radiation Levels for Packages and Overpack	24
Section 31.	Categories of Packages, Overpack and Freight Containers	24
Section 32.	Marking, Labelling, Placarding	25
Section 33.	Requirements on Segregation and Stowage during Transport and Storage in Transit	30
Section 34.	Transport of Other Goods	31
Section 35.	Additional Requirements Relating to Transport by Rail and by Road	31
Section 36.	Additional Requirements Relating to Transport by Air	32
Section 37.	Additional Requirements Relating to Transport by Sea and Inland Waters, or by Special Use Vessel	33
Section 38	Import/Export Controls	33

V. TEST PROCEDURES

Section 39.	Leaching Test for LSA-III Material	33
Section 40.	Tests for Special Form Radioactive Material	34
Section 41.	Tests for Low Dispersible Radioactive Material	35
Section 42.	Tests for Packages	35

VI. RECORDS, REPORTS AND NOTIFICATION

Section 43.	Records	38
Section 44.	Reports	38
Section 45.	Notification of Incidents	39

VII. INSPECTION AND ENFORCEMENT

Section 46.	Inspections	39
Section 47.	Enforcement	39

VIII. EFFECTIVITY

Section 48.	Effective Date	40

FIGURES

Figure 1	Figure 1. Basic trefoil symbol	27
Figure 2	Figure 2. Category I-WHITE label	27
Figure 3	Figure 3. Category II-YELLOW label	28
Figure 4	Figure 4. Category III-YELLOW label	28
Figure 5	Figure 5. Placard	29
Figure 6	Figure 6. Placard for separate display of United Nations number	29

TABLES

Table I	TABLE I. BASIC RADIONUCLIDE VALUES FOR UNKNOWN RADIONUCLIDES OR MIXTURES	13
Table II	TABLE II. ACTIVITY LIMITS FOR EXCEPTED PACKAGES	16
Table III	TABLE III. INDUSTRIAL PACKAGE REQUIREMENTS FOR LSA MATERIAL AND SCO	22
Table IV	TABLE IV. CONVEYANCE ACTIVITY LIMITS FOR LSA MATERIAL AND SCO IN INDUSTRIAL PACKAGES OR UNPACKAGED	23
Table V	TABLE V. MULTIPLICATION FACTORS FOR TANKS, □ FREIGHT CONTAINERS AND UNPACKAGED LSA-I□ AND SCO-I	23
Table VI	TABLE VI. CATEGORIES OF PACKAGES, OVERPACKS AND FREIGHT CONTAINERS	25
Table VII	TABLE VII. UN MARKING FOR PACKAGES AND OVERPACKS	26
Table VIII	TABLE VIII. TRANSPORT INDEX LIMITS FOR FREIGHT CONTAINERS AND CONVEYANCES NOT UNDER EXCLUSIVE USE	31
Table IX	TABLE IX. FREE DROP DISTANCE FOR TESTING PACKAGES TO NORMAL CONDITIONS OF TRANSPORT	36

APPENDICES

Appendix A	EXCERPTS FROM THE LIST OF UN NUMBERS, PROPER SHIPPING NAMES AND DESCRIPTIONS	41
Appendix B	APPENDIX B. BASIC RADIONUCLIDE VALUES	43
Appendix C	APPENDIX C. TI LIMITS FOR FRIEGHT CONTAINERS AND CONVEYANCES NOT UNDER EXLUSIVE USE	56

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PHILIPPINE NUCLEAR RESEARCH INSTITUTE
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CPR Part 4. REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIAL IN THE PHILIPPINES

I. GENERAL PROVISIONS

Section 1. Purpose.

(a) This Part is promulgated pursuant to Sections 4(i) and 18 of Republic Act No. 5207, as amended, which provides for the establishment and issuance of regulations and orders for the transport of atomic energy materials and facilities to ensure safety and protection of persons, property and the environment from radiation and thermal hazards associated with the transport of radioactive material.

(b) This Part prescribes for the requirements and provisions for the safe transport of radioactive material in the Philippines.

Section 2. Scope.

(a) This Part shall apply to the transport of radioactive material in the Philippines by all modes of transport, by land, water and air, including transport that is incidental to the use of the radioactive material. This Part applies a graded approach in specifying the performance standards, which are characterized in terms of three general severity levels:
   (1) Routine conditions of transport (incident free);
   (2) Normal conditions of transport (minor mishaps);
   (3) Accident conditions of transport.

(b) This Part establishes the requirements for:
   (1) radioactive material for transport anywhere in the Philippines;
   (2) packaging and packages;
   (3) preparation for shipment, consigning, loading, carriage including in-transit storage, unloading and receipt at the final destination of loads of radioactive material and packages;
   (4) procedures and standards for the control of shipments and for the approval of packaging and packages;
   (5) maintenance and repair of packaging;

(c) The requirements in this Part shall apply to license holders specifically authorized by the Philippine Nuclear Research Institute (PNRI) to transport radioactive materials, as may be provided for by law and relevant regulations and orders.

(d) The requirements in this Part shall apply in conjunction with the radiation safety requirements of CPR Part 3, “Standards for Protection against Radiation” and radioactive source security requirements of CPR Part 26, “Security of Radioactive Sources” and CPR Part 27, “Security Requirements in the Transport of Radioactive

Material" and all other applicable regulations of other government agencies with jurisdiction in all modes of transport.

(e) The requirements in this Part do not apply to any of the following:

(1) Radioactive material that is an integral part of the means of transport

(2) Radioactive material moved within an establishment which is subject to appropriate safety regulations in force in the establishment and where the movement does not involve public roads or railways;

(3) Radioactive material implanted or incorporated into a person or live animal either for diagnostic or therapeutic purposes;

(4) 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.

(5) Radioactive material in consumer products that have received regulatory approval, following their sale to the end user;

(6) Natural material and ores containing naturally occurring radionuclides which may have been processed, provided that, the activity concentration of the radioactive material does not exceed ten (10) times the values specified in Appendix B of this Part or calculated in accordance with the provisions of Section 19 of this Part. For natural materials and ores containing naturally occurring radionuclides that are not in secular equilibrium, the calculation of the activity concentration shall be performed in accordance with the provisions of Section 19of this Part;

(7) Non-radioactive solid objects with radioactive substances present on any surfaces in quantities not in excess of 0.4 Bq/cm^2 for beta and gamma emitters and low toxicity alpha emitters or 0.04 Bq/cm^2 for all other alpha emitters;

(8) Nuclear material as defined in the Convention on the Physical Protection of Nuclear Material, except for sources incorporating Plutonium-239, such as in PuBe neutron sources; and

(9) Radioactive materials in exempt quantity which is specified in Appendix B column 4 and 5.

Section 3. Definitions.

As used in this Part:

(a) "**Act**" means the Republic Act No. 5207, as amended, otherwise known as the Atomic Energy Regulatory and Liability Act of 1968.

(b) **"A_1"** means the activity value of special form radioactive material that is listed in Appendix B of this Part or derived in accordance with Section 19of this Part and is used to determine the activity limits for the requirements of these Regulations.

(c) **"A_2"** means the activity value of radioactive material, other than special form radioactive material, that is listed in Appendix B of this Part or derived in accordance with Section 19of this Part and is used to determine the activity limits for the requirements of these Regulations.

(d) **"Carrier"** means person, organization or government undertaking the carriage of radioactive material by land, air or water, as a common or contract carrier. Carriers may include either carriers for hire or carriers on own account.

(e) **"Consignor's Declaration (CD)"** means the document certifying that the package meets the requirements for the safe transport of radioactive material in accordance with this Part.

(f) **"Consignee"** means any person, organization or government that is entitled to take a delivery of a consignment.

(g) **"Consignment"** means any package or packages, or load of radioactive material, presented by a consignor for transport.

(h) **"Consignor"** means any person, organization or government that prepares a consignment for transport.

(i) **"Containment System"** means the assembly of components of the packaging intended to retain the radioactive material during transport.

(j) **"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,

(1) **"Non-fixed Contamination"** means contamination that can be removed from a surface during routine conditions of transport,

(2) **"Fixed Contamination"** means contamination other than non-fixed contamination.

(k) "**Conveyance**" means:

(1) for transport by road or rail: any vehicle;

(2) for transport by water: any vessel, or any hold, compartment, or defined deck area of a vessel; and

(3) for transport by air: any aircraft.

(l) **"Design"** means the description of special form radioactive material, low dispersible radioactive material, package or packaging including specifications, engineering drawings, reports demonstrating compliance with regulatory requirements, and other relevant documentation.

(m) **"Excepted Package"** means a package in which the radioactive material content is restricted to the limits specified in Section 22 (a) of this Part.

(n) **"Exclusive Use"** means the sole use of a conveyance by a single consignor and for which all initial, intermediate, and final loading and unloading and shipment are carried out in accordance with the direction of the consignor or consignee.

(o) **"Freight Container"** means an article of transport equipment that is of a permanent character and accordingly strong enough to be suitable for repeated use; specially designed to facilitate the transport of goods, by one or other modes of transport, without intermediate reloading, designed to be secured and/or readily handled, having fittings for these purposes. It does not include the vehicle.

(1) "**Small Freight Container**" means a freight container that has an internal volume of not more than $3m^3$.

(2) "**Large Freight Container**" means a freight container that has an internal volume of more than $3m^3$.

(p) **"Industrial Package"** means a package meeting the applicable requirements specified in this Part and used for the transport of certain low specific activity material

and surface contaminated objects.

(q) **"Licensee"** means the consignor or consignee who is a holder of a PNRI license issued pursuant to the Code of PNRI Regulations.

(r) **"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.

(s) **"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.

(t) "**Management System**" means a system that is developed, implemented or assessed for activities relating to the transport of radioactive material that include, but are not limited to, design, fabrication, inspection and testing, maintenance, transport and disposal of radioactive material packaging.

(u) "**Multilateral Approval**" means 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.

(v) **Nuclear Material** refers to:

1) nuclear fuel, other than natural uranium and depleted uranium, capable of producing energy by a self-sustaining chain process of nuclear fission outside a nuclear reactor, either alone or in combination with some other materials; and
2) Plutonium except that with isotopic concentration exceeding 80% in plutonium-238; uranium-233; uranium enriched in the isotope 235 or 233; uranium containing the mixture of isotopes as occurring in nature other than in the form of ore or ore residue; any material containing one or more of the foregoing;

(w) **"Overpack"** means an enclosure which is used by a single consignor to contain one or more packages and to form one unit for convenience of handling and stowage during transport.

(x) **"Package"** means the complete product of the packing operation, consisting of the packaging and its contents prepared for transport.

(y) **"Packaging"** means one or more receptacles and other components or materials necessary for the receptacles to perform the containment and other safety functions.

(z) **"Person"** means:

(1) any individual, firm, partnership, association, trust, estate, private or public body, whether corporate or not, or government agency other than PNRI, or any province, city, municipality, or any political subdivision or entity within the Philippines; and
(2) any legal successor, representative, agent or agency of the foregoing.

(aa) **"Radiation Level"** means the corresponding dose rate expressed in millisievert per hour (mSv/h) or microsievert per hour (µSv/h).

(bb) **"Radioactive Contents"** means the radioactive material together with any contaminated or activated solids, liquids and gases within the packaging.

(cc) **"Radioactive Material"** means any material containing radionuclides where both the activity concentration and the total activity in the consignment exceed the basic radionuclide values specified in Appendix B. Basic Radionuclide Values.

(dd) "**Radiation Protection Programme**" means systematic arrangements that are aimed at providing adequate consideration of radiation protection measures.

(ee) **"Shipment"** means the specific movement of a consignment from origin to destination.

(ff) **"Special Arrangement"** means the provisions for transport, approved by PNRI, under which consignments that do not satisfy all the applicable requirements of this Part may be transported.

(gg) **"Special Form Radioactive Material"** means either an indispersible solid radioactive material or a sealed capsule containing radioactive material;

(hh) **"Specific Activity"** means the activity per unit mass of a particular radionuclide or, as the case may be, the activity per unit mass or volume of the material in which the radionuclides are essentially uniformly distributed;

(ii) **"Surface Contaminated Object (SCO)"**means a solid object which is not itself radioactive but which has radioactive material distributed on its surface;

(jj) **"Transport"** means the deliberate physical movement of radioactive material from one place to another.

(kk) **"Transport Index"** (TI) means a single number which is used to provide control over radiation exposure assigned to a package, overpack, tank or freight container or to unpackaged LSA-1 or SCO-1.

(ll) "**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.

