FEDERAL ENVIRONMENTAL, INDUSTRIAL AND NUCLEAR SUPERVISION SERVICE

ORDINANCE
No. 5 of October 04, 2004

CONCERNING APPROVAL AND IMPLEMENTATION OF THE FEDERAL CODES AND REGULATIONS IN THE FIELD OF ATOMIC ENERGY USE "SAFETY REGULATIONS FOR TRANSPORT OF RADIOACTIVE MATERIAL"

The Federal Environmental, Industrial and Nuclear Supervision Service hereby resolves:

To approve and implement the enclosed federal codes and regulations in the field of atomic energy use "Safety regulations for the transport of radioactive material," (NP-053-04) as of January 5, 2005.

Acting Chief Executive Officer
A.B. Malyshev

Approved by:
Ordinance of the Federal
Environmental, Industrial and
Nuclear Supervision Service
of Russia
No. 5 of October 04, 2004

Implemented
as of January 5, 2005

FEDERAL CODES AND REGULATIONS IN THE FIELD OF ATOMIC ENERGY USE

SAFETY REGULATIONS FOR TRANSPORT OF RADIOACTIVE MATERIAL

NP-053-04

Regulatory document "Safety regulations for transport of radioactive material" establishes the requirements for safety during transportation of radioactive material.

Requirements of the regulatory document shall apply to the transport of radioactive material by all types of vehicles.

The regulatory document is issued instead of the Safety regulations for transport of radioactive material (PBTRV-73) and Principal rules for safe transport and physical protection of nuclear material (OPB3-83) <*>.

<*> The regulatory document has been elaborated with due consideration of the IAEA recommendations given in the document "Regulations for the safe transport or radioactive material". 1996 Edition/ N ST-1, IAEA, 1996. Alterations and amendments stipulated in the IAEA document "Regulations for the Safe Transport of Radioactive Material" are considered in the regulatory document. Edition 1996 (Revised). N TS-R-1 (ST-1, Revised), IAEA, 2000".

Elaborated by the Federal Environmental, Industrial and Nuclear Supervision Service and Federal Atomic Energy Agency, with the participation of the specialists of Ministry of Health of the Russian Federation, RF Ministry of Internal Affairs of Russia, Traffic Ministry of Russia, RF Ministry of Transportation, including A.M. Agapov, V.V. Ananyiev, V.N. Androsyuk, E.B. Antipin, A.V. Afanasyiev, A.N. Barkovsky, V.N. Vnukov, I.K. Gordeyev, V.N. Yershov, E.A. Zhuravlev, P.M. Zelinsky, A.I. Kislov, A.S. Kolesnihov, Yu.V. Kuznetsov, I.F. Maximkin, M.V. Mikhailov, I.A. Okhotina, S.A. Popov, V.V. Romanov, V.I. Sviridov, A.A. Semenov, S.L. Silinsky, N.S. Tikhonov, A.I. Tokarenko, G.O. Treiman, V.N. Tazhkorob, S.A. Ulanov, V.I. Shapovalov, R.B. Sharaphutdinov, Yu.I. Shcherbakov, V.A. Yakushev.

LIST OF ABBREVIATIONS

ERT - Emergency Rescue Teams

CSI - Criticality Safety Index

ICAO - International Civil Aviation Organization

IMO - International Marine Organization

ISO - International Organization for Standardization

IAEA- International Atomic Energy Agency

UN - United Nations

IAEA Regulations - Regulations for the safe transport of radioactive material. Edition 1996 (amended)

TI - Transport Index

TERMS AND DEFINITIONS

The following terms and definitions are used within these Regulations.

A1 - the activity value of special form radioactive material, which is listed in Table I and II of Appendix 1 or derived in Appendix 1 and is used to determine the activity limits for the requirements of these Regulations.

2. A2 - the activity value of radioactive material other than special form radioactive material, which is listed in Tables I and II of Appendix 1 or derived in Appendix 1, and is used to determine the activity limits for the requirements of these Regulations.

3. Activity is a measure of radioactivity.

The quantity A for an amount of radionuclide in a given energy state at a given time, defined as:

$$A = dN/dt,$$

where dN is the expectation value of the number of spontaneous nuclear transformations from the given energy state in the time interval dt. The Becquerel (Bq) is the SI unit of activity.

4. Low toxicity alpha emitters are natural uranium; depleted uranium; natural thorium; uranium-235 or uranium-238; thorium-232; thorium-228 and thorium-230 when

contained in ores or physical and chemical concentrates; or alpha emitters with a half-life of less than 10 days.

5. Fission materials are uranium-233, uranium-235, plutonium-239, plutonium-241 or any combination of these radionuclides.

The following materials fall within this definition:

a) Natural uranium or depleted uranium, which is unirradiated;

b) Natural uranium or depleted uranium, which has been irradiated in thermal reactors only.

6. Criticality Safety Index (CSI) is a number assigned to a package, overpack or freight container containing fissile material, which is used to provide control over the accumulation of packages, overpacks or freight containers containing fissile material.

7. Exclusive use is the sole use, by a single consignor, of a conveyance or of a large freight container, in respect of which all the initial, intermediate and final loading and unloading are carried out in accordance with the directions of the consignor or consignee.

8. Category (of the package or overpack) is the designation of the radiation hazard degree of the package or overpack to be defined according to the irradiation level on the surface and transport index (TI).

9. Intermediate bulk container (IBC) is a movable packing cask, which

a) has a capacity of not more than 3 cubic meters;

b) Is designed for mechanical handling;

c) Is resistant to the stresses produced in handling and transport, as determined by performance tests;

d) Is designed to conform to the standards in the chapter on Recommendations on Intermediate Bulk Containers (IBCs) of the United Nations Recommendations on the Transport of Dangerous Goods Chapter 16, UN Edition ST/SG/AC.10/1).

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

11. Low specific activity material (LSA) is radioactive material, which by its nature has a limited specific activity, or radioactive material for which limits of estimated average specific activity apply.

External shielding materials surrounding the low specific activity material shall not be considered in determining the estimated average specific activity.

Low specific activity material shall be classified in one of three groups:

11.1. LSA-I materials:

a) uranium and thorium ores and concentrates of such ores, and other ores containing naturally occurring radionuclides (such as uranium, thorium) which are intended to be processed for the use of these radionuclides;

b) natural uranium, depleted uranium, natural thorium or their compounds or mixtures, provided that they are unirradiated and in solid or liquid form;

c) Radioactive material for which the A2 value is unlimited, excluding fissile material in quantities not excepted under It. 2.12.2;

d) Other radioactive material in which the activity is distributed throughout and the estimated average specific activity does not exceed 30 times the values for activity concentration specified in Appendix 1, excluding fissile material in quantities not excepted under It. 2.12.2.

11.2. LSA-II materials:

a) Water with tritium concentration up to 0.8 TBq/l;

b) Other material in which the activity is distributed throughout and the estimated average specific activity does not exceed 10^{-4} A2/g for solids and gases and 10^{-5} A2/g for liquids.

11.3. LSA-III materials are solids (e.g. consolidated waste, activated material), excluding powders, in which:

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

b) 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 seven days would not exceed 0.1 A2 during 7 days);

c) the estimated average specific activity of the solid, excluding any shielding material, does not exceed $2x10^{-3}$ A2/g.

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

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

14. Fixed radioactive contamination of the surface is radioactive material, which spontaneously or upon contact with the surface do not moves from the contaminated surface to the environment under the normal transportation conditions.

15. Depleted uranium is uranium containing a lesser mass percentage of uranium-235 than in natural uranium. A small amount of uranium-234 is present.

16. Enriched uranium is uranium containing a greater mass percentage of uranium-235 as compared with natural uranium. A small amount of uranium-234 is present.