(mm) **"UN Number"** means a four-digit number that identifies the hazardous substance in the framework of international transport.

(nn) "**Vehicle"** means a road vehicle including an articulate vehicle such as tractor and semi-trailer, railroad car or railway wagon. Each trailer shall be considered as a separate vehicle.

(oo) "**Vessel"** means any seagoing vessel or inland waterway craft used for carrying cargo.

(pp) **"Worker"** means any individual engaged in the transport of radioactive material (either full time or part time).

***Note:** Terms defined in the Act and in other Parts of the Code of PNRI Regulations (CPR) shall have the same meaning when used in this Part to the extent that such terms are not specifically defined in this Part.

Section 4. Interpretation.

Except as specifically authorized by the Director in writing, no interpretation of the meaning of the requirements in this Part shall be recognized to be binding upon PNRI.

Section 5. Communication.

All communications and reports concerning the license and the requirements in this Part shall be addressed to

The Director
Philippine Nuclear Research Institute
Commonwealth Avenue, Diliman, Quezon City

Section 6. Specific Regulatory Exemptions.

The PNRI may, upon application by any licensee or upon its own initiative, grant such exemption/s from the requirements in this Part as provided by the Atomic Energy Regulatory and Liability Act of 1968 (Republic Act No. 5205) as amended by P.D. 1484.

Only the Director may issue exemptions, and no licensee may take or cause to be taken any action not in compliance with this Part unless the PNRI has issued an applicable exemption to the licensee.

Exemptions will only be granted in extraordinary circumstances and providing that said grant of an exemption shall not endanger life, property, and the environment.

Section 7. Transport Regulations Addressed by Other National Modal Agencies.

The safe transport of radioactive materials in the Philippines shall be carried out in compliance with other relevant provisions of the following:

(1) Philippine Civil Aviation Regulations, Technical Instructions for the Safe Transport of Dangerous Goods by Air and all applicable amendments thereto;

(2) Philippine Ports Authority Act and specific provisions of the International Maritime Dangerous Goods (IMDG) Code, Safety of Life at Sea (SOLAS).

(3) Other relevant regulations adopted by other national modal agencies on transport.

Section 8. Authorization to Transport Radioactive Material.

No person shall transport or cause to transport radioactive material(s) by any mode - land, water or air, including transport which is incidental to the use of radioactive materials except in accordance with:

(1) An authorization granted in the radioactive material license issued by the PNRI; or

(2) Section 11, Permit to Transport issued to PNRI license holders not specifically authorized to transport radioactive material in their radioactive material license.

II. ADMINISTRATIVE REQUIREMENTS

Section 9. Radiation Protection Program for Transport of Radioactive Material.

(a) A Radiation Protection Program (RPP) shall be established by the licensee for the transport of radioactive material to ensure that doses to persons are below the relevant dose limits. The nature and extent of the measures to be employed in the program shall be related to the magnitude and likelihood of radiation exposures.

(b) The principal radiation protection consideration to be accounted for in a RPP shall cover the following basic elements contributing to protection and safety:
(1) Scope of the program;
(2) Roles and responsibilities for the implementation of the program;
(3) Dose assessment;
(4) Dose limits, constraints and optimization;
(5) Surface contamination;
(6) Segregation and other protective measures;
(7) Emergency response and arrangements;
(8) Training;
(9) Management systems.

(c) For occupational exposures arising from transport activities, where it is assessed that the effective dose either:

(1) is likely to be between 1 and 6 mSv in a year, a dose assessment program via workplace monitoring or individual monitoring shall be conducted; or
(2) is likely to exceed 6 mSv in a year, individual monitoring shall be conducted.

When individual monitoring or workplace monitoring is conducted, appropriate records shall be kept.

(d) A transport safety procedure shall be developed when the applicant/licensee applies for authorization to transport or when authorization to transport is authorized in the license.

(e) The transport safety procedure shall be tested or evaluated by the licensee and updated at least once a year or as maybe deemed necessary by PNRI.

(f) Deficiencies identified in the transport safety procedure shall be promptly remedied and reported in accordance with Section 43 of this Part.

(g) The licensee shall retain a copy of the current transport safety procedure until PNRI terminates its license and, if any portion of the procedure is amended, the amended material shall be retained for five (5) years from the date of amendment.

Section 10. Transport Documents.

(a) Each consignor/licensee shall prepare a **Consignor's Declaration** which contains the necessary information for assuring that each package can be transported safely in accordance with this Part. The **Consignor's Declaration** shall include the following information, as may be applicable:

(1) Date of issuance, and if appropriate, an expiration date;
(2) Name, address, telephone/telefax number or e-mail address of the consignor (licensee) and PNRI license number;
(3) Name and address of the consignor's RSO;
(4) Information on the date of shipment and the expected date and time of arrival;
(5) Description (name or symbol of each radionuclide, physical and chemical form and activity) of the radioactive material that will be transported;
(6) Description of the package (category and dimension);
(7) Measured dose rate on specific points of the package;
(8) Transport index (for categories II-YELLOW and III-YELLOW only) and, if appropriate, any restrictions on the mode of transport and routing instructions;
(9) Location, address and telephone number of the origin of the transport package;
(10) Location, address and telephone number of the destination of the transport package;
(11) Name, address and PNRI license number of the consignee/licensee;
(12) Identification of the mode of transport. If transport is handled by a carrier/forwarder, indicate its name and other relevant information; and
(13) Location, address and telephone number of the destination of the transport package;
(14) Signature of consignor's RSO or consignor's representative responsible for the approval of the Consignor's Declaration; and
(15) A declaration in the following terms or in terms having an equivalent meaning:

> "I hereby declare that the content/s of this consignment is/are fully and accurately described above by the proper shipping name and classified, packaged, marked and labeled/placarded, and is/are, in all respects, in proper condition for the transport of **RADIOACTIVE MATERIALS** in accordance with PNRI regulations and applicable national governmental regulations."

(b) The consignor shall submit to PNRI on a quarterly basis a report of all radioactive materials transported. Copies of **Consignor's Declaration** shall be made available for inspection by PNR at any time.

Section 11. Permit to Transport.

Any shipment to be made by a PNRI license-holder not specifically authorized in his radioactive material license or by a non-PNRI license consignor to transport any radioactive material shall secure a **Permit to Transport** from PNRI. An application for a **Permit to Transport** shall include**:**

(a) A **Consignor's Declaration**, in accordance with the requirements in Section 10 (a);

(b) The period of time, related to the shipment, for which the authority is sought;

(c) The details of how the precautions and administrative or operational controls are to be put into effect;

(d) Other transport documents as deemed necessary by PNRI; and

(e) Payment of applicable transport fees and other charges in accordance with CPR Part 22.

Section 12. Management System.

(a) A management system based on international, national or other standards acceptable to PNRI shall be established and implemented for all activities within the scope of the Regulations to ensure compliance with the requirements of this Part.

(b) The manufacturer, consignor and consignee shall be prepared:
(1) To provide facilities for inspection during manufacture and use; and
(2) To demonstrate compliance with this Part to PNRI.

Section 13. Emergency Response.

(a) In the event of accidents or incidents during transport of radioactive material, emergency response measures, as established by PNRI and relevant organizations, shall be observed to protect persons, property and the environment.

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

(c) The transport vehicle for the radioactive consignment shall be equipped with utility tools to respond to any transport accident.

Section 14. Non-compliance.

(a) In the event of non-compliance with any limit stipulated in this Part applicable to radiation level or contamination, the consignor, consignee, carrier and any organization involved during transport who may be affected, shall be informed of the non-compliance by:
(1) The carrier if the non-compliance is identified during the transport; or
(2) The consignee if the non-compliance is identified upon receipt.

(b) The carrier, consignor or consignee, as may be provided for by law and relevant regulations and orders, shall:
(1) Take immediate steps to mitigate the consequences of the non-compliance;
(2) Investigate the non-compliance and its causes, circumstances and consequences;
(3) Take appropriate action to remedy the causes and circumstances that led to the non-compliance and to prevent a recurrence of circumstances similar to those that led to the non-compliance;
(4) Communicate to PNRI of the causes of the non-compliance and on corrective or preventive actions taken or to be taken.

(c) The communication of the non-compliance to the consignor and PNRI, respectively, shall be made as soon as practicable and it shall be immediate whenever an emergency exposure situation has developed or is developing.

Section 15. Special Arrangement.

(a) If consignments do not satisfy all the applicable requirements of this Part, it may be

transported under a special arrangement operation approved by PNRI, provided that the overall level of safety in transport shall be at least equivalent to that level of safety if all the requirements had been met.

(b) A consignment that is delivered for international transport under special arrangement shall require multilateral approval.

Section 16. Training.

(a) Workers shall receive appropriate training concerning radiation protection, including the precautions to be observed in order to restrict their occupational exposure and the exposure of other persons who might be affected by their actions.

(b) Persons engaged in the transport of radioactive material shall receive training in the contents of this Part commensurate with their responsibilities.

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

(1) General awareness/familiarization training:

(i) Each person shall receive training designed to provide familiarity with the general provisions of this Part.
(ii) Such training shall include a description of the categories of radioactive material; labelling, marking, placarding and packaging and segregation requirements; a description of the purpose and content of the radioactive material transport document; and a description of available emergency response documents.

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

(3) Safety training: Commensurate with the risk of exposure in the event of a release and the functions performed, each person shall receive training on:

(i) Methods and procedures for accident avoidance, such as proper use of package handling equipment and appropriate methods of stowage of radioactive material.
(ii) Available emergency response information and how to use it.
(iii) General dangers presented by the various categories of radioactive material and how to prevent exposure to those hazards, including, if appropriate, the use of personal protective clothing and equipment.
(iv) Immediate procedures to be followed in the event of an unintentional release of radioactive material, including any emergency response procedures for which the person is responsible and personal protection procedures to be followed.

(d) Records of all safety training undertaken shall be kept by the licensee and made

available to the worker if requested.

Section 17. Retraining.

The training required in the immediately preceding section shall be provided or verified upon employment in a position involving radioactive material transport and shall be periodically supplemented with retraining every five (5) years or as may be deemed appropriate by PNRI.

Section 18. Information for Carriers.

(a) Actions, if any, that are required to be taken by the carrier as specified by the consignor in the transport documents shall be implemented. The statement provided by the consignor shall be in the languages deemed necessary by the carrier or the authorities concerned and shall include at least the following points:

(1) 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, or a statement that no such requirements are necessary;
(2) Restrictions on the mode of transport or conveyance and any necessary routeing instructions;
(3) Emergency arrangements appropriate to the consignment.

(b) The consignor shall make available to the carrier the Consignor's Declaration before loading and unloading.

III. ACTIVITY LIMITS AND CLASSIFICATIONS

Section 19. Assignment of UN Numbers.

Radioactive material shall be assigned to one of the UN numbers specified in **Appendix A**.

Section 20. Determination of Basic Radionuclide Values.

(a) The following basic values for individual radionuclides are given in **Appendix B**:
(1) A_1 and A_2 in TBq;
(2) Activity concentration limits for exempt material in Bq/g;
(3) Activity limits for exempt consignments in Bq.

(b) For individual radionuclides which are not listed in **Appendix B**, the determination of the basic radionuclide values referred in (a) shall require PNRI approval or, for international transport, multilateral approval. For these radionuclides, activity concentrations for exempt material and activity limits for exempt consignments shall be calculated in accordance with the principles established in CPR Part 3, Standards for Protection Against Radiation. It is permissible to use an A_2value 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 I** may be used without obtaining PNRI approval.

(c) 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 Section 22 (a) (2) (iii), alternative basic radionuclide values to those in **Appendix B** 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 set out in the CPR Part 3.

(d) In the calculations of A_1 and A_2 for a radionuclide not listed in **Appendix B**, a single radioactive decay chain in which the radionuclides are present in their naturally occurring proportions, and in which no daughter nuclide has a half-life either longer than 10 days or longer than that of the parent nuclide, shall be considered as a single radionuclide; and the activity to be taken into account and the A_1 or A_2 value to be applied shall be those corresponding to the parent nuclide of that chain.

(e) In the case of radioactive decay chains in which any daughter nuclide has a half-life either longer than 10 days or greater than that of the parent nuclide, the parent and such daughter nuclides shall be considered as mixtures of different nuclides.

(f) The basic radionuclide values for mixtures of radionuclides 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 for exempt material or the activity limit for an exempt consignment as appropriate for the radionuclide i; and
X_m is the derived value of A_1 or A_2, or the activity concentration for exempt material or the activity limit for an exempt consignment in the case of a mixture.