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

17.1. SCO-I - a solid object on which:

a) 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/cm2 for beta and gamma emitters and low toxicity alpha emitters, or 0.4 Bq/cm2 for all other alpha emitters; and

b) 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 $4x10^{4}$ Bq/cm^2 for beta and gamma emitters and low toxicity, or $4x10^{3}$ Bq/cm^2 for all other alpha emitters; and

c) the non-fixed contamination plus the fixed contamination on the in accessible surface averaged over 300 cm^2 (or the area of the surface is less than 300 cm^2) does not exceed $4x10^{4}$ Bq/cm^2 for beta and gamma emitters and low toxicity alpha emitters, or $4x10^{3}$ Bq/cm^2 for all other alpha emitters.

17.2. 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:

a) 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; and

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

c) the non-fixed contamination plus the fixed contamination on the in accessible surface averaged over 300 cm^2 (or the area of the surface is less than 300 cm^2) does not exceed 8 x 10^5 Bq/cm^2 for beta and gamma emitters and low toxicity alpha emitters, or 8 x 10^4 Bq/cm^2 for all other alpha emitters.

18. Natural uranium is uranium containing the naturally occurring distribution of uranium isotopes (approximately 99.28% of uranium-238 and 0.72% of uranium-235 by mass). A small amount of uranium-234 is present.

19. Radiation protection programme are systematic arrangements, which are aimed at providing adequate consideration of radiation protection measures.

20. Radioactive substance is substance that, while not in the category of nuclear materials, emits ionizing radiation.

21. Special form radioactive material is either non-dispersible solid radioactive material or sealed capsule containing radioactive material that meets the requirements of these Regulations to special form radioactive material.

22. Low dispersible radioactive material is either solid radioactive material, or solid radioactive material in a sealed capsule, that has limited dispersibility and is not in powder form, and that meet these Regulations' requirements to low dispersible radioactive material.

23. Radioactive contamination of the surface is the presence of man-caused radioactive material on the surface of vehicles, freight containers, packages and other objects in quantities exceeding 0.4 Bq/sq.cm for beta and gamma emitters and low toxicity alpha emitters, and 0.04 Bq/sq.cm for all other alpha emitters.

24. Radioactive contents are the radioactive material together with any contaminated or activated solids, liquids and gases within the packaging.

25. Radioactive material is nuclear material and/or radioactive substance. The term is used in these Regulations as generalized when there are no differences requirements to the transport of radioactive substances and nuclear material. Hereinafter, radioactive material should be also meant radioactive-based products.

26. Tank is a tank container, a road tank vehicle, a rail tank wagon or a receptacle with a capacity of not less than 450 L for containing liquids, powders, granules, or mixtures, and of not less than 1,000 L for containing gases.

A tank container shall be capable of being carried on land or on sea and of being loaded and discharged without the need of removal of its structural equipment, shall possess stabilizing members and tie-down attachments external to the shell, and shall be capable of being lifted when full.

27. Self-sustaining nuclear chain reaction is a radionuclide fission process under which a number of neutrons produced during nuclear fission within a time period is equal to or more that a number of neutrons going out from the system due to leak or absorption within the same time period.

28. (Package) Containment system is a substructure of the transportation cask designed to confine the radioactive contents during transportation.

29. Non-fixed contamination is radioactive material that can be removed from a surface during routine conditions of transport.

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

31. Special arrangement are the provisions elaborated and approved by interested ministries and departments under the established procedure, under which consignments

which do not satisfy all the applicable requirements of these Regulations and rules (instructions) in force in any mode of transport, may be transported. Fulfillment of these provisions shall ensure at least the same safety level as for fulfillment of the requirements of these Regulations.

32. Transport package (overpack) is a unit load device generated from several unit loads (packages) using various methods and facilities of packing to facilitate the overall mechanization of handling, loading, unloading and storage. The packing facilities include: shipping pallets (flat, rack, grate, crate), flexible or rigid binding (tapes, slings, nets, films), wire, cable braces and other fasteners.

33. Transport index (TI) is a number assigned to a package, overpack, freight container, tank, or to unpackaged LSA-I or SCO-I, which is used to control over radiation exposure during transportation of radioactive material. The procedure for calculating a transport index is given in It. 5.3 of these Regulations.

34. Isotope specific activity is the activity per mass unit of the isotope.

35. Specific activity of a material is the activity per unit mass or volume of the material in which the radionuclides are essentially uniformly distributed.

36. Package is the packaging with its radioactive contents as presented for transport.

The types of packages covered by these Regulations are:

Excepted package;

Industrial package (IP) Types 1, 2, 3 (IP-1, IP-2, IP-3);

Type A package;

Type B package;

Type C package.

Packages containing fissile material are subject to additional requirements (see Section 2.12).

Packages containing uranium hexafluoride are subject to additional requirements (see Section 2.7).

Latin letters "B" and "C" are applied for designation of the package types for the uniformity of package classification according to the IAEA Regulations.

37. Packing cask (transfer packing cask) is the assembly of components necessary to enclose the radioactive contents completely.

It may in particular consist of one or more receptacles, absorbent materials, spacing structures, radiation shielding and devices for cooling and thermal insulation, absorbing mechanical shocks. The packing cask may be a box, drum or similar receptacle, or may also be a freight container, tank or intermediate bulk container.

38. Radiation level is the corresponding dose rate expressed in millisieverts per hour.

39. Physical security is a set of organizational measures, engineered features and activities of guard forces to prevent theft of radioactive material and sabotage related to radioactive material and vehicles transferring radioactive material.

40. Nuclear material is a material containing or capable of reproducing fissile nuclear material (substances).

1. INTRODUCTION

1.1. Designation and scope of application

1.1.1. These Regulations establish the requirements for safe transport of radioactive material, including the requirements for operations and conditions, which are associated with movement of radioactive material and form this process (design, manufacture, maintenance and repair of the package; preparation, loading, shipping, including temporary (transit) storage; unloading (handling) and acceptance of radioactive material and packages at the final destination point).

1.1.2. These Regulations shall apply to the transport of radioactive material by all modes of transport, by road, air and waterways, and shall be in force over the whole territory of the Russian Federation.

1.1.3. These Regulations shall apply to the transport of radioactive material including transport of radioactive material as part of the products, the operation of which is associated with shipping, excluding:

a) radioactive material during the activities associated with development, manufacture, testing, operation and disposal of nuclear weapon;

b) radioactive material being the integral part of a vehicle;

c) radioactive material implanted or introduced into the human or animal body for diagnostics or cure;

d) radioactive material in consumer goods, for which the Ministry of Health of the Russian Federation has issued the sanitary and epidemiological inspection report on exception of the radioactive material from radiation monitoring and accounting after the sale to the customer;

e) natural material and ores containing natural radionuclides, which are either in the natural state or subject to processing just for other purposes in addition to the radionuclide extraction, and which are not subject of processing for the use of these radionuclides provided the specific activity of such material does not exceed 10 times the values specified in Tables I and II of Appendix 1, or have the effective specific activity of no more than 10 Bq/g;

f) radioactive material, the specific activity of which or total activity of the goods does not exceed the values given in Tables I and II of Appendix 1.

1.1.4. These Regulations shall not apply to internal (i.e. without entry into the public transport routes) transportation of radioactive material within the territory of the enterprises, where the materials are made, used and stored, excluding the requirements of these Regulations for preparation of packing casks and packages for transportation with entry into the public transport routes.

1.1.5. These Regulations are mandatory for all legal and natural entities that perform the activity in the field of transportation of radioactive material and take part in the development, manufacture, testing and operation of packing casks and packages, as well as temporary (transit) storage of radioactive material (packages) during their transport.

1.2. General provisions of the safe transport

1.2.1. Requirements of these Regulations for the goods and conditions of transportation are based on the following basic provisions:

1.2.1.1. Limitation of radiation from packages and vehicles (motor, trailer or semitrailer, railway equipment, any vessel, or any hold, compartment, or defined deck area

of a vessel, any aircraft), radioactive contamination of their surfaces and release of radioactive contents from the packages.