(g) When the identity of each radionuclide is known but the individual activities of some of the radionuclides are not known, the radionuclide may be grouped and the lowest radionuclide value, as appropriate for the radionuclides in each group, may be used in applying the formulas in (f) of this Section and in Section 22 (b) (2). Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, and the lowest radionuclide value for the alpha emitters or beta/gamma emitters, respectively.

(h) The radionuclide values for unknown radionuclides or mixtures are given in **TABLE I**.

TABLE I. 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}

Section 21. Classification of Material.

(a) **Low Specific Activity (LSA) Material**
LSA material shall be in one of three groups:

(1) 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 value is unlimited.
- (iv) Other radioactive material in which the activity is distributed throughout and the estimated average specific activity does not exceed 30 times the values for the activity concentration specified in Section 19.

(2) 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}/g for solids and gases, for liquids.

(3) LSA-III:
Solids (e.g. consolidated wastes, activated materials), in which:
- (i) The radioactive material is distributed throughout a solid or a collection of solid objects, or is essentially uniformly distributed in a solid compact binding agent (such as concrete, bitumen and ceramic);
- (ii) The radioactive material is relatively insoluble, or is intrinsically contained in a relatively insoluble matrix, so that, even under loss of packaging, the loss of radioactive material per package by leaching when placed in water for 7 days would not exceed $0.1A_2$; and

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

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

(b) **Surface Contaminated Object (SCO)**

SCO shall be in one of two groups:

(1) 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 4×10^4 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 4×10^4 Bq/cm^2 for beta and gamma emitters and low toxicity alpha emitters, or 4000 Bq/cm^2 for all other alpha emitters.

(2) 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 8×10^5 Bq/cm^2 for beta and gamma emitters and low toxicity alpha emitters, or 8×10^4 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 8×10^5 Bq/cm^2 for beta and gamma emitters and low toxicity alpha emitters, or 8×10^4 Bq/cm^2 for all other alpha emitters.

(c) Special Form Radioactive Material

(1) Radioactive material may be classified as special form radioactive material if it is either an indispersible solid radioactive material or a sealed capsule containing radioactive material. 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 procedures such as impact, percussion, bending and/or heat tests, it shall meet the following requirements:
(i) It would not break or shatter under the impact, percussion and

bending tests;

(ii) It would not melt or disperse in the heat test; and

(iii) The activity in the water from the leaching tests would not exceed 2 kBq; or alternatively, for sealed sources, the leakage rate for the volumetric leakage assessment test specified in the International Organization for Standardization document ISO 9978: Radiation Protection — Sealed Radioactive Sources — Leakage Test Methods, would not exceed the applicable acceptance threshold acceptable to the PNRI.

(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.

(d) 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:

(i) The radiation level at 3 m from the unshielded radioactive material does not exceed 10mSv/h;

(ii) If subjected to the tests such as enhanced thermal test and/or impact test, the airborne release in gaseous and particulate forms of up to 100 μm aerodynamic equivalent diameter would not exceed $100A_2$. A separate specimen may be used for each test; and

(iii) If subjected to leaching tests, the activity in the water would not exceed $100A_2$. In the application of this test, the damaging effects of the tests specified in (ii) shall be taken into account.

Section 22. Classification of Packages.

The quantity of radioactive material in a package shall not exceed the relevant limits for the package type as specified below.

(a) Classification as Excepted Package

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

(i) It is an empty package having contained radioactive material;

(ii) It contains radioactive material or instruments or articles not exceeding the activity limits specified in **TABLE II**;

(iii) It contains articles manufactured of natural uranium, depleted uranium or natural thorium;

(iv) It contains less than 0.1 kg of uranium hexafluoride not exceeding the activity limits specified in column 4 of **TABLE II**.

TABLE II. ACTIVITY LIMITS FOR EXCEPTED PACKAGES

Physical State of Contents	Instrument or Article		Materials
	Item Limits	Package Limits	Package Limits
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 x10^{-2} A_2	2x10^{-1} A_2	2x10^{-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

(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:

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

(ii) Each instrument or article bears the marking “RADIOACTIVE” on its external surface except for the following:

a. Radio-luminescent timepieces or devices do not require markings;

b. Consumer products that have either received regulatory approval in accordance with Section 2 (e) (5) or do not individually exceed the activity limit for an exempt consignment in **Appendix B** (column 5) do not require markings, provided that such products are transported in a package that bears the marking “RADIOACTIVE” on its internal surface in such a manner that a warning of the presence of radioactive material is visible on opening the package; and

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

(iii) 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).

(iv) The limits specified in columns 2 and 3 of **TABLE II** are met for each individual item and each package, respectively.

(3) Radioactive material in forms other than as specified in (c) and with an activity not exceeding the limits specified in column 4 of **TABLE II** may be classified under UN 2910, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE — LIMITED QUANTITY OF MATERIAL, provided that:

(i) The package retains its radioactive contents under routine conditions of transport; and

(ii) The package bears the marking “RADIOACTIVE” on either:

a. An internal surface in such a manner that a warning of the presence of radioactive material is visible on opening the package; or

b. The outside of the package, where it is impractical to mark an internal surface.

(4) An empty packaging that had previously contained radioactive material may be classified under UN 2908, RADIOACTIVE MATERIAL, EXCEPTEDPACKAGE — EMPTY PACKAGING, provided that:
(i) It is in a well-maintained condition and securely closed;
(ii) 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;
(iii) The level of internal non-fixed contamination does not exceed 100 times the levels specified in Section 21 (a); and
(iv) Any labels that may have been displayed on it in conformity with Section 26 (c) are no longer visible.

(b) Classification as Type A Package

(1) Type A packages shall not contain activities greater than either of the following:
(i) For special form radioactive material -- A_1; or
(ii) For all other radioactive material -- A_2.

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

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

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.

(c) **Classification as Type B(U), Type B(M) and Type C Package**

(1) Type B(U), Type B(M) and Type C packages shall not contain:
(i) Activities greater than those authorized for the package design;
(ii) Radionuclides different from those authorized for the package design; or
(iii) Contents in a form, or a physical or chemical state different from those authorized for the package design, as specified in their certificates of approval.

(2) Type B(U) and Type B(M) packages transported by air shall not contain activities greater than the following:
(i) For low dispersible radioactive material -- as authorized for the package design;
(ii) For special form radioactive material -- 3000 A_1 or 100,000 A_2, whichever is lower; or
(iii) For all other radioactive material -- 3000 A_2.

IV. TECHNICAL REQUIREMENTS AND CONTROLS FOR TRANSPORT

Section 23. Requirements Before the First Shipment.

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 this Part. 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, checks shall be performed to confirm the presence and distribution of neutron poisons.

Section 24. Requirements Before Each Shipment.

(a) Before each shipment of any package, it shall be ensured that all the requirements specified in the relevant provisions of this Part, (e.g., labeling, marking, etc.) and in the applicable transport documents, have been fulfilled. The following requirements shall also be fulfilled, if applicable:
   (1) The packaging is appropriate for the contents to be shipped or meets the applicable provisions in Section 20(c) of this Part;
   (2) The outside of the packaging is conspicuously and durably marked with its serial/ID number, gross weight, appropriate type (e.g., "Type A") the package design conforms to, and an identification of either the consignor or consignee, or both;
   (3) The package is in an unimpaired physical condition except for superficial defects such as marks and dents;
   (4) Each closure device of the packaging, including any required gasket, is properly installed and secured and free of defects;
   (5) Any system for containing liquid is sealed and has space or other specified provision for expansion of liquid;
   (6) Any pressure relief device is operable and set in accordance with the certificate of compliance for the package;
   (7) The package has been loaded and the containment system closed in accordance with written procedures;
   (8) All closures, valves or other opening of the package are properly closed in accordance with instructions set out by the designer, manufacturer or distributor of the package;
   (9) Any feature of the package that could be used as a point of attachment for

lifting purposes but which is not designed for that purpose has been removed or otherwise rendered unusable; and

(10) In the case of a Type B(M) package or Type B(U) package, thermal and pressure equilibria have been attained.

(b) The consignee has been advised of the transport of the material, has made reasonable arrangements for receipt of the material, and has received a copy of any applicable transport document; and

(c) The carrier has been advised of the nature of the material, and has received a copy of the applicable transport document and other information to ensure the safety of the package.

Section 25. Consignor's Responsibilities.

(a) The consignor shall not transport radioactive material unless it is properly packaged, marked, labeled, placarded, described and certified on a transport document, and in a condition for transport as required by this Part.

(b) The consignor who transports radioactive material to and from one authorized location to another by land, air, or sea shall prepare and/or secure appropriate transport documents in accordance with the requirements in Section 10 or Section 11 of this Partas appropriate.

(c) The consignor shall include in the transport documents with each consignment the following information and documents, as applicable;

(1) **Consignor's Declaration** including all information specified in Section 10 (a);

(2) **Permit to Transport**, as applicable, in accordance with the requirement in Section 11;

(3) For consignments of more than one package, the information contained in Section 10 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 and appropriate amendments shall be made to the transport index of the overpack;

(4) Where a consignment is required to be shipped under exclusive use, the statement "EXCLUSIVE USE SHIPMENT"; and/or

(5) For LSA-II, LSA-III, SCO-I and SCO-II, the total activity of the consignment as a multiple of A2. For radioactive material for which the A2 value is unlimited, the multiple of A2 shall be zero.

(d) The consignor shall retain a copy of each of the transport documents containing the information specified in Section 10, as applicable, for a minimum period of three (3) years. When the documents are kept electronically, the consignor shall be able to reproduce them in a printed form.

(e) The consignor shall remove or cover the labels in an empty packaging which had previously contained radioactive material before he may transport it as an excepted package.

Section 26. General Requirements for Packaging and Packages.

(a) 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.

(b) 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.

(c) 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 paragraph (b) or shall be removable or otherwise rendered incapable of being used during transport.

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

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

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

(g) 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.

(h) 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 behavior under irradiation.

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

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

(k) A package shall be so designed that it provides sufficient shielding to ensure that, under routine conditions of transport and with the maximum radioactive contents that the package is designed to contain, the radiation level at any point on the external surface of the package would not exceed the values specified in Sections 28(a), (b) & (c).

(l) For radioactive material having subsidiary risks, and for transport of radioactive material with other dangerous goods, the relevant transport regulations for dangerous goods shall apply in addition to these Regulations.

Section 27. Requirements and Controls for Contamination and for Leaking Packages.

(a) 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 averaged over any area of 300 cm^2 of any part of the surface:

(1) 4 Bq/cm^2 for beta and gamma emitters and low toxicity alpha emitters;

(2) 0.4 Bq/cm^2 for all other alpha emitters.

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

(b) If it is evident that a package is damaged or leaking, or if it is suspected that the package may have leaked or been damaged, access to the package shall be restricted and a qualified person shall, as soon as possible assess the extent of contamination and the resultant radiation level of the package.

(c) 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 forwarded until repaired or reconditioned and decontaminated.

(d) 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.

(e) Any conveyance, or equipment or part thereof that has become contaminated above the limits specified in paragraph (a) in the course of the transport of radioactive material, or that shows a radiation level in excess of 5 μSv/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:

(1) The non-fixed contamination shall not exceed the limits specified in paragraph (a); and

(2) The radiation level resulting from the fixed contamination shall not exceed 5 μSv/h at the surface.

(f) A freight container, tank, IBC or conveyance dedicated to the transport of unpacked radioactive material under exclusive use shall be excepted from the requirements of paragraph(a) and (e) solely with regards to its internal surfaces and only for as long as it remains under the specific exclusive use.

Section 28. Requirements and Controls for Transport of Packages.

(a) The radiation level at any point on the external surface of an excepted package shall not exceed 5 μSv/h.

(b) 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 radiation level at 3 m from the unshielded material or object or collection of objects does not exceed 10 mSv/h and the activity in a single

package shall be so restricted that the activity limits for a conveyance specified in Section 27(e) is not exceeded.

(c) LSA material and SCO in groups LSA-I and SCO-I may be transported, unpackaged, under the following conditions:

(1) 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;

(2) Each conveyance shall be under exclusive use, except when only transporting SCO-I on which the contamination on the accessible and the inaccessible surfaces is not greater than 10 times the applicable level specified in Section 3 (j);

(3) For SCO-I where it is suspected that non-fixed contamination exists on inaccessible surfaces in excess of the values specified in Section 21 (b) (1) (i), measures shall be taken to ensure that the radioactive material is not released into the conveyance.