1.2.1.2. Limitation of the amount and radionuclide composition of the radioactive contents to be transported in one package depending on the package capability to maintain the tightness and radiation shield under various shipping conditions and on the radioactive content capability for dissipation.

1.2.1.3. Limitation on the amount of fissile nuclear material in a package and/or establishment of requirements for exclusion of self-sustaining chain reaction conditions during transportation of such material.

1.2.1.4. Use of the packing casks, the safe operation of which should be provided by the packing cask design subject to the minimum scope of special organizational-technical measures to be taken during transportation.

1.2.1.5. Limitation of the amount of packages to be transported by one vehicle based on the degree of radiation hazard and risk of self-sustaining chain reaction.

1.2.1.6. Provision for required marking, labeling (danger signs) and caution signs on the cargo and vehicle.

1.2.1.7. Availability of the Russian certificate (Approval certificate) for the package design and certificate (Approval certificate) for shipping and other certificates (approval certificates) in cases provided by these Regulations (see Section 4).

1.2.2. Radiation shield under transportation shall be provided so that the values of individual doses, collective doses, and nuclear radiation potential should be maintained as low as reasonably achievable, whereas the individual exposure doses should not exceed the established limits.

The measures to be taken by consignor (consignee) to fulfill these requirements are given in the radiological protection programme.

1.2.3 The employees that are engaged in the handling of packages and unpackaged radioactive material during the acceptance, loading, storage, unloading, transportation, shall be properly trained in terms of the nuclear and radiation safety of the activities and preventive measures to be taken to limit their exposure and exposure of other persons that

could be damaged due to the personnel actions. The training shall be followed by mandatory periodical knowledge assessment.

The employees to be involved in the temporary activities associated with loading, unloading, and transportation shall be duly briefed before the activities.

The briefing results shall be documented.

In case of occupational exposure during the transport activities, when it is estimated that the effective dose in the amount:

a) more than 1 mSv/year is highly unlikely, no special schedules of work, detailed radiation monitoring, dose assessment programs or keeping the individual records are required;

b) 1-5 mSv/year is very likely; the dose assessment programs shall be implemented by radiation monitoring of the workplaces or individual radiation monitoring. The relevant personnel fall into the "B" Group;

c) more than 5 mSv/year is very likely; the individual radiation monitoring shall be implemented. The relevant personnel fall into the "A" Group;

The individual radiation monitoring or radiation monitoring of the workplaces shall be duly documented.

1.2.4. Radioactive material shall be separated from undeveloped motion picture films, photographic films, radiographic films, photographic plates, and X-ray plates (hereinafter referred to as photosensitive material). The segregation distance is determined so that irradiation of the specified material due to transport of radioactive material is limited to 0.1 mSv per consignment of photosensitive material (see Appendix 2).

1.2.5. The consignor, consignee, and carrier shall implement measures to prevent transport incidents and accidents and to mitigate their consequences in accordance with requirements of these Regulations and regulations concerning the carriage of (dangerous) goods in force for various types of transport.

1.2.6. The quality assurance programs shall be developed and implemented for designing, manufacture, testing, documentation, use, maintenance and inspection of all the special form radioactive material, low dispersible radioactive material, and packages, as

well as regards the transport operations and temporary (transit) storage, for the purpose of fulfilling these Regulations.

For the packing casks elaborated and/or manufactured before implementation of these Regulations, non-availability of the quality assurance programs at the development and/or manufacture stages is allowed.

In this case the operation quality assurance programs shall include the relevant compensatory provisions.

1.2.7. If individual safety requirements stipulated in Sections 2 and 5 cannot be fulfilled, the transportation can be carried out only under certain conditions.

1.2.8. Other hazardous properties of these materials or package materials shall be additionally considered during transportation of radioactive material in accordance with the Regulations concerning the carriage of dangerous goods. It is also necessary to consider the potential for generation of hazardous products due to the interaction of radioactive material or package material and atmospheric air or water.

1.3. Classification and limits of package loading

1.3.1. Requirements to packages and packing material depend on the quantity and hazard level of the transported radioactive material with due consideration of the following shipping conditions:

- ordinary transport conditions (without incidents and accidents);
- normal transport conditions (minor accidents, for example, fall of packages from the car body, impacts on the structures in moving, etc.) simulated during the testing in accordance with these Regulations;
- emergency conditions simulated during the testing in accordance with these Regulations.

1.3.2. Packages are classified as follows:

1.3.2.1. Excepted package is a packing cask containing radioactive material with the activity not exceeding the values given in Table 5.5. The design of such packing cask shall meet the general requirements to transfer packing casks and packages (see Subsection 2.4 and It. 2.8.2).

1.3.2.2. Industrial package Type 1 (IP-1) is a packing cask containing LSA-I and SCO-I material, the design of which meets the general requirements to transfer packing casks and packages (see Subsection 2,4 and It. 2.8.2).

1.3.2.3. Industrial package Type 2 (IP-2) is a packing cask containing some kinds of LSA-I, LSA-II, LSA-III and SCO-II materials (see Table. 5.6), the design of which meets the general requirements to transfer packing casks and packages (see Subsection 2.4 and It. 2.8.2), as well as supplementary requirements (see Section 2.6).

1.3.2.4. Industrial package Type 3 (IP-3) is a packing cask containing some kinds of LSA-II or LSA-III materials (see Table. 5.6), the design of which meets the general requirements to transfer packing casks and packages (see Subsection 2.4 and It. 2.8.2), as well as supplementary requirements (see Section 2.6).

1.3.2.5. Type A package is a packing cask containing radioactive material with the activity of up to A1 for special form radioactive material or up to A2 for other types of radioactive material, the design of which meets the general requirements to transfer packing casks and packages (see. Subsection 2.4), as well as requirements to Type A packages (see Subsection 2.8).

1.3.2.6. Type B package is a packing cask containing radioactive material with the activity exceeding A1 for special form radioactive material or A2 for other types (see Appendix 1), the design of which meets the requirements to Type B(U) or B(M) packages (see Subsections 2.9 and 2.10).

1.3.2.7. Type C package is a packing cask containing radioactive material with the activity exceeding 3,000A1 or 100,000A2 (whichever is the lower) for special form radioactive material and more than 3,000A2 for other radioactive material (see Appendix 1) the design of which meets the requirements to Type C packages (see Subsection 2.11).

1.3.3. Packages shall contain only radioactive materials permitted for certain package design.

Therewith, the following general requirements to quantity and parameters of the radioactive material loaded shall be fulfilled:

1.3.3.1. Excepted packages:

a) for radioactive material other than items of natural uranium, depleted uranium or natural thorium, the excepted package shall not contain radioactive material, the activity of which exceeds the following values:

- the limits specified in columns 2 and 3 of Table for each individual item and each package correspondingly, for radioactive material contained in the instrument or being a part of the instrument or other industrial product, such as watch or electronic equipment;

- the activity limits specified in column 4 of Table 5.5 for radioactive material not used as mentioned above;

b) excepted package can contain any quantity of items made of natural uranium, depleted uranium or natural thorium, subject to the external surface of uranium or thorium is covered with the non-radioactive casing made of metal or other rigid material.

1.3.3.2. For IP-1, IP-2, IP-3 packages the total activity of LSA and SCO material is limited so that the radiation levels specified in It. 5.6.1, and the activity limits for a transport vehicle specified in Table 5.7 are not exceeded.

For the air transport of packages containing non-combustible solid material LSA-II or LSA-III their activity shall not exceed 3,000A2.

For the air transport of packages containing non-combustible solid material LSA-II or LSA-III their activity shall not exceed 3,000A2.

1.3.3.3. Type A packages

1.3.3.3.1. shall not contain radioactive material, the activity of which exceeds the following values:

- A1 for special form radioactive material;

- A2 for other radioactive materials.

1.3.3.3.2. shall not contain radioactive material, the form, physical or chemical condition of which differ from those permitted for certain package design.

1.3.3.3.3. For radionuclide mixtures, the composition and relevant activity of which are known, the following condition is applied to the radioactive contents of the Type A packages:

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

where B(i) is the activity of i-radionuclide as special form radioactive material, and A1(i) is the value of i-radionuclide;

C(j) is the activity of j-radionuclide as radioactive material other than special form radioactive material, and A2(j) is A2 value for j-radionuclide.

1.3.3.4. Type B packages shall not contain:

a) radioactive material the activity of which exceeds the value permitted for certain package design;

b) radioactive material, the form, physical state, chemical state or radionuclide composition of which differ from those that are permitted for certain package design and are specified in the certificates (approval certificates) for the package design.

Besides, the type B packages to be transported by air shall not contain material the activity of which exceeds the following values:

- values permitted for certain package design and specified in the certificate (Approval certificate) for the package design, for low dispersible radioactive material;

- 3,000A1 or 100,000A2, whichever is the lower, for special form radioactive material; or

- 3,000A2 for other radioactive materials.

1.3.3.5. Type C packages shall not contain:

a) radioactive material the activity of which exceeds the value permitted for certain package design;

b) radioactive material, the form, physical state, chemical state or radionuclide composition of which differ from those that are permitted for certain package design and are specified in the certificates (approval certificates) for the package design.

1.3.3.6. The fissile nuclear material packages shall not contain:

a) any radionuclide or fissile material other than those permitted for certain package design;

b) fissile material, the weight, form, physical state, chemical state or geometrical arrangement of which differ from those that are permitted for certain package design and are specified in the certificates (approval certificates) for the package design.

1.3.3.7. Mass of uranium hexafluoride in the package shall not exceed a value that could lead to formation of ullage less than 5% at the maximum temperature of the package, which is indicated for the factory systems where the package is to be used. Uranium hexafluoride shall be in the solid form and the package internal pressure shall not exceed the atmospheric one in transport.

1.3.3.8. If a package meets the requirements of these Regulations when it is loaded with other radioactive material (other than those specified in the relevant certificate (Approval certificate)), loading of other radioactive material is allowed subject to the execution of new certificate (Approval certificate) or the supplement to the existing certificate (Approval certificate).

2. REQUIREMENTS FOR RADIOACTIVE MATERIALS, TRANSFER PACKING CASKS AND PACKAGES

2.1. Requirements for LSA-III radioactive materials

2.1.1. LSA-III materials shall be hard and have such properties so that the water activity does not exceed 0.1A2 during testing of all the package contents specified in Subsection 3.2.

2.2. Requirements for special form radioactive materials

2.2.1. Special form radioactive material shall have at least one overall size not less than 5 mm.

2.2.2. Special form radioactive material shall have such properties and be designed so that the following requirements are fulfilled during the testing stipulated in Subsection 3.3:

a) it shall not be broken or failed during the collision, shock and bending tests specified in It. 3.3.4 - 3.3.6 or 3.3.8 (as applicable);

b) it shall not be melted or dissipated under the thermal tests specified in It. 3.3.7 or 3.3.8 (as applicable);

c) water activity after the leaching tests according to It. 3.3.9 or 3.3.10 shall not exceed 2 kBq (50 nCi). As an alternative for sealed radioactive sources the leakage rate after the relevant testing by the volumetric leakage assessment method specified in ISO International Standard 9978. "Radiation protection. Sealed radioactive sources Leakage test methods," shall not exceed the relevant permissible limit to be agreed during issuance of the certificate (approval certificate).

2.2.3. If a component of special form radioactive material is a sealed capsule, it shall be non-demountable.

2.3. Requirement for low dispersible radioactive materials

2.3.1. Low dispersible radioactive material shall have the properties so that:

a) the radiation level at 3 meters from the specified non-protected radioactive material does not exceed 10 mSv/h (1,000 mRem/h);

b) release of gaseous or aerosol form particles with the aerodynamic equivalent diameter up to 100 μm into the atmosphere does not exceed 100A2 during the tests indicated in It. 3.4.6.3 or 3.4.6.4. An individual specimen can be used for each test;

c) the water activity does not exceed 100 A2 during the leaching test specified in It. 3.2. One should consider a potential destruction after the tests specified in "b".

2.4. General requirements for packages and transfer packing casks

2.4.1. The package design shall provide for easy and safe handling during loading, unloading and transportation with due consideration of the weight, volume and form. Besides, the package shall be design so that it can be duly fastened in a vehicle during transportation.

2.4.2. The package fasteners designed for its movement (lifting) shall not fail in handling according to the operating manual, and in case of their failure the package shall meet the relevant requirements of these Regulations depending on the type. The safety factors (strength, etc.) shall be taken into account for movement (lifting) of the package with a jerk.

2.4.3. The accessories located on the external surface of the package that could be used (sanctioned or not) for its movement (lifting) shall carry its weight in accordance with requirement of It. 2.4.2, or they shall be removed or made unsuitable for use during transportation.

2.4.4. The packing cask shall be designed and made as soon as practical so that its external surfaces have no protruding parts and their decontamination can be easy, whereas the external surface design does not allow for any water collection.

2.4.5. The fasteners that are located on the package during transportation and are not a part of the package shall not deteriorate its safety to such an extent when it could no longer meets the requirements of these Regulations.

2.4.6. The package shall be capable of resisting any acceleration, vibration or vibration resonance that could occur under the usual transport conditions without any deterioration of the efficiency of shutoff devices or integrity of the whole package. Nuts, bolts, and other fasteners shall be mounted so that no inadvertent release is allowed even during their repeated use.

Maximum accelerations for various types of vehicles specified in Table 2.1 can be accepted as maximum acceleration values.

Table 2.1

MAXIMUM ACCELERATIONS FOR VARIOUS MODES OF TRANSPORT

Maximum accelerations for various modes of transport

Mode of transport	Maximum acceleration, g		
	Longitudinal	lateral	vertical
Road	±2	±1	+3; -2
Rail	±10	±2	±4
Sea	±2	±2	±2
Inland waterway	±1.6	±2	±1
Air	+9; -1.5	±2.5	+6; -2.5

For air transport, the packages shall be capable of resisting vibrations within the range from 5 mm and 7Hz (which corresponds to 1g) to 0.05 mm and 200 Hz (which corresponds to 8g).

2.4.7. The radioactive contents, material of the packing cask, and other elements (such as package-to-vehicle tie-down), which could contact each other, shall be physical and chemical compatible. Their condition and interaction under the irradiation conditions shall be considered.

2.4.8. All the valves, which could release the radioactive contents, shall be structurally protected against any unauthorized impact on them.

2.4.9. The package design shall also consider any other hazardous properties of the radioactive contents and elements of the packing cask.

2.4.10. The radioactive contents of the package shall meet the requirements given in It. 1.3.3.1 - 1.3.3.7 depending on the package type.

2.4.11. For air transport, all the package types shall meet the following additional requirements:

- the temperature of the package accessible surfaces shall not exceed 50 °C at the ambient air temperature 38°C without regard to insolation;

- packages shall be designed so that the containment system integrity is maintained within the range of external temperatures from -40 to +55°C;

- packages shall be capable of resisting the decrease in ambient pressure to 5 kPa (0.05 kgf/cm^2) without leakage or resisting the internal pressure which creates the pressure drop at least 95 kPa (0.95 kgf/cm^2), without leakage.

2.5. Requirements for excepted packages

2.5.1. Excepted packages shall meet the requirements specified in It. 2.4.1 - 2.4.10, and for air transport, they shall meet the additional requirements stipulated in It. 2.4.11.