(d) LSA material and SCO, except as otherwise specified in this Section, shall be packaged in accordance with **TABLE III**.

(e) 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 IV**.

TABLE III. INDUSTRIAL PACKAGE REQUIREMENTS FOR LSA MATERIAL AND SCO

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

[a]Under the conditions specified in Section 26 (c), LSA-I material and SCO-I may be transported unpackaged

TABLE IV. 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	$100A_2$	$10A_2$

Section 29. Determination of Transport Index (TI).

(a) The TI for a package, overpack or freight container, or for unpackaged LSA-I or SCO-I, shall be the number derived in accordance with the following procedure:

(1) Determine the maximum radiation level in units of millisievert per hour (mSv/h) at a distance of 1 m from the external surfaces of the package, overpack, freight container or unpackaged LSA-I and SCO-I. The value determined shall be multiplied by 100 and the resulting number is the TI;

(2) For tanks, freight containers and unpackaged LSA-I and SCO-I, the value determined in step (1) shall be multiplied by the appropriate factor from **TABLE V**;

(3) The value obtained in steps (1) and (2) 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.

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

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

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

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

Section 30. Limits on TI and Radiation Levels for Packages and Overpack.

(a) Except for consignments under exclusive use, the TI of any package or overpack shall not exceed **10**.

(b) Except for packages or overpack transported under exclusive use and special arrangement by vessel or by air, the maximum radiation level at any point on the external surface of a package or overpack shall not exceed **2 mSv/h**.

(c) For consignments under the exclusive use, the radiation level shall not exceed:

(1) **10 mSv/h** at any point on the external surface of any package or overpack;

(2) **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;

(3) **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.

Section 31. Categories of Packages, Overpack and Freight Containers.

(a) Packages, overpack and freight containers shall be assigned to either category I-WHITE, II-YELLOW or III-YELLOW in accordance with the conditions specified in **TABLE VI** and with the following requirements:

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

(2) The TI shall be determined following the procedures specified in Section 29 of this Part.

(3) If the surface radiation level is greater than 2 mSv/h, the package or overpack shall be transported under exclusive use and under the provisions of Section 30, as appropriate.

TABLE VI. CATEGORIES OF PACKAGES, OVERPACKS AND FREIGHT CONTAINERS

CONDITIONS		CATEGORY
Transport Index	**Maximum radiation level 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 0.005mSv/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 2mSv/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.
[b] Shall also be transported under exclusive use.

(4) Packages or overpack having a surface radiation level greater than 2 mSv/h shall not be transported by air except by special arrangement.

(5) An overpack or freight container that contains packages transported under special arrangement shall be assigned to category III-YELLOW.

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

Section 32. Marking, Labeling and Placarding.

(a) For each package or overpack, the UN number and proper shipping name shall be determined (see **Appendix A**). 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.

(b) 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 markings 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 marking as specified in **TABLE VII**. Additionally, each overpack shall be legibly and durably marked with the word “OVERPACK” and the UN marking as specified in **TABLE VII** unless all the markings of the packages within the overpack are clearly visible. Other required markings include the type of package that it conforms to (e.g. “TYPE A”, “TYPE B(U)”, “TYPE B(M)”, etc.).

(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.

(4) 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**.

(5) Where LSA-I or SCO-I material is contained in receptacles or wrapping materials and is transported under exclusive use, the outer surface of these receptacles or wrapping materials may bear the marking "RADIOACTIVE LSA-I" or "RADIOACTIVE SCO-I", as appropriate.

TABLE VII. 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

[a] See APPENDIX A for listing of UN numbers and proper shipping names.

(c) 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 para (d) (1) for large freight containers and tanks, according to the appropriate category. Any labels that do not relate to the contents shall be removed or covered.

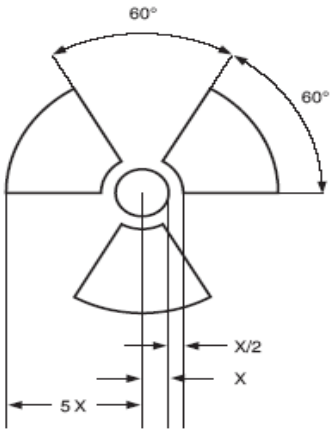

Figure 1. Basic trefoil symbol with proportions based on a central circle of radius X. The minimum allowable size of X shall be 4 mm.

(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 overpackor on the outside of all four sides of a freight container or tank. The labels shall not cover the markings specified in para (a) of this section.

(3) Each label shall be completed with the following information:
- (i) The name(s) of the radionuclide(s);
- (ii) The maximum activity of the radioactive contents during transport expressed in units of becquerels (Bq) with the appropriate SI prefix symbol; and
- (iii) The transport index.

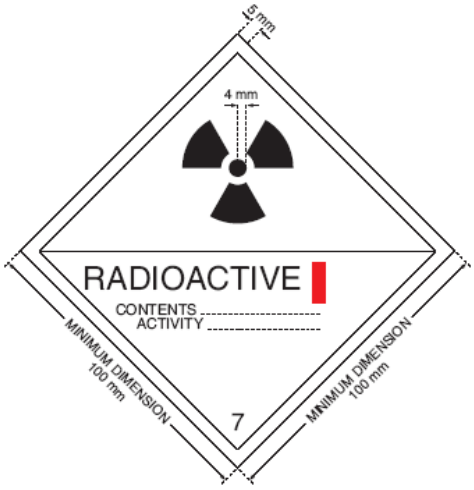

Figure 2. Category I-WHITE label. The background color of the label shall be white, the color of the trefoil and the printing shall be black, and the color of the category bar shall be red.

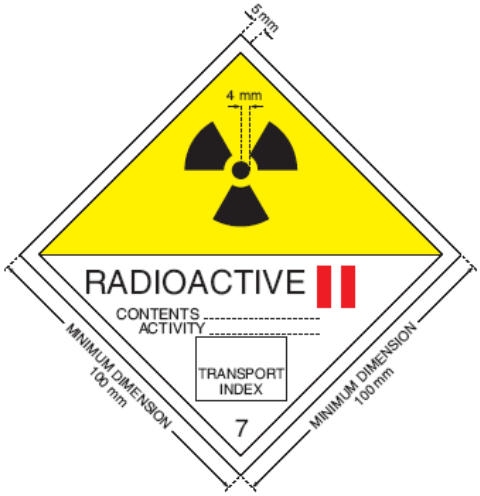

Figure 3. Category II-YELLOW label. The background color of the upper half of the label shall be yellow and the lower half white, the color of the trefoil and the printing shall be black, and the color of the category bars shall be red.

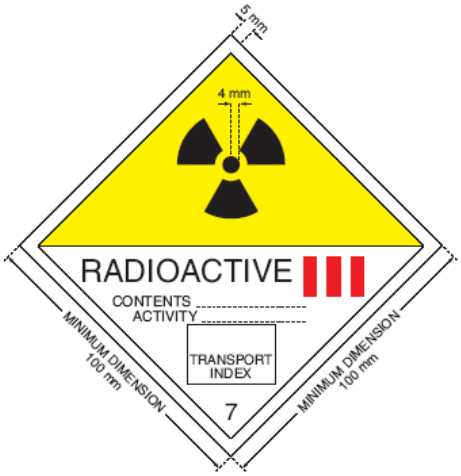

Figure 4. Category III-YELLOW label. The background color of the upper half of the label shall be yellow and the lower half white, the color of the trefoil and the printing shall be black, and the color of the category bars shall be red.

(d) Placarding.

(1) Large freight containers carrying packages other than excepted packages, and tanks shall bear four placards that conform to the model given in **Fig. 5**. 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. 5**.

(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 **APPENDIX A**) shall also be displayed, in black digits not less than 65 mm high, either:

(i) In the lower half of the placard shown in **Fig. 5** and against the white background; or
(ii) On the placard shown in **Fig. 6**.

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

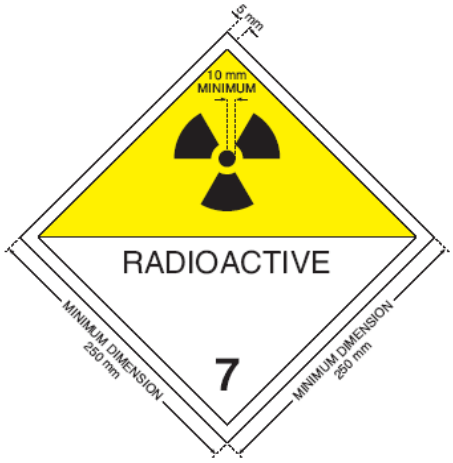

Figure 5. Placard. Minimum dimensions shall be as shown; when different dimensions are used, the relative proportions shall be maintained. The number '7' shall not be less than 25 mm high. The background color of the upper half of the placard shall be yellow and the lower half white, the color of the 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.

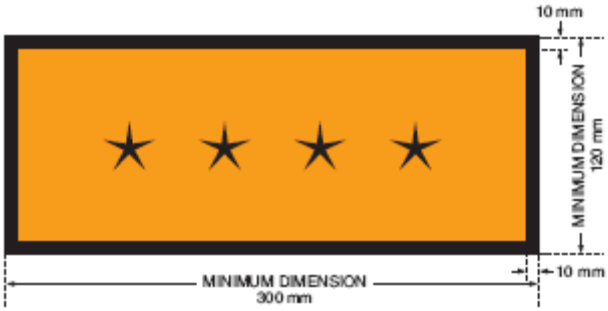

Figure 6. Placard for separate display of United Nations number. The background color of the placard shall be orange and the border and United Nations number shall be black. The symbol "****" denotes the space in which the appropriate United Nations number for radioactive material shall be displayed.

Section 33. Requirements on Segregation and Stowage during Transport and Storage in Transit.

(a) Packages, overpack and freight containers containing radioactive material and unpackaged radioactive material shall be segregated during transport and during storage in transit:

(1) From workers in regularly occupied working areas by distances calculated using a dose criterion of 5 mSv in a year and conservative model parameters;
(2) 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;
(3) 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;
(4) From other dangerous goods in accordance with para. 506.

(b) Packages of radioactive material that give off significant heat shall be securely stowed.

(c) Category II-YELLOW or III-YELLOW packages or overpack shall not be carried in compartments occupied by passengers, except those exclusively reserved for couriers specially authorized to accompany such packages or overpack.

(d) The total number of packages, overpack and freight containers aboard a single conveyance shall be so limited that the sum of the TIs aboard the conveyance does not exceed the values shown in **TABLE VIII**.

(e) Rail and road vehicles carrying packages, overpack or freight containers labeled with any of the labels shown in Section 32 (c), or carrying consignments under exclusive use, shall display the placard shown in Fig. 5 on each of 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.

(f) In the case of road vehicles, no persons other than the driver and assistants shall be permitted in vehicles carrying packages, overpack or freight containers bearing Category II-YELLOW or III-YELLOW labels.

(g) The radiation level under routine conditions of transport shall not exceed 2 mSv/h at any point on, and 0.1 mSv/h at 2 m from, the external surface of the conveyance, except for consignments transported under exclusive use by road or rail, for which the radiation limits around the vehicle are as follows:
(1) 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.
(2) 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.

TABLE VIII. 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, overpack, small freight containers	50
Large freight containers	200
(ii) Total vessel:	
Packages, overpack, small freight containers	200
Large freight containers	No limit

[a] Packages or overpack carried in or on a vehicle may be transported by vessels provided that they are not removed from the vehicle at any time while on board the vessel.

Section 34. Transport of Other Goods.

(a) A package shall not contain any other items except such articles and documents as are necessary for the use of the radioactive material.

(b) Tanks and intermediate bulk containers used for the transport of radioactive material shall not be used for the storage or transport of other goods unless decontaminated below the level of **0.4 Bq/cm^2** for beta and gamma emitters and low toxicity alpha emitters and **0.04 Bq/cm^2** for all other alpha emitters.

(c) The transport of other goods with consignments being transported under exclusive use may be permitted provided that the arrangements are controlled only by the consignor and it is not prohibited by other regulations.

(d) Consignments shall be segregated from other dangerous goods during transport in compliance with other relevant transport regulations for dangerous goods and, where applicable, with the regulations of the cognizant transport organizations, as well as these regulations.

Section 35. Additional Requirements Relating to Transport by Rail and by Road.

(a) Rail and road vehicles carrying packages, overpack or freight containers labeled with any of the labels shown in Figs 2–4, or carrying consignments under exclusive use, shall display the placard shown in Fig. 5 on each of:

(1) The two external lateral walls in the case of a rail vehicle;
(2) 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. 5 may be reduced to 100 mm. Any placards that do not relate to the contents shall be removed.