2.6. Requirements for industrial packages

2.6.1. Industrial packages Type 1 (IP-1) shall meet the requirements specified in It. 2.4.1 - 2.4.10 and 2.8.2; for air transport they shall meet the additional requirements given in It. 2.4.11.

2.6.2. Industrial package Type 2 (IP-2) shall meet the requirements for industrial package Type 1 (IP-1) as specified in It. 2.6.1, and after the tests identified in It. 3.4.2.4 and 3.4.2.5, or tests for package groups I and II according to the UN Classification, they shall prevent:

- release or dissipation of radioactive contents;

- damage of the radiation shielding which could lead to increase in the radiation level by more than 20% on the external package surface.

For testing according to the UN classification, the package shall also meet the requirements specified in the Chapter "General packaging recommendations" of the United Nations Recommendations on the transport of dangerous goods (UN Edition - ST/SG/AC.10/1).

2.6.3. Industrial package Type 3 (IP-3) shall meet the requirements for industrial package Type 1 (IP-1) as specified in It. 2.6.1, and the requirements stipulated in It. 2.8.3 - 2.8.15.

2.6.4. Tanks can be also used as industrial packages Types 2 and 3 (IP-2 and IP-3) provided that:

a) they meet the requirements for industrial package type 1 (IP-1) specified in It. 2.6.1;

b) they are designed in accordance with standards established in the Chapter "Recommendations on intermodal transport of dangerous goods in tank containers" of the United Nations Recommendations on the Transport of Dangerous Goods (UN Edition - ST/SG/AC.10/1) or other equivalent requirements, and are capable of withstanding testing pressure of 265 kPa;

c) they are designed so that any additional protection can withstand static and dynamic loads that occur in the normal handling and ordinary transport conditions, and

can maintain its protective features to avoid any increase in the radiation level more than 20% on the external surface of the tank.

2.6.5. Other tanks in addition to tank containers can be used as industrial packages of Types 2 and 3 (IP-2 and IP3) for the transport of liquid radioactive materials and gases, LSA-I and LSA-II, in accordance with requirements of Table 5.6 subject to they meet the standards equivalent to those specified in It. 2.6.4.

2.6.6. Freight containers can be used as industrial packages Types 2 and 3 (IP-2 and IP-3) provided that:

a) their radioactive content is in the solid state;

b) they meet the requirements for Type 1 industrial packages (IP-1) as specified in It. 2.6.1;

c) they are designed to meet the requirements (with the exception for sizes and loading) established by ISO Standard 1496/1 "Series 1 freight containers. Specification and testing. Part 1: General type containers"; and considering the tests specified in this document and accelerations that occur under ordinary transport conditions the design prevents:

- release or dissipation of radioactive contents;

- damage of the radiation shielding, which could lead to increase in the radiation level by more than 20% on the external surface of the container.

2.6.7. Intermediate bulk metal containers can be used as industrial package of Type 2 or 3 (IP-2 or IP-3) provided that:

a) they meet the requirements for industrial packages IP-1 as specified in It. 2.6.1;

b) they are designed in accordance with the standards established in the Chapter concerning recommendations for intermediate bulk containers, the United Nations Recommendations on the Transport of Dangerous Goods (UN Edition - ST/SG/AC.10/1), and under the tests established in this document (provided that their orientation during the drop test is selected with regard to maximum damage) their design prevents:

- release or dissipation of radioactive contents;

- damage of the shielding, which could lead to increase in the radiation level by more than 20% on any external surface of the intermediate bulk container.

2.7. Requirements for uranium hexafluoride packages

2.7.1. Except in cases provided by It. 2.7.4, uranium hexafluoride is placed in the package and transported in accordance with the provisions of ISO 7195 "Packaging of Uranium Hexafluoride (UF6) for Transport," as well as in accordance with the requirements of It. 2.7.2 and 2.7.3. The package shall meet the requirements established in other sections of these Regulations and related to the nuclear and radiation characteristics of the material.

2.7.2. Each package intended for uranium hexafluoride in the amount of 0.1 kg and more shall be designed so that it meets the following requirements:

a) the package shall withstand the test specified in It 3.5.1 without leakage and impermissible stress;

b) the package shall withstand the test specified in It. 3.4.2.4 without leakage or dissipation of uranium hexafluoride;

c) the package shall withstand the test specified in It. 3.4.4.3 without damage of the containment system.

2.7.3. The packages containing uranium hexafluoride in the amount of 0.1 kg or more shall not be equipped with pressure release devices.

2.7.4. The packages containing uranium hexafluoride in the amount of 0.1 kg and more can be transported in the following cases subject to the availability of the package design certificate (approval certificate):

a) the package are designed in accordance with the requirement other than those specified in ISO 7195 and in It. 2.7.2 and 2.7.3, and at the same time they meet the requirements of It. 2.7.2 and 2.7.3 as much as possible ;

b) the packages are designed to withstand the testing pressure less than 2.76 MPa, as specified in It. 3.5.1 without leakage and impermissible stress;

c) for packages intended for 9,000 kg of uranium hexafluoride or more, the packages do not meet the requirements of It. 2.7.2 "c".

2.8. Requirements for Type A packages

2.8.1. Type A package shall be designed so that the requirements of Subsection 2.4 and It. 2.8.2 - 2.8.17 are fulfilled.

2.8.2. The total minimum dimension of the package shall be at least 0.1 m.

2.8.3. The external surface of the package shall be equipped with facilities for sealing by the consignor, which could not be broken up or damaged during transportation.

2.8.4. The fasteners available on the package shall be designed so that the loads occurring under the normal and emergency conditions could not reduce the package capacity to meet the requirements of these Regulations.

2.8.5. The package shall be designed for the range of temperatures of the packaging components from -40 to +70°C. It is necessary to consider the freezing point of liquid contents and potential deterioration of the packaging material properties within the specified temperature range.

If a package is designed for the transport in a restricted area and/or at a certain season and/or by a certain mode of transport, the temperature values can be accepted based on the climatic conditions of the regions, season and conditions provided by the vehicle design. The relevant permanent label concerning the restriction of climatic conditions within the package operation area shall be available on the external surface.

2.8.6. The package shall include a containment system to be properly closed by a locking device, which cannot be opened accidentally or eventually due to the pressure variation, which could occur inside the package under the normal transport conditions.

2.8.7. Special form radioactive material can be considered as a component of the containment system.

2.8.8. If the containment system is a separate part of the package, it shall be equipped with a locking device, which is independent of any other packaging element.

2.8.9. The design of any component of the containment system shall consider the radiolytic decomposition of liquids and other materials, if any, as well as gas generation as a result of the chemical reactions and radiolysis.

2.8.10. The containment system shall retain the radioactive contents in case of ambient pressure decrease up to 60 kPa (0.60 kgf/cm^2).

2.8.11. All the valves, except for safety valves (pressure relief valves), shall have cavities and plugs to prevent any leakages through the valves.

2.8.12. Under the normal transport conditions (see It. 3.4.2.1 - 3.4.2.6) the package shall prevent:

a) release or dissipation of radioactive contents;

b) damage of the radiation shielding which could lead to increase in the radiation level by more than 20% on the external package surface.

2.8.13. The radiation protection system that includes a package component being a part of the containment system shall be designed so that an inadvertent release of this component beyond the protection is avoided. If the radiation protection with such component forms an individual assembly, the radiation protection system shall be reliably closed by a locking device, which is independent of any other packaging element.

2.8.14. The design and method of manufacture of the package and its elements shall meet the relevant codes and standards.

2.8.15. The design of the package for liquid radioactive contents shall provide for additional under-filled space to compensate temperature variations of the contents, dynamic effects and filling dynamics.

2.8.16. The Type A package designed for liquid radioactive material shall additionally meet the requirements specified in It. 2.8.12, after the tests described in It. 3.4.3.1, and:

- it shall have a sufficient amount of absorbent to absorb a double volume of the liquid radioactive contents. Such adsorbent shall be placed so that it directly contacts liquid in case of leakage; or

- It shall have a containment system consisting of the primary internal and secondary external isolation parts specially designed to ensure the liquid radioactive content retention inside the secondary external isolation part even in case of any leakage from the primary internal isolation part.

2.8.17. The package intended for gases shall prevent from any loss or dissipation of radioactive contents, if it has been subjected to the tests specified in It. 3.4.3.1. This requirement does not apply to the Type A package designed for tritium or noble gases.

2.9. Requirements for Type B (U) packages

2.9.1. Type B (U) packages shall meet the general requirements for packaging (packing casks) and packages (see Subsection 2.4), requirements for Type A packages according to It. 2.8.2 - 2.8.15, except for It. 2.8.12 "a", and requirements of this Subsection. Requirements of It. 2.8.4 shall also apply to emergency transport conditions

2.9.2. The package shall be designed so that after the tests simulating the emergency transport conditions (see It. 3.4.4.1 - 3.4.4.4) the radiation level at 1 m distance from the package surface does not exceed 0.01 Sv/h (1 Rem/h) provided that the radioactive contents have the maximum activity permitted for such package.

2.9.3. The package shall be designed so that the heat released inside the package with radioactive contents under the environment conditions specified in It. 2.9.11, and under the normal transport conditions (in accordance with the tests described in It. 3.4.2.1 - 3.4.2.6) does not have an adverse impact upon the package, at which the package no longer meets the relevant requirements for the containment system and protective properties, if it is not serviced within one week. One should consider the heat effect, which can:

a) change an arrangement, geometric form or physical state of radioactive contents, or cause deformation or melting of a vessel, confinement or radioactive contents, if the radioactive material is within a vessel or a confinement;

b) blunt the effectiveness of the package radiation shielding due to different thermal expansion of the radiation shielding;

c) hasten corrosion under the humid conditions.

2.9.4. The package that includes the thermal shield to meet the requirements of the heat tests described in It. 3.4.4.3 shall be designed so that the thermal shield maintains the efficiency after the package tests specified in It. 3.4.2.1 - 3.4.2.6 and 3.4.4.2. The thermal shield located beyond the package shall keep its functions when applying the tear, cut, slip and friction forces, or in case of improper handling.

2.9.5. The package design shall ensure the fulfillment of the following requirements:

a) loss of radioactive contents does not exceed 10^{-6} A2 per hour under the normal transport conditions in accordance with the tests described in it. 3.4.2.1-3.4.2.6. Therewith, when assessing the permissible release of radioactive contents it is necessary to consider the external contamination limits defined in It. 5.3.11;

b) loss of radioactive contents from the package during a week does not exceed 10A2 for krypton-85 and A2 for other radionuclides under the emergency transport conditions in accordance with the tests defined in It. 3.4.4.1 - 3.4.4.4. For mixtures of various radionuclides the provisions of Appendix 1 are applied, except for krypton-85, for which effective value A equal to 10A2 can be used.

2.9.6. Maintenance of the package characteristics based on the permissible limits of the radioactive content release from the package shall not depend on filters and forced cooling system.

2.9.7. The package shall not have a device of pressure relief from the containment system, which would allow for release of the radioactive contents into the environment under normal, ordinary and emergency transport conditions, in accordance with the tests described in It. 3.4.2.1 - 3.4.2.6 and 3.4.4.1 - 3.4.4.4.

2.9.8. The package shall be designed so that, when maximum normal operating pressures are created in the containment system before and during the tests simulating the normal and emergency transport conditions, as specified in It. 3.4.2.1 - 3.4.2.6, 3.4.4.1 - 3.4.4.4, the stresses in the containment system do not reach the values, at which the package would no longer meet the relevant requirement.

2.9.9. Maximum normal operating pressure in the package shall not exceed 700 kPa (7 kgf/cm^2).

2.9.10. Under the normal transport conditions, the maximum temperature at any accessible surface of the package shall not exceed 50°C in the absence of insolation, if the package is not transported under the exclusive use conditions.

For the transport under the exclusive use conditions, except the air transport, the temperature at any accessible package surface shall not exceed 85°C considering the use of protective means (fences) to restrict the transport workers' access. No testing of protective means (fences) is required.

2.9.11. The package shall be designed with regard to the range of ambient temperatures from -40 to +38°C and insolation parameters specified in Table 2.2.

Table 2.2

Insolation parameters

Package surface form and arrangement	Insolation during 12h/day, W/m/м^2
Flat surfaces in the horizontal:	
base surface	No
other surfaces	800
Flat surfaces out of the horizontal:	
Each surface	200*
Curved surfaces	400*

* Insolation for a particular surface can be determined by calculations based on the isolation of the horizontal surface and the angle of this surface to the horizontal.

For transporting the package in a closed vehicle where the temperature can be higher than 38°C, the B(U) type package shall be designed with due regard to the higher temperature at the ambient air temperature 38°C.

2.9.12. The package with the radioactive content the activity of which exceeds 10^5 A2 shall be designed so that under the deep submersion test of the package according to It. 3.4.4.5 the containment system is kept integral and no release of constructional elements of the solid radioactive contents from the package occurs.

2.9.13. The package containing low dispersible radioactive material shall be designed so that any materials added to low dispersible radioactive material or any internal packaging components could not negatively affect the characteristics of low dispersible radioactive material.

2.10. Requirements for Type B(M) packages

2.10.1. The Type B(M) packages shall be designed so that general requirements for transfer packing casks and packages (see Subsection 2.4), requirements for Type A packages according to It. 2.8.2 - 2.8.15, excluding It. 2.8.12 "a", and requirements for Type B(U) packages specified in It. 2.9.2 - 2.9.5 are fulfilled. The requirements for Type B(U) packages described in It. 2.9.6 - 2.9.13 for Type B(M) packages shall be fulfilled as far as reasonably practicable. The certificate (approval certificate) for the package design shall include the items of these Regulations, which the package does not meet.

2.10.2. The periodical pressure release from the Type B(M) packages during transportation may be allowed subject to the in-service inspection conditions are included in the package design certificate (approval certificate).

For such pressure release it is necessary to ensure that the permissible loss of activity is not exceeded under the normal transport conditions in accordance with It. 2.9.5 "a".

2.11. Requirements for Type C packages

2.11.1. The Type C package shall be designed so that the general requirements for packing casks and packages (see Subsection 2.4), requirements for Type A packages of It. 2.8.2 - 2.8.15, excluding the requirements described in It. 2.8.12 "a", as well as requirements for Type B(U) packages of It. 2.9.3, 2.9.6 - 2.9.11, 2.9.13 and It. 2.11.2 - 2.11.4 are fulfilled.

2.11.2. The Type C package shall meet the requirements specified in It. 2.9.2, 2.9.5 "b" and 2.9.8, after submersion in a medium characterized by thermal conductance 0,33 W/(m x K) and temperature 38°C in a steady state. As the initial conditions of assessment one shall confirm that a thermal insulation of the package is integral, the package is under the maximum normal operating pressure conditions, and ambient air temperature is 38°C.

2.11.3. The Type C package shall be designed so that under the maximum normal operating pressure:

a) during the tests simulating the normal transport conditions described in It. 3.4.2.1-3.4.2.6, leakage of radioactive contents does not exceed 10^{-6} A_2 per hour;

b) during the tests to be conducted in a sequence provided in It. 3.4.6.1, the package meets the following requirements:

- to retain the protective features that ensures the radiation level at 1 m distance from the package surface not more than 10 mSv/h even when the radioactive content to be transported in this package has the maximum permissible activity;

- the activity of the total radioactive content leakage within a week shall not exceed 10A2 for krypton-85 and A2 for all other radionuclides.