(b) Where the consignment in or on the vehicle is unpackaged LSA-I material or SCO-I or where a consignment is required to be shipped under exclusive use and is packaged radioactive material with a single UN number, the appropriate UN number shown in **Appendix A** shall also be displayed, in black digits not less than 65 mm high, either:

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

When the alternative given in (2) 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.

(c) For consignments under exclusive use, the radiation level shall not exceed:

(1) 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.
  (iii) There is no loading or unloading during the shipment.

(2) 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.

(3) 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.

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

Section 36. Additional Requirements Relating to Transport by Air.

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

(b) Vented Type B(M) packages, packages which require external cooling by an ancillary

cooling system, packages subject to operational controls during transport, and packages containing pyrophoric materials shall not be transported by air.

(c) Packages or overpack having a surface radiation level greater than **2 mSv/h** shall not be transported by air except by special arrangement.

Section 37. Additional Requirements Relating to Transport by Sea and Inland Waters, or by Special Use Vessel.

(a) Packages or overpack having a surface radiation level greater than **2 mSv/h** shall not be transported by vessel except under special arrangement, unless being carried in or on a vehicle under exclusive use and that the packages or overpack are not removed from the vehicle at any time while on board the vessel.

(b) The transport of consignments by means of a special use vessel which is dedicated to the purpose of carrying radioactive material shall be excepted from specific requirements on radiation levels and transport indexes provided that the following conditions are met:

(1) A radiation protection program for the shipment shall be approved by PNRI;
(2) Stowage arrangements shall be predetermined for the whole voyage including any consignments to be loaded at ports of call enroute; and
(3) The loading carriage and unloading of the consignments shall be supervised by persons qualified in the transport of radioactive material.

Section 38. Import/Export Controls.

(a) A licensee who imports radioactive material from another country shall submit to PNRI true copies of transport documents such as Consignor's Declaration, bill of lading, or airway bill with packing list of a radioactive material shipment that will arrive or have arrived at the Philippine Port of Entry. Upon verification/inspection as applicable of the shipment, the PNRI may grant the licensee a **Certificate of Release** for submission to the Bureau of Customs in compliance with the requirements for the release of such package from the customs cargo hold area.

(b) The licensee shall ensure that any package opened on customs instructions shall, before being forwarded to the consignee, be restored to its original condition.

(c) The licensee shall secure the applicable transport documents in accordance with the requirements in Section 10 of this Part, as applicable.

V. TEST PROCEDURES

Section 39. Leaching Test FOR LSA-III Material.

A solid material sample representing the entire contents of the package shall be immersed for **7 days** in water at ambient temperature. The volume of water to be used in the test shall be sufficient to ensure that at the end of the 7day 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 20^0C. The total activity of the free volume of water shall be measured following

the 7 days immersion of the test sample.

Section 40. Tests for Special Form Radioactive Material.

(a) **Test Methods**

(1) **Impact test:** The specimen shall drop onto the target from a height of **9 m**.

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

(4) **Heat test:** The specimen shall be heated in air to a temperature of **800^{0}C** and held at that temperature for a period of 10 minutes and shall then be allowed to cool.

(b) **Leaching and Volumetric Leakage Assessment Methods**

(1) The leaching assessment for specimens which comprise or simulate indispersible solid material shall be performed as follows:

(i) The specimen shall be immersed for 7 days in water at ambient temperature. The volume of water to be used in the test shall be sufficient to ensure that at the end of the 7day 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^{o}C;

(ii) The water with specimen shall then be heated to a temperature of (50 $\pm$5)^{o}C and maintained at this temperature for 4 hours;

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

(iv) The specimen shall then be kept for at least 7 days in still air at not less than 30^{o}C and relative humidity not less than 90 %;

(v) The specimen shall then be immersed in water of the same specification as in (1) above and the water with the specimen heated to (50 $\pm$5)^{o}C and maintained at this temperature for 4 hours; and

(vi) 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 mSv/m at 20°C.
(ii) The water and the specimen shall be heated to a temperature of 50 ± 5°C and maintained at this temperature for 4 h.
(iii) The activity of the water shall then be determined.
(iv) The specimen shall then be kept for at least 7 days in still air at not less than 30°C and with a relative humidity of not less than 90%.
(v) The process in (i), (ii) and (iii) shall be repeated.

(b) The alternative volumetric leakage assessment shall comprise any of the tests prescribed in the International Organization for Standardization document ISO 9978: Radiation Protection — Sealed Radioactive Sources — Leakage Test Methods provided that they are acceptable to PNRI.

Section 41. 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 **Section 42(f2),** the impact test specified in **Section 42(h3)**, and the leach test specified in **Section 39** and it shall be determined if the requirements for low dispersible radioactive material have been met.

Section 42. Tests for Packages.

(a) **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:
(i) divergence from the design;
(ii) defects in manufacture;
(iii) corrosion or other deterioration; and
(iv) 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 specimen.

(b) **Testing the integrity of the containment system and shielding and assessing criticality safety**
(1) After each of the applicable tests specified in (d) to (j) of this Section:
(i) Faults and damage shall be identified and recorded;
(ii) It shall be determined whether the integrity of the containment system and shielding has been retained for the package under test; and
(iii) For packages containing fissile material, it shall be determined whether the assumptions and conditions used in the assessments are valid.

(c) **Target for drop tests**
The target for the drop tests shall be a flat, horizontal surface of such a character that any increase in its resistance to displacement or deformation upon impact by the specimen would not significantly increase the damage to the specimen.

(d) **Tests for demonstrating ability to withstand normal conditions of transport**

Specimens that comprise or simulate the package shall be subjected to the water spray test until such time that the water has soaked in to the maximum extent, without appreciable drying of the exterior of the specimen, before each of the following tests:

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

(2) **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.

(i) The height of drop measured from the lowest point of the specimen to the upper surface of the target shall not be less than the distance specified in **Table IX** for the applicable mass.

(ii) 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.

(iii) For cylindrical fibreboard packages not exceeding a mass of **100 kg**, a separate specimen shall be subjected to a free drop onto each of the quarters of each rim from a height of 0.3 m.

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

Package mass (kg)	Free drop distance (m)
Package mass < 5 000	1.2
5 000 ≤ Package mass < 10 000	0.9
10 000 ≤ Package mass < 15 000	0.6
15 000 ≤ Package mass	0.3

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

(i) The equivalent of 5 times the mass of the actual package; and

(ii) 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.

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

(i) A bar of 3.2 cm in diameter with a hemispherical end and a mass of 6 kg shall be dropped and directed to fall, with its longitudinal axis vertical, onto the center 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.

(ii) The height of drop of the bar measured from its lower end to the intended point of impact on the upper surface of the specimen shall be 1 **m.**

(e) **Additional tests for Type A packages designed for liquids and gases**

(1) **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.**

(2) **Penetration test**. The specimen shall be subjected to the test **in Section 41 (d) (4)**except that the height of drop shall be increased to **1.7 m.**

(f) **Tests for demonstrating ability to withstand accident conditions of transport**

(1) Mechanical test

(i) **Drop I.** The specimen shall drop onto the target so as to suffer the maximum damage, and the height of the drop measured from the lowest point of the specimen to the upper surface of the target shall be 9 m.

(ii) **Drop II.** The specimen shall drop so as to suffer the maximum damage onto a bar rigidly mounted perpendicularly on the target. The height of the drop measured from the intended point of impact of the specimen to the upper surface of the bar shall be 1 m. The bar shall be of solid mild steel of circular section, (15.0 $\pm$ 0.5) cm in diameter and 20 cm long unless a longer would cause greater damage. The upper end of the bar shall be flat and horizontal with its edges rounded off to a radius of not more than 6mm.

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

(2) **Thermal test.** The specimen shall be in thermal equilibrium under conditions of an ambient temperature of **38^{o}C**, subject to the solar insolation conditions 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.

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

(g) **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 **one hour**. For demonstration purposes, an external gauge pressure of at least **2 MPa** shall be considered to meet these conditions.

(h) **Tests for Type C packages**

(1) Specimens shall be subjected to the effects of each of the following test sequences:

(i) **Mechanical tests** (Drop I and Drop III), puncture/tearing test and enhanced thermal test in this order; and

(ii) **Impact test**.

Separate specimens are allowed to be used for each of the sequences above.

(2) **Puncture/tearing test**. The specimen shall be subjected to the damaging

effects of a solid probe made of mild steel. The orientation of the probe to the surface of the specimen shall be such as to cause maximum damage at the conclusion of the test sequence **(h) (1) (i)** above.

(i) The specimen, representing a package having a mass 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 a frustum of a right circular cone with a 30 cm height and 2.5 cm diameter at the top.

(ii) 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 shall have the same properties and dimensions as in (I) above except that the length and mass of the probe shall be such as to incur maximum damage to the specimen.

(3) **Enhanced thermal test.** The conditions shall be the same as in **Section 41 (f) (2),** except that the exposure to the thermal environment shall be for a period of **60 minutes**.

(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.

VI. RECORDS, REPORTS AND NOTIFICATION

Section 43. Records.

The licensee shall maintain and keep records of each shipment of licensed material transported in accordance with this Part for a period of three (3) years. Such records shall be signed and authenticated, accordingly by authorized personnel of the licensee.

Section 44. Reports.

The licensee shall report to the PNRI Director within thirty (30) calendar days from knowledge or occurrence of:

(a) Any instance in which a significant reduction in the effectiveness of any authorized packaging during transport is observed;

(b) Detailed information of significant defects in the packaging after first or subsequent use, including the measures employed to repair the defects and prevent their recurrence; and

(c) Any transport incident or accident that had occurred, of which the report shall, as a minimum, include:

(1) The kind, quantity and the chemical and physical form of the radioactive materials involved;

(2) A description of the circumstances of the incident or accident;

(3) Radiation exposures of individuals involved in the incident/accident, the circumstances under which such exposures occurred, and exposures to the

public; and

(4) Corrective steps taken and planned to prevent recurrence.

Section 45. Notification of Incidents.

(a) The licensee shall immediately notify PNRI within twenty-four (24) hours from the time of occurrence by telephone or any similar fast means of communication, of any incident involving theft, hijacking, or loss of a radioactive package in the course of transport thereof; or any accident involving the transport carrier that could or could have caused damage to the packaging resulting to a significant reduction of the effectiveness of the packaging to contain the radioactive material.

(b) The licensee may request the assistance of PNRI in case of an accident that may result into a radiological emergency in the course of transporting radioactive material.

(c) The licensee shall describe how all significant incidents, including accidents, or deviations from this Part, are required to be reported. State if a threshold exposure value is specified in the relevant regulations for the immediate communication of non-compliance

VII. INSPECTION AND ENFORCEMENT

Section 46. Inspections.

(a) The licensee, or its authorized carrier, shall extend cooperation to the PNRI at all times inspection of the licensee's facility, conveyance and activities related to transport operations to assure compliance with the requirements of this Part.

(b) The licensee shall make available to PNRI for inspection, records kept pursuant to this Part at the address specified in the license.

Section 47. Enforcement.

(a) A notice of violation shall be issued to any person found to have violated any rule, regulation, or order issued by PNRI; or any term, condition, or limitation of any license issued hereunder.

(b) Any license may be modified, suspended, or revoked, after due process, for any violation that PNRI determines to adversely affect the health and safety of the workers and the public.

(c) Any person who willfully violates, attempts to violate or conspires to violate any rule or regulation or order issued hereunder, may be guilty of a crime, and upon conviction, may be punished by a fine or imprisonment or both as provided by Sections 64 and 65 of Republic Act No. 5207.

VIII. EFFECTIVITY

Section 48. Effective Date.

The requirements in this Part shall take effect fifteen (15) days following the publication in the Official Gazette or in a newspaper of general circulation.