For mixtures of various radionuclides the provisions of Appendix 1 shall be applied except for krypton-85, for which the effective value equal to 10A2 can be applied. For case "a" the external contamination limits specified in It. 5.3.11 are considered in the assessment.

2.11.4. The Type C package shall be designed so that under the deep submersion tests according to It. 3.4.4.5 the containment system is kept integral and no release of constructional elements of the solid radioactive contents from the package occurs.

2.12. Requirements for packages containing fissile material

2.12.1. The packages containing fissile material (except for materials specified in It. 2.12.2) shall meet the requirements for industrial packages or Type Am or Type B(U), or Type B(M) packages of Type C packages with regard to the properties and activity of the radioactive content, as well as the requirements of this subsection.

2.12.2. The following packages and fissile materials are excepted from requirements of these subsection and other requirements of these Regulations related to the transport of nuclear material (for exception from the requirements all the packages at the same vehicle shall meet provisions of the same paragraphs below:

a) uranium enriched up to 1% in uranium-235 with the total content of plutonium and uranium-233 does not exceed 1% of U-235 weight, subject to fissile material is distributed uniformly throughout the material.

Besides, if uranium-235 is available as metal, oxide or carbide, it shall not be placed as the ordered lattice;

b) the packages containing nitric-acid uranium solutions enriched to no more than 2% in uranium-235 with the total content of plutonium and uranium-233 no more than 0.1% of the uranium-235 weight, with the radio of the number of nitrogen atoms to the number of uranium atoms at least 2;

c) the consignment, the mass of which meets the formula:

$$\frac{\text{mass of uranium-235, g,}}{X} + \frac{\text{mass of other fissile substance, g}}{Y} < 1$$

where X и Y - weight limits defined in Table 2.3, subject to:

- each individual package contains not more than 15 g of fissile nuclear material; for unpackaged substance this quantitative limit shall be applied for a consignment to be shipped inside a vehicle;

- fissile material is a homogeneous hydrogenous solution or mixture, where the ratio of fissile nuclide and hydrogen is less than 5% by weight; or

- no more than 5 g of fissile nuclear material contains in any 10-l volume of substance.

Beryllium and deuterium shall not be available in the amounts exceeding 0.1% of the weight of fissile material;

d) packages containing plutonium in the amount of no more than 1 kg, where there are no more than 20% of plutonium-239, plutonium-241 or any mixture of these nuclides.

Table 2.3

CONSIGNMENT MASS LIMITS FOR EXCEPTION FROM THE REQUIREMENTS FOR PACKAGES CONTAINING FISSILE MATERIAL

Consignment mass limits for exception from the requirements for packages containing fissile material

Fissile material	**Mass of fissile nuclear material mixed with substances, which the average hydrogen density is lower or equal to water density, g.**	**Mass of fissile nuclear material mixed with substances, which the average hydrogen density is higher that water density, g.**
Uranium-235 (X)	400	290
Other fissile nuclear material (Y)	250	180

2.12.3. Fissile material shall be packaged and transported to avoid the attainment of critical mass under the normal, ordinary and emergency transport conditions.

One should consider that when transporting packages containing fissile material the possibility exists of:

- water leakage into/out of the package;
- loss of efficiency of the package neutron moderators or absorbers;
- re-allocation of fissile material either inside the package or as a consequence of its falling out of the package;
- decrease of distances between the packages;
- transfer of packages into water or snow;
- effects due to temperature changes;
- presence of people near or inside a group of packages.

2.12.4. The effective multiplication factor (Keff) of an individual package shall not exceed 0.95 under the normal, ordinary and emergency transport conditions.

To determine a permissible quantity of packages the criticality safety index (CSI) is used at the vehicle.

To calculate the CSI a permissible number of packages (N) shall be determined, which should meet the following conditions:

- under the normal conditions the quintuple quantity of packages N shall be kept subcritical at any arrangement, in the conditions defined in It. 2.12.12.1;

- under the emergency conditions the double quantity of packages N shall be kept subcritical at any arrangement, in the conditions defined in It. 2.12.12.2.

2.12.5. The packing cask after the tests that simulate the normal transport conditions as specified in It. 3.4.2.2 - 3.4.2.6 shall prevent from any ingress of a cube with 10 cm edge inside the package.

2.12.6. The package shall be designed with due regard to the ambient air temperature range from -40 to +38°C, unless otherwise expressly stipulated by the certificate (approval certificate).

2.12.7. When analyzing nuclear safety of an individual insulated package and package system it is necessary:

2.12.7.1. To consider all the packages in the vehicle or in the group on the marine vessel arranged back-to-back as close as possible in terms of the package design with due consideration of deformation under the normal and emergency conditions, and as far as it results in the maximum Keff.

2.12.7.2. To assume for each insulated package that water could ingress into the free space of the package or flow out of the package, including the space inside the containment system. However, if the design has special features to prevent such water ingress in certain void volumes or water leakage out of them even due to the human errors, the absence of leakage can be assumed for such void volumes. Special features shall include:

a) a number of highly reliable water barriers, each of which would be water-proof, if the package is tested as specified in It. 2.12.12 "b", is subject to high extent of quality

control during the manufacture, maintenance and repair of packing casks, as well as tested for sealing before each transport; or

b) for packing casks containing only uranium hexafluoride:

- after the testing described in 2.12.12 "b", there is no direct valve contact with any other component of the packing cask except an initial attachment point, and besides after the tests described in It. 3.4.4.3, the valve are maintained resistant to leak;

- high extent of quality control during the manufacture, maintenance and repair of packing casks in combination with the tests for sealing of each package prior to each shipment.

2.12.7.3. To consider the quantities, distribution and density of the neutron moderator (in particular, water) placed in the package and between the packages in emergency conditions, which lead to the maximum Keff with due regard to the general arrangement in terms of water ingress and leakage according to It. 2.12.7.2.

2.12.7.4. To assume for every insulated package or a group of packages the availability of the full water reflector (or the most effective reflecting material available in the analyzed system) around the packages, with the thickness of no less than 20 cm in addition to reflective capacity of the package structural element.

2.12.7.5. To evaluate the package or a group of packages under the normal and emergency transport conditions, if a chemical or physical form, isotopic composition, mass or concentration, rate of neutron moderation or density, or geometric configuration are unknown based on the assumption that each unknown parameter has such a value, at which neutron multiplication attains the maximum level that corresponds to the known conditions and parameters of these evaluations.

2.12.7.6. To consider the irradiated nuclear fuel as fresh, if Keff decreases with burning off, and as irradiated to a value relevant to the maximum Keff, if the Keff increases with burning off. It is allowed to use the burn-up fraction as the nuclear safety parameter, if the burn-up fraction is measured using special devices. The record thereof shall be introduced in the package design certificate (approval certificate).

2.12.7.7. To ignore the availability of absorbing elements in the fuel assemblies of nuclear reactors or in the packages, if it is not proved that their functions are kept within the specified limits under the normal and emergency transport conditions.

2.12.7.8. To determine and consider the most dangerous configuration, neutron moderation and full reflector for fissile materials, if it can go beyond the package (packages) in the vehicle under the normal and emergency transport conditions.

2.12.7.9. To determine and consider the configuration of fissile material and other package elements, which results in the maximum Keff and which can occur under the normal and emergency transport conditions.

2.12.7.10. To consider the possibility of Keff increase as a consequence of the temperature increase or decrease under the normal and emergency transport conditions.

2.12.7.11. To consider inaccuracy of the calculation methods, to introduce due corrections.

2.12.7.12. To take into account the dimensional tolerances during manufacture and operation of the packages.

2.12.7.13. To consider package damages during simulation of the normal and emergency transport conditions that lead to increase of Keff, with due regard to propagation of such damages to all the packages within a group.