Approved:

CARLOS PRIMO C. DAVID, Ph.D.
OIC, PNRI

Date: 6 January 2017

APPENDIX A

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

Assignment of UN Numbers	PROPER SHIPPING NAME and description*
Excepted Package	
UN 2908	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE — EMPTY PACKAGING
UN 2909	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE — ARTICLES MANUFACTURED FROM NATURAL URANIUM or DEPLETED URANIUM or NATURAL THORIUM
UN 2910	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE — LIMITED QUANTITY OF MATERIAL
UN 2911	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE — INSTRUMENTS or ARTICLES
UN 3507	URANIUM HEXAFLUORIDE, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, less than 0.1 kg per package, non-fissile or fissile-excepted[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 or SCO-II), non-fissile or fissile-excepted[b]
UN 3326	RADIOACTIVE MATERIAL, SURFACE CONTAMINATED OBJECTS (SCO-I or SCO-II), FISSILE
Type A Package	
UN 2915	RADIOACTIVE MATERIAL, TYPE A PACKAGE, non-special form, non-fissile or fissile-excepted[b]

UN 3327	RADIOACTIVE MATERIAL, TYPE A PACKAGE, FISSILE, non-special form
UN 3332	RADIOACTIVE MATERIAL, TYPE A PACKAGE, SPECIAL FORM, non-fissile or fissile-excepted[b]
UN 3333	RADIOACTIVE MATERIAL, TYPE A PACKAGE, SPECIAL FORM, FISSILE
Type B(U) package	
UN 2916	RADIOACTIVE MATERIAL, TYPE B(U) PACKAGE, non-fissile or fissile-excepted[b]
UN 3328	RADIOACTIVE MATERIAL, TYPE B(U) PACKAGE, FISSILE
Type B(M) package	
UN 2917	RADIOACTIVE MATERIAL, TYPE B(M) PACKAGE, non-fissile or fissile-excepted[b]
UN 3329	RADIOACTIVE MATERIAL, TYPE B(M) PACKAGE, FISSILE
Type C package	
UN 3323	RADIOACTIVE MATERIAL, TYPE C PACKAGE, non-fissile or fissile-excepted[b]
UN 3330	RADIOACTIVE MATERIAL, TYPE C PACKAGE, FISSILE
Special arrangement	
UN 2919	RADIOACTIVE MATERIAL, TRANSPORTED UNDER SPECIAL ARRANGEMENT, non-fissile or fissile-excepted[b]
UN 3331	RADIOACTIVE MATERIAL, TRANSPORTED UNDER SPECIAL ARRANGEMENT, FISSILE
Uranium hexafluoride	
UN 2977	RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, FISSILE
UN 2978	RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, non-fissile or fissile-excepted

[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.

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APPENDIX B

BASIC RADIONUCLIDE VALUES

Radionuclide (atomic number)	A1	A2	Activity concentration limit for exempt material	Activity limit for an exempt consignment
	(TBq)	(TBq)	(Bq/g)	(Bq)
Actinium (89)				
Ac-225 (a)	8×10^{-1}	6×10^{-3}	1×10^{1}	1×10^{4}
Ac-227 (a)	9×10^{-1}	9×10^{-5}	1×10^{-1}	1×10^{3}
Ac-228	6×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{6}
Silver (47)				
Ag-105	2×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Ag-108m (a)	7×10^{-1}	7×10^{-1}	1×10^{1}(b)	1×10^{6} (b)
Ag-110m (a)	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{6}
Ag-111	2×10^{0}	6×10^{-1}	1×10^{3}	1×10^{6}
Aluminium (13)				
Al-26	1×10^{-1}	1×10^{-1}	1×10^{1}	1×10^{5}
Americium (95)				
Am-241	1×10^{1}	1×10^{-3}	1×10^{0}	1×10^{4}
Am-242m (a)	1×10^{1}	1×10^{-3}	1×10^{0} (b)	1×10^{4} (b)
Am-243 (a)	5×10^{0}	1×10^{-3}	1×10^{0} (b)	1×10^{3} (b)
Argon (18)				
Ar-37	4×10^{1}	4×10^{1}	1×10^{6}	1×10^{8}
Ar-39	4×10^{1}	2×10^{1}	1×10^{7}	1×10^{4}
Ar-41	3×10^{-1}	3×10^{-1}	1×10^{2}	1×10^{9}
Arsenic (33)				
As-72	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
As-73	4×10^{1}	4×10^{1}	1×10^{3}	1×10^{7}
As-74	1×10^{0}	9×10^{-1}	1×10^{1}	1×10^{6}
As-76	3×10^{-1}	3×10^{-1}	1×10^{2}	1×10^{5}
As-77	2×10^{1}	7×10^{-1}	1×10^{3}	1×10^{6}
Astatine (85)				
At-211 (a)	2×10^{1}	5×10^{-1}	1×10^{3}	1×10^{7}
Gold (79)				
Au-193	7×10^{0}	2×10^{0}	1×10^{2}	1×10^{7}
Au-194	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Au-195	1×10^{1}	6×10^{0}	1×10^{2}	1×10^{7}
Au-198	1×10^{0}	6×10^{-1}	1×10^{2}	1×10^{6}
Au-199	1×10^{1}	6×10^{-1}	1×10^{2}	1×10^{6}
Barium (56)				
Ba-131 (a)	2×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Ba-133	3×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}

Ba-133m	2×10^{1}	6×10^{-1}	1×10^{2}	1×10^{6}
Ba-140 (a)	5×10^{-1}	3×10^{-1}	1×10^{1} (b)	1×10^{5} (b)
Beryllium (4)				
Be-7	2×10^{1}	2×10^{1}	1×10^{3}	1×10^{7}
Be-10	4×10^{1}	6×10^{-1}	1×10^{4}	1×10^{6}
Bismuth (83)				
Bi-205	7×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{6}
Bi-206	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
Bi-207	7×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{6}
Bi-210	1×10^{0}	6×10^{-1}	1×10^{3}	1×10^{6}
Bi-210m (a)	6×10^{-1}	2×10^{-2}	1×10^{1}	1×10^{5}
Bi-212 (a)	7×10^{-1}	6×10^{-1}	1×10^{1} (b)	1×10^{5} (b)
Berkelium (97)				
Bk-247	8×10^{0}	8×10^{-4}	1×10^{0}	1×10^{4}
Bk-249 (a)	4×10^{1}	3×10^{-1}	1×10^{3}	1×10^{6}
Bromine (35)				
Br-76	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}
Br-77	3×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Br-82	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{6}
Carbon (6)				
C-11	1×10^{0}	6×10^{-1}	1×10^{1}	1×10^{6}
C-14	4×10^{1}	3×10^{0}	1×10^{4}	1×10^{7}
Calcium (20)				
Ca-41	Unlimited	Unlimited	1×10^{5}	1×10^{7}
Ca-45	4×10^{1}	1×10^{0}	1×10^{4}	1×10^{7}
Ca-47 (a)	3×10^{0}	3×10^{-1}	1×10^{1}	1×10^{6}
Cadmium (48)				
Cd-109	3×10^{1}	2×10^{0}	1×10^{4}	1×10^{6}
Cd-113m	4×10^{1}	5×10^{-1}	1×10^{3}	1×10^{6}
Cd-115 (a)	3×10^{0}	4×10^{-1}	1×10^{2}	1×10^{6}
Cd-115m	5×10^{-1}	5×10^{-1}	1×10^{3}	1×10^{6}
Cerium (58)				
Ce-139	7×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Ce-141	2×10^{1}	6×10^{-1}	1×10^{2}	1×10^{7}
Ce-143	9×10^{-1}	6×10^{-1}	1×10^{2}	1×10^{6}
Ce-144 (a)	2×10^{-1}	2×10^{-1}	1×10^{2} (b)	1×10^{5} (b)
Californium (98)				
Cf-248	4×10^{1}	6×10^{-3}	1×10^{1}	1×10^{4}
Cf-249	3×10^{0}	8×10^{-4}	1×10^{0}	1×10^{3}
Cf-250	2×10^{1}	2×10^{-3}	1×10^{1}	1×10^{4}
Cf-251	7×10^{0}	7×10^{-4}	1×10^{0}	1×10^{3}
Cf-252	1×10^{-1}	3×10^{-3}	1×10^{1}	1×10^{4}
Cf-253 (a)	4×10^{1}	4×10^{-2}	1×10^{2}	1×10^{5}
Cf-254	1×10^{-3}	1×10^{-3}	1×10^{0}	1×10^{3}
Chlorine (17)				
Cl-36	1×10^{1}	6×10^{-1}	1×10^{4}	1×10^{6}

Cl-38	2×10^{-1}	2×10^{-1}	1×10^{1}	1×10^{5}
Curium (96)				
Cm-240	4×10^{1}	2×10^{-2}	1×10^{2}	1×10^{5}
Cm-241	2×10^{0}	1×10^{0}	1×10^{2}	1×10^{6}
Cm-242	4×10^{1}	1×10^{-2}	1×10^{2}	1×10^{5}
Cm-243	9×10^{0}	1×10^{-3}	1×10^{0}	1×10^{4}
Cm-244	2×10^{1}	2×10^{-3}	1×10^{1}	1×10^{4}
Cm-245	9×10^{0}	9×10^{-4}	1×10^{0}	1×10^{3}
Cm-246	9×10^{0}	9×10^{-4}	1×10^{0}	1×10^{3}
Cm-247 (a)	3×10^{0}	1×10^{-3}	1×10^{0}	1×10^{4}
Cm-248	2×10^{-2}	3×10^{-4}	1×10^{0}	1×10^{3}
Cobalt (27)				
Co-55	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{6}
Co-56	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
Co-57	1×10^{1}	1×10^{1}	1×10^{2}	1×10^{6}
Co-58	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Co-58m	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{7}
Co-60	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}
Chromium (24)				
Cr-51	3×10^{1}	3×10^{1}	1×10^{3}	1×10^{7}
Cesium (55)				
Cs-129	4×10^{0}	4×10^{0}	1×10^{2}	1×10^{5}
Cs-131	3×10^{1}	3×10^{1}	1×10^{3}	1×10^{6}
Cs-132	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{5}
Cs-134	7×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{4}
Cs-134m	4×10^{1}	6×10^{-1}	1×10^{3}	1×10^{5}
Cs-135	4×10^{1}	1×10^{0}	1×10^{4}	1×10^{7}
Cs-136	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{5}
Cs-137 (a)	2×10^{0}	6×10^{-1}	1×10^{1} (b)	1×10^{4} (b)
Copper (29)				
Cu-64	6×10^{0}	1×10^{0}	1×10^{2}	1×10^{6}
Cu-67	1×10^{1}	7×10^{-1}	1×10^{2}	1×10^{6}
Dysprosium (66)				
Dy-159	2×10^{1}	2×10^{1}	1×10^{3}	1×10^{7}
Dy-165	9×10^{-1}	6×10^{-1}	1×10^{3}	1×10^{6}
Dy-166 (a)	9×10^{-1}	3×10^{-1}	1×10^{3}	1×10^{6}
Erbium (68)				
Er-169	4×10^{1}	1×10^{0}	1×10^{4}	1×10^{7}
Er-171	8×10^{-1}	5×10^{-1}	1×10^{2}	1×10^{6}
Europium (63)				
Eu-147	2×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Eu-148	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{6}
Eu-149	2×10^{1}	2×10^{1}	1×10^{2}	1×10^{7}
Eu-150 (short lived)	2×10^{0}	7×10^{-1}	1×10^{3}	1×10^{6}
Eu-150 (long lived)	7×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{6}
Eu-152	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}

Eu-152m	8×10^{-1}	8×10^{-1}	1×10^{2}	1×10^{6}
Eu-154	9×10^{-1}	6×10^{-1}	1×10^{1}	1×10^{6}
Eu-155	2×10^{1}	3×10^{0}	1×10^{2}	1×10^{7}
Eu-156	7×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{6}
Fluorine (9)				
F-18	1×10^{0}	6×10^{-1}	1×10^{1}	1×10^{6}
Iron (26)				
Fe-52 (a)	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{6}
Fe-55	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{6}
Fe-59	9×10^{-1}	9×10^{-1}	1×10^{1}	1×10^{6}
Fe-60 (a)	4×10^{1}	2×10^{-1}	1×10^{2}	1×10^{5}
Gallium (31)				
Ga-67	7×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Ga-68	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{5}
Ga-72	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}
Gadolinium (64)				
Gd-146 (a)	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{6}
Gd-148	2×10^{1}	2×10^{-3}	1×10^{1}	1×10^{4}
Gd-153	1×10^{1}	9×10^{0}	1×10^{2}	1×10^{7}
Gd-159	3×10^{0}	6×10^{-1}	1×10^{3}	1×10^{6}
Germanium (32)				
Ge-68 (a)	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{5}
Ge-71	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{8}
Ge-77	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
Hafnium (72)				
Hf-172 (a)	6×10^{-1}	6×10^{-1}	1×10^{1}	1×10^{6}
Hf-175	3×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Hf-181	2×10^{0}	5×10^{-1}	1×10^{1}	1×10^{6}
Hf-182	Unlimited	Unlimited	1×10^{2}	1×10^{6}
Mercury (80)				
Hg-194 (a)	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Hg-195m (a)	3×10^{0}	7×10^{-1}	1×10^{2}	1×10^{6}
Hg-197	2×10^{1}	1×10^{1}	1×10^{2}	1×10^{7}
Hg-197m	1×10^{1}	4×10^{-1}	1×10^{2}	1×10^{6}
Hg-203	5×10^{0}	1×10^{0}	1×10^{2}	1×10^{5}
Holmium (67)				
Ho-166	4×10^{-1}	4×10^{-1}	1×10^{3}	1×10^{5}
Ho-166m	6×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{6}
Iodine (53)				
I-123	6×10^{0}	3×10^{0}	1×10^{2}	1×10^{7}
I-124	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
I-125	2×10^{1}	3×10^{0}	1×10^{3}	1×10^{6}
I-126	2×10^{0}	1×10^{0}	1×10^{2}	1×10^{6}
I-129	Unlimited	Unlimited	1×10^{2}	1×10^{5}
I-131	3×10^{0}	7×10^{-1}	1×10^{2}	1×10^{6}
I-132	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}

I-133	7×10^{-1}	1×10^{1}	1×10^{1}	1×10^{6}
I-134	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
I-135 (a)	6×10^{-1}	6×10^{-1}	1×10^{1}	1×10^{6}
Indium (49)				
In-111	3×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
In-113m	4×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
In-114m (a)	1×10^{1}	5×10^{-1}	1×10^{2}	1×10^{6}
In-115m	7×10^{0}	1×10^{0}	1×10^{2}	1×10^{6}
Iridium (77)				
Ir-189 (a)	1×10^{1}	1×10^{1}	1×10^{2}	1×10^{7}
Ir-190	7×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{6}
Ir-192	1×10^{0} (c)	6×10^{-1}	1×10^{1}	1×10^{4}
Ir-194	3×10^{-1}	3×10^{-1}	1×10^{2}	1×10^{5}
Potassium (19)				
K-40	9×10^{-1}	9×10^{-1}	1×10^{2}	1×10^{2}
K-42	2×10^{-1}	2×10^{-1}	1×10^{2}	1×10^{2}
K-43	7×10^{-1}	6×10^{-1}	1×10^{1}	1×10^{1}
Krypton (36)				
Kr-81	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{4}
Kr-85	1×10^{1}	1×10^{1}	1×10^{5}	1×10^{5}
Kr-85m	8×10^{0}	3×10^{0}	1×10^{3}	1×10^{3}
Kr-87	2×10^{-1}	2×10^{-1}	1×10^{2}	1×10^{2}
Lanthanum (57)				
La-137	3×10^{1}	6×10^{0}	1×10^{3}	1×10^{3}
La-140	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{1}
Lutetium (71)				
Lu-172	6×10^{-1}	6×10^{-1}	1×10^{1}	1×10^{6}
Lu-173	8×10^{0}	8×10^{0}	1×10^{2}	1×10^{7}
Lu-174	9×10^{0}	9×10^{0}	1×10^{2}	1×10^{7}
Lu-174m	2×10^{1}	1×10^{1}	1×10^{2}	1×10^{7}
Lu-177	3×10^{1}	7×10^{-1}	1×10^{3}	1×10^{7}
Magnesium (12)				
Mg-28 (a)	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
Manganese (25)				
Mn-52	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
Mn-53	Unlimited	Unlimited	1×10^{4}	1×10^{9}
Mn-54	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Mn-56	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
Molybdenum (42)				
Mo-93	4×10^{1}	2×10^{1}	1×10^{3}	1×10^{8}
Mo-99 (a)	1×10^{0}	6×10^{-1}	1×10^{2}	1×10^{6}
Nitrogen (7)				
N-13	9×10^{-1}	6×10^{-1}	1×10^{2}	1×10^{9}
Sodium (11)				
Na-22	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{6}
Na-24	2×10^{-1}	2×10^{-1}	1×10^{1}	1×10^{5}

Niobium (41)				
Nb-93m	4×10^{1}	3×10^{1}	1×10^{4}	1×10^{7}
Nb-94	7×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{6}
Nb-95	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Nb-97	9×10^{-1}	6×10^{-1}	1×10^{1}	1×10^{6}
Neodymium (60)				
Nd-147	6×10^{0}	6×10^{-1}	1×10^{2}	1×10^{6}
Nd-149	6×10^{-1}	5×10^{-1}	1×10^{2}	1×10^{6}
Nickel (28)				
Ni-59	Unlimited	Unlimited	$\times 10^{4}$	1×10^{8}
Ni-63	4×10^{1}	3×10^{1}	1×10^{5}	1×10^{8}
Ni-65	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{6}
Neptunium (93)				
Np-235	4×10^{1}	4×10^{1}	1×10^{3}	1×10^{7}
Np-236 (short lived)	2×10^{1}	2×10^{0}	1×10^{3}	1×10^{7}
Np-236 (long lived	9×10^{0}	2×10^{-2}	1×10^{2}	1×10^{5}
Np-237	2×10^{1}	2×10^{-3}	1×10^{0} (b)	1×10^{3} (b)
Np-239	7×10^{0}	4×10^{-1}	1×10^{2}	1×10^{7}
Osmium (76)				
Os-185	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Os-191	1×10^{1}	2×10^{0}	1×10^{2}	1×10^{7}
Os-191m	4×10^{1}	3×10^{1}	1×10^{3}	1×10^{7}
Os-193	2×10^{0}	6×10^{-1}	1×10^{2}	1×10^{6}
Os-194 (a)	3×10^{-1}	3×10^{-1}	1×10^{2}	1×10^{5}
Phosphorus (15)				
P-32	5×10^{-1}	5×10^{-1}	1×10^{3}	1×10^{5}
P-33	4×10^{1}	1×10^{0}	1×10^{5}	1×10^{8}
Protactinium (91)				
Pa-230 (a)	2×10^{0}	7×10^{-2}	1×10^{1}	1×10^{6}
Pa-231	4×10^{0}	4×10^{-4}	1×10^{0}	1×10^{3}
Pa-233	5×10^{0}	7×10^{-1}	1×10^{2}	1×10^{7}
Lead (82)				
Pb-201	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Pb-202	4×10^{1}	2×10^{1}	1×10^{3}	1×10^{6}
Pb-203	4×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Pb-205	Unlimited	Unlimited	1×10^{4}	1×10^{7}
Pb-210 (a	1×10^{0}	5×10^{-2}	1×10^{1} (b)	1×10^{4} (b)
Pb-212 (a)	7×10^{-1}	2×10^{-1}	1×10^{1} (b)	1×10^{5} (b)
Palladium (46)				
Pd-103 (a)	4×10^{1}	4×10^{1}	1×10^{3}	1×10^{8}
Pd-107	Unlimited	Unlimited	1×10^{5}	1×10^{8}
Pd-109	2×10^{0}	5×10^{-1}	1×10^{3}	1×10^{6}
Promethium (61)				
Pm-143	3×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Pm-144	7×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{6}
Pm-145	3×10^{1}	1×10^{1}	1×10^{3}	1×10^{7}
Pm-147	4×10^{1}	2×10^{0}	1×10^{4}	1×10^{7}
Pm-148m (a)	8×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{6}
Pm-149	2×10^{0}	6×10^{-1}	1×10^{3}	1×10^{6}
Pm-151	2×10^{0}	6×10^{-1}	1×10^{2}	1×10^{6}
Polonium (84)				
Po-210	4×10^{1}	2×10^{-2}	1×10^{1}	1×10^{4}

Praseodymium (59)				
Pr-142	4×10^{-1}	4×10^{-1}	1×10^{2}	1×10^{5}
Pr-143	3×10^{0}	6×10^{-1}	1×10^{4}	1×10^{6}
Platinum (78)				
Pt-188 (a)	1×10^{0}	8×10^{-1}	1×10^{1}	1×10^{6}
Pt-191	4×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Pt-193	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{7}
Pt-193m	4×10^{1}	5×10^{-1}	1×10^{3}	1×10^{7}
Pt-195m	1×10^{1}	5×10^{-1}	1×10^{2}	1×10^{6}
Pt-197	2×10^{1}	6×10^{-1}	1×10^{3}	1×10^{6}
Pt-197m	1×10^{1}	6×10^{-1}	1×10^{2}	1×10^{6}
Plutonium (94)				
Pu-236	3×10^{1}	3×10^{-3}	1×10^{1}	1×10^{4}
Pu-237	2×10^{1}	2×10^{1}	1×10^{3}	1×10^{7}
Pu-238	1×10^{1}	1×10^{-3}	1×10^{0}	1×10^{4}
Pu-239	1×10^{1}	1×10^{-3}	1×10^{0}	1×10^{4}
Pu-240	1×10^{1}	1×10^{-3}	1×10^{0}	1×10^{3}
Pu-241 (a)	4×10^{1}	6×10^{-2}	1×10^{2}	1×10^{5}
Pu-242	1×10^{1}	1×10^{-3}	1×10^{0}	1×10^{4}
Pu-244 (a)	4×10^{-1}	1×10^{-3}	1×10^{0}	1×10^{4}
Radium (88)				
Ra-223 (a)	4×10^{-1}	7×10^{-3}	1×10^{2} (b)	1×10^{5} (b)
Ra-224 (a)	4×10^{-1}	2×10^{-2}	1×10^{1} (b)	1×10^{5} (b)
Ra-225 (a)	2×10^{-1}	4×10^{-3}	1×10^{2}	1×10^{5}
Ra-226 (a)	2×10^{-1}	3×10^{-3}	1×10^{1} (b)	1×10^{4} (b)
Ra-228 (a)	6×10^{-1}	2×10^{-2}	1×10^{1} (b)	1×10^{5} (b)
Rubidium (37)				
Rb-81	2×10^{0}	8×10^{-1}	1×10^{1}	1×10^{6}
Rb-83 (a)	2×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Rb-84	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Rb-86	5×10^{-1}	5×10^{-1}	1×10^{2}	1×10^{5}
Rb-87	Unlimited	Unlimited	1×10^{4}	1×10^{7}
Rb (nat)	Unlimited	Unlimited	1×10^{4}	1×10^{7}
Rhenium (75)				
Re-184	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Re-184m	3×10^{0}	1×10^{0}	1×10^{2}	1×10^{6}
Re-186	2×10^{0}	6×10^{-1}	1×10^{3}	1×10^{6}
Re-187	Unlimited	Unlimited	1×10^{6}	1×10^{9}
Re-188	4×10^{-1}	4×10^{-1}	1×10^{2}	1×10^{5}
Re-189 (a)	3×10^{0}	6×10^{-1}	1×10^{2}	1×10^{6}
Re (nat)	Unlimited	Unlimited	1×10^{6}	1×10^{9}
Rhodium (45)				
Rh-99	2×10^{0}	2×10^{0}	1×10^{1}	1×10^{6}
Rh-101	4×10^{0}	3×10^{0}	1×10^{2}	1×10^{7}
Rh-102	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{6}
Rh-102m	2×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Rh-103m	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{8}
Rh-105	1×10^{1}	8×10^{-1}	1×10^{2}	1×10^{7}
Radon (86)				
Rn-222 (a)	3×10^{-1}	4×10^{-3}	1×10^{1} (b)	1×10^{8} (b)
Ruthenium (44)				
Ru-97	5×10^{0}	5×10^{0}	1×10^{2}	1×10^{7}
Ru-103 (a)	2×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}

Ru-105	1×10^{0}	6×10^{-1}	1×10^{1}	1×10^{6}
Ru-106 (a)	2×10^{-1}	2×10^{-1}	1×10^{2} (b)	1×10^{5} (b)
Sulphur (16)				
S-35	4×10^{1}	3×10^{0}	1×10^{5}	1×10^{8}
Antimony (51)				
Sb-122	4×10^{-1}	4×10^{-1}	1×10^{2}	1×10^{4}
Sb-124	6×10^{-1}	6×10^{-1}	1×10^{1}	1×10^{6}
Sb-125	2×10^{0}	1×10^{0}	1×10^{2}	1×10^{6}
Sb-126	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}
Scandium (21)				
Sc-44	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{5}
Sc-46	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{6}
Sc-47	1×10^{1}	7×10^{-1}	1×10^{2}	1×10^{6}
Sc-48	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
Selenium (34)				
Se-75	3×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Se-79	4×10^{1}	2×10^{0}	1×10^{4}	1×10^{7}
Silicon (14)				
Si-31	6×10^{-1}	6×10^{-1}	1×10^{3}	1×10^{6}
Si-32	4×10^{1}	5×10^{-1}	1×10^{3}	1×10^{6}
Samarium (62)				
Sm-145	1×10^{1}	1×10^{1}	1×10^{2}	1×10^{7}
Sm-147	Unlimited	Unlimited	1×10^{1}	1×10^{4}
Sm-151	4×10^{1}	1×10^{1}	1×10^{4}	1×10^{8}
Sm-153	9×10^{0}	6×10^{-1}	1×10^{2}	1×10^{6}
Tin (50)				
Sn-113 (a)	4×10^{0}	2×10^{0}	1×10^{3}	1×10^{7}
Sn-117m	7×10^{0}	4×10^{-1}	1×10^{2}	1×10^{6}
Sn-119m	4×10^{1}	3×10^{1}	1×10^{3}	1×10^{7}
Sn-121m (a)	4×10^{1}	9×10^{-1}	1×10^{3}	1×10^{7}
Sn-123	8×10^{-1}	6×10^{-1}	1×10^{3}	1×10^{6}
Sn-125	4×10^{-1}	4×10^{-1}	1×10^{2}	1×10^{5}
Sn-126 (a)	6×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}
Strontium (38)				
Sr-82 (a)	2×10^{-1}	2×10^{-1}	1×10^{1}	1×10^{5}
Sr-85	2×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Sr-85m	5×10^{0}	5×10^{0}	1×10^{2}	1×10^{7}
Sr-87m	3×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Sr-89	6×10^{-1}	6×10^{-1}	1×10^{3}	1×10^{6}
Sr-90 (a)	3×10^{-1}	3×10^{-1}	1×10^{2} (b)	1×10^{4} (b)
Sr-91 (a)	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
Sr-92 (a)	1×10^{0}	3×10^{-1}	1×10^{1}	1×10^{6}
Tritium (1)				
T(H-3)	4×10^{1}	4×10^{1}	1×10^{6}	1×10^{9}
Tantalum (73)				
Ta-178 (long lived)	1×10^{0}	8×10^{-1}	1×10^{1}	1×10^{6}
Ta-179	3×10^{1}	3×10^{1}	1×10^{3}	1×10^{7}
Ta-182	9×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{4}
Terbium (65)				
Tb-157	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{7}
Tb-158	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Tb-160	1×10^{0}	6×10^{-1}	1×10^{1}	1×10^{6}

Technetium (43)				
Tc-95m (a)	2×10^{0}	2×10^{0}	1×10^{1}	1×10^{6}
Tc-96	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{6}
Tc-96m (a)	4×10^{-1}	4×10^{-1}	1×10^{3}	1×10^{7}
Tc-97	Unlimited	Unlimited	1×10^{3}	1×10^{8}
Tc-97m	4×10^{1}	1×10^{0}	1×10^{3}	1×10^{7}
Tc-98	8×10^{-1}	7×10^{-1}	1×10^{1}	1×10^{6}
Tc-99	4×10^{1}	9×10^{-1}	1×10^{4}	1×10^{7}
Tc-99m	1×10^{1}	4×10^{0}	1×10^{2}	1×10^{7}
Tellurium (52)				
Te-121	2×10^{0}	2×10^{0}	1×10^{1}	1×10^{6}
Te-121m	5×10^{0}	3×10^{0}	1×10^{2}	1×10^{5}
Te-123m	8×10^{0}	1×10^{0}	1×10^{2}	1×10^{7}
Te-125m	2×10^{1}	9×10^{-1}	1×10^{3}	1×10^{7}
Te-127	2×10^{1}	7×10^{-1}	1×10^{3}	1×10^{6}
Te-127m (a)	2×10^{1}	5×10^{-1}	1×10^{3}	1×10^{7}
Te-129	7×10^{-1}	6×10^{-1}	1×10^{2}	1×10^{6}
Te-129m (a)	8×10^{-1}	4×10^{-1}	1×10^{3}	1×10^{6}
Te-131m (a)	7×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{6}
Te-132 (a)	5×10^{-1}	4×10^{-1}	1×10^{2}	1×10^{7}
Thorium (90)				
Th-227	1×10^{1}	5×10^{-3}	1×10^{1}	1×10^{4}
Th-228 (a)	5×10^{-1}	1×10^{-3}	1×10^{0} (b)	1×10^{4} (b)
Th-229	5×10^{0}	5×10^{-4}	1×10^{0} (b)	1×10^{3} (b)
Th-230	1×10^{1}	1×10^{-3}	1×10^{0}	1×10^{4}
Th-231	4×10^{1}	2×10^{-2}	1×10^{3}	1×10^{7}
Th-232	Unlimited	Unlimited	1×10^{1}	1×10^{4}
Th-234 (a)	3×10^{-1}	3×10^{-1}	1×10^{3} (b)	1×10^{5} (b)
Th (nat)	Unlimited	Unlimited	1×10^{0} (b)	1×10^{3} (b)
Titanium (22)				
Ti-44 (a)	5×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}
Thallium (81)				
Tl-200	9×10^{-1}	9×10^{-1}	1×10^{1}	1×10^{6}
Tl-201	1×10^{1}	4×10^{0}	1×10^{2}	1×10^{6}
Tl-202	2×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Tl-204	1×10^{1}	7×10^{-1}	1×10^{4}	1×10^{4}
Thulium (69)				
Tm-167	7×10^{0}	8×10^{-1}	1×10^{2}	1×10^{6}
Tm-170	3×10^{0}	6×10^{-1}	1×10^{3}	1×10^{6}
Tm-171	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{8}

Uranium (92)				
U-230 (fast lung absorption)	4×10^{1}	1×10^{-1}	1×10^{1} (b)	1×10^{5} (b)
U-230 (medium lung absorption)(a)(e)	4×10^{1}	4×10^{-3}	1×10^{1}	1×10^{4}
U-230 (slow lung absorption)	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 (nat)	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 (dep)	Unlimited	Unlimited	1×10^{0}	1×10^{3}
Vanadium (23)				
V-48	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}
V-49	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{7}
Tungsten (74)				
W-178 (a)	9×10^{0}	5×10^{0}	1×10^{1}	1×10^{6}
W-181	3×10^{1}	3×10^{1}	1×10^{3}	1×10^{7}
W-185	4×10^{1}	8×10^{-1}	1×10^{4}	1×10^{7}
W-187	2×10^{0}	6×10^{-1}	1×10^{2}	1×10^{6}
W-188 (a)	4×10^{-1}	3×10^{-1}	1×10^{2}	1×10^{5}
Xenon (54)				
Xe-122 (a)	4×10^{-1}	4×10^{-1}	1×10^{2}	1×10^{9}
Xe-123	2×10^{0}	7×10^{-1}	1×10^{2}	1×10^{9}
Xe-127	4×10^{0}	2×10^{0}	1×10^{3}	1×10^{5}

Xe-131m	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{4}
Xe-133	2×10^{1}	1×10^{1}	1×10^{3}	1×10^{4}
Xe-135	3×10^{0}	2×10^{0}	1×10^{3}	1×10^{10}
Yttrium (39)				
Y-87 (a)	1×10^{0}	1×10^{0}	1×10^{1}	1×10^{6}
Y-88	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{6}
Y-90	3×10^{-1}	3×10^{-1}	1×10^{3}	1×10^{5}
Y-91	6×10^{-1}	6×10^{-1}	1×10^{3}	1×10^{6}
Y-91m	2×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Y-92	2×10^{-1}	2×10^{-1}	1×10^{2}	1×10^{5}
Y-93	3×10^{-1}	3×10^{-1}	1×10^{2}	1×10^{5}
Ytterbium (70)				
Yb-169	4×10^{0}	1×10^{0}	1×10^{2}	1×10^{7}
Yb-175	3×10^{1}	9×10^{-1}	1×10^{3}	1×10^{7}
Zinc (30)				
Zn-65	2×10^{0}	2×10^{0}	1×10^{1}	1×10^{6}
Zn-69	3×10^{0}	6×10^{-1}	1×10^{4}	1×10^{6}
Zn-69m (a)	3×10^{0}	6×10^{-1}	1×10^{2}	1×10^{6}
Zirconium (40)				
Zr-88	3×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Zr-93	Unlimited	Unlimited	1×10^{3} (b)	1×10^{7} (b)
Zr-95 (a)	2×10^{0}	8×10^{-1}	1×10^{1}	1×10^{6}
Zr-97 (a)	4×10^{-1}	4×10^{-1}	1×10^{1} (b)	1×10^{5} (b)

(a) A1 and/or A2 values for these parent radionuclides include contributions from their progeny with half-lives less than 10 days, as listed in the following:

Mg-28	Al-28
Ar-42	K-42
Ca-47	Sc-47
Ti-44	Sc-44
Fe-52	Mn-52m
Fe-60	Co-60m
Zn-69m	Zn-69
Ge-68	Ga-68
Rb-83	Kr-83m
Sr-82	Rb-82
Sr-90	Y-90
Sr-91	Y-91m
Sr-92	Y-92
Y-87	Sr-87m
Zr-95	Nb-95m
Zr-97	Nb-97m, Nb-97
Mo-99	Tc-99m
Tc-95m	Tc-95
Tc-96m	Tc-96
Ru-103	Rh-103m
Ru-106	Rh-106
Pd-103	Rh-103m
Ag-108m	Ag-108
Ag-110m	Ag-110
Cd-115	In-115m
In-114m	In-114
Sn-113	In-113m
Sn-121m	Sn-121

Sn-126	Sb-126m
Te-118	Sb-118
Te-127m	Te-127
Te-129m	Te-129
Te-131m	Te-131
Te-132	I-132
I-135	Xe-135m
Xe-122	I-122
Cs-137	Ba-137m
Ba-131	Cs-131
Ba-140	La-140
Ce-144	Pr-144m, Pr-144
Pm-148m	Pm-148
Gd-146	Eu-146
Dy-166	Ho-166
Hf-172	Lu-172
W-178	Ta-178
W-188	Re-188
Re-189	Os-189m
Os-194	Ir-194
Ir-189	Os-189m
Pt-188	Ir-188
Hg-194	Au-194
Hg-195m	Hg-195
Pb-210	Bi-210
Pb-212	Bi-212, Tl-208, Po-212
Bi-210m	Tl-206
Bi-212	Tl-208, Po-212
At-211	Po-211
Rn-222	Po-218, Pb-214, At-218, Bi-214, Po-214
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Po-211, Tl-207
Ra-224	Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
Ra-225	Ac-225, Fr-221, At-217, Bi-213, Tl-209, Po-213, Pb-209
Ra-226	Rn-222, Po-218, Pb-214, At-218, Bi-214, Po-214
Ra-228	Ac-228
Ac-225	Fr-221, At-217, Bi-213, Tl-209, Po-213, Pb-209
Ac-227	Fr-223
Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
Th-234	Pa-234m, Pa-234
Pa-230	Ac-226, Th-226, Fr-222, Ra-222, Rn-218, Po-214
U-230	Th-226, Ra-222, Rn-218, Po-214
U-235	Th-231
Pu-241	U-237
Pu-244	U-240, Np-240m
Am-242m	Am-242, Np-238
Am-243	Np-239
Cm-247	Pu-243
Bk-249	Am-245
Cf-253	Cm-249

(b) Parent nuclides and their progeny included in secular equilibrium are listed in the following:

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, Bi-214, Po-214, Pb-210, Bi-210, Po-210
Np-237	Pa-233
Am-242m	Am-242
Am-243	Np-239

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

(d) These values apply only to compounds of uranium that take the chemical form of UF6, UO2F2 and UO2(NO3)2 in both normal and accident conditions of transport.

(e) These values apply only to compounds of uranium that take the chemical form of UO3,UF4, UCl4 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.

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APPENDIX C

TI LIMITS FOR FREIGHT CONTAINERS AND CONVEYANCES NOT UNDER EXCLUSIVE USE

Type of freight container or conveyance	Limit on total sum of Transport Indexes in a freight container or aboard a conveyance
Freight container - Small	50
Freight container - Large	50
Vehicle	50
Aircraft	
Passenger	50
Cargo	200
Inland water-way vessel	50
Seagoing vessel	
(1) Hold, compartment or defined deck area:	
Packages, overpack, small freight containers	50
Large freight containers	200
(2) Total vessel:	
Packages, overpack, small freight containers	200
Large freight containers	No limit