2.12.8. If the packing cask includes the neutron absorbers for nuclear safety, it is necessary to conduct the absorbers effectiveness test during the manufacture and periodical inspections of their availability during the operation, if applicable. Methods of inspection of the absorber availability during the operation shall be included in the packing cask operating instruction. These methods can provide for both the documentation control with the justification of such method and measurements.

2.12.9. It is not allowed to use liquid neutron absorbers in the package.

2.12.10. To determine the permissible quantity of packages in the vehicle in terms of nuclear safety the criticality safety index is used in accordance with It. 5.3.5.

2.12.11. The following requirements shall be met for the packages to be transported by air:

a) the package shall be subcritical during the test specified in It. 3.4.6.1.

It is assumed that there is no water inside the package, and the full water reflector with a thickness of at least 20 cm is located around the package.

b) special facilities defined in It. 2.12.7.2, are not taken into account, if after the tests specified in 3.4.6.1 and 3.4.5.3, water ingress into the void volumes or water leakage from these volumes is not prevented.

2.12.12. To assess the package capability to ensure the nuclear safety the normal and emergency transport conditions shall be simulated during the following tests:

2.12.12.1. The normal transport conditions are simulated by the tests specified in It. 3.4.2.2 - 3.4.2.6.

When calculating Keff under the normal transport conditions, it is expected that:

a) spaces between the packages are left unfilled, and the water layer with the thickness of at least 20 cm all around the packages performs the reflector functions;

a) the package state conforms to their ambient conditions after the tests specified in It. 3.4.2.

2.12.12.2. Emergency transport conditions are simulated during the following tests and conditions, which lead to the worst consequences in terms of the nuclear safety. The following tests are conducted after the tests described in It. 3.4.2.2 - 3.4.2.6:

- tests described in It. 3.4.4.2 "b", as well as either the tests specified in It. 3.4.4.2 "c" for the packages the weight of which does not exceed 500 kg and the total density based on the overall sizes is not more than 1,000 kg/m3, or the tests specified in It. 3.4.4.2 "a" for the rest packages; then perform the tests described in It. 3.4.4.3, and finally the tests specified in It. 3.4.5;

- tests specified in It. 3.4.4.4.

When calculating Keff under the emergency transport conditions, it is expected that:

a) spaces between the packages shall be filled with hydrogenous moderators, and the water layer with the thickness of at least 20 cm all around the packages performs the reflector functions;

b) if there is leakage of fissile material beyond the containment system as a consequence of the tests described in It. 2.12.12.2, one should consider that such leakage is detected in each package of the group, whereas the configuration and moderation of

neutrons for all fissile materials are that maximum neutron multiplication occurs, at which the surrounding water layer with the thickness of at least 20 cm performs the reflector functions.

3. TESTING OF RADIOACTIVE MATERIAL, TRANSFER PACKING CASKS AND PACKAGES

3.1. General provisions

3.1.1. The conformance of radioactive material, packing casks, and packages to the requirements from Section 2, can be confirmed by any methods given below or by combination of the methods:

a) testing of specimens of the LSA-III or special form radioactive material or low dispersible radioactive material, or testing of the packing cask prototypes or models, when the content of the specimen or packing cask should simulate the expected range of radioactive content characteristics as accurately as possible, whereas the tested specimen or packing cask should be available as transported;

b) a reference to the previous satisfactory confirmation of similar nature;

c) testing of the scale models equipped with the elements important to a tested specimen, if the technical experience shows that results of such tests are acceptable for the development purposes. When using the scale models one should consider the need for correction of certain testing parameters, such as diameter of the mandrel plug or compressive load;

d) analysis or reasonable argument, when reliability or conservatism of the analytical methods and parameters is generally acknowledged.

3.1.2. Confirmation of the conformity of radioactive materials, packing casks and packages to the requirements of Section 2, which are not covered by the tests described in this Section (for example, capability to withstand vibration loads, loads from jerk movement (lifting), thermal mode of the package under the normal transport conditions, leakage test, radiolytic decomposition test, etc.) is performed in accordance with the regulatory documentation applicable in the Russian Federation. If there is no required regulatory documentation the general provisions stipulated in It. 3.1.1 are applied.

3.1.3 The pilot model of packing casks for the transport of spent nuclear fuel shall be subject to the acceptance testing for primary use.

3.1.4 The target for the collision test, free fall impact test, mechanical damage and puncture tests specified in It. 3.3.4, 3.4.2.4, 3.4.3.1 "a", 3.4.4.2, 3.4.6.2 and 3.4.6.4, shall be a flat horizontal surface.

During the tests under It. 3.4.6.4 it is allowed to use a target as a vertical flat surface. Direction of movement of the tested specimen shall be perpendicular to the target surface.

Resistance to shift and strain of the target and its surface shall ensure that any increase in the resistance does not lead to a significant increase in specimen damage when it drops onto the target.

3.2. Testing of LSA-III radioactive material

3.2.1. Solid radioactive material in the amount equal to the package contents is immersed in water for seven days at the room temperature. Water volume shall be sufficient so that at the end of testing the remaining volume of unabsorbed and unreacted water is at least 10% of the amount of the tested specimen. The initial value of water pH shall be 6-8, the maximum water conductivity - 1 mS/m (10 μmho/cm) at 20°C. Upon expiry of 7 days, the total activity of the remaining water volume is measured.

3.3. Testing of special form radioactive material and low dispersible radioactive material

3.3.1. Special form radioactive material are subject to the testing for conformity to the requirements stipulated in It. 2.2.2, in particular: impact test, drop test, bending test, leaching test, and thermal test.

3.3.2. Various specimens can be used for each test.

3.3.3. After each test as specified in It. 3.3.4 - 3.3.7, the specimen is assessed by leaching or by determination of leakage using a method no less sensitive than the methods defined in It. 3.3.9 for solid non-dispersible material, and in It. 3.3.10 - for material in capsule.

3.3.4. Impact test. The specimen is dropped to the target from 9 m height.

3.3.5. Drop test. The specimen is placed onto the lead plate located on the smooth flat surface. The specimen is subject to an impact by the flat surface of the steel ingot with the weight of 1.4 kg under its free fall from the height of 1 m. The flat surface of the ingot shall have the diameter of 25 mm, with the edges having the rounding radius of 3.0 mm +/- 0.3 mm. The lead plate with the hardness of 3.5-4.5 according to the Vickers scale, and thickness of nor more than 25 mm, shall have a surface larger than the base area of the specimen. For each drop (impact) testing a new lead plate shall be used. The ingot impact upon the specimen shall be done with a highest possible damage.

3.3.6. Bending test. Bending test is applied to only special form radioactive material with a length of at least 19 cm and with a length-maximum width ratio of at least 10. The specimen shall be rigidly fixed in the horizontal so that the half of its length protrudes over the clamp. The specimen shall be positioned so that it can get a highest possible damage on impact with the flat surface of the ingot with a mass of 1.4 kg under its free fall from the 1 m height to the free end of the specimen. The flat surface of the ingot shall have a diameter of 25 mm and the edges with the rounding radius of 3.0 mm +/- 0.3 mm.

3.3.7. Thermal test. The specimen is heated up in the air medium to the temperature of 800°C, held at this temperature during 10 min, and it cools naturally.

3.3.8. Specimens of radioactive material in capsule or its simulator cannot be subject to the following tests:

a) tests specified in It. 3.3.4 and 3.3.5, if weight of such special form radioactive materials is less than 200 g and alternatively they are subject to the collision test of Class 4 according to ISO 2919 "Sealed radioactive sources. Classification";

b) tests specified in It. 3.3.7, if alternatively they are subject to the thermal test of Class 6 according to ISO 2919 "Sealed radioactive sources. Classification".

3.3.9. For specimens of special form radioactive material or its simulator the leaching test is conducted as follows:

a) the specimen is immersed in water for seven days at the room temperature. The water volume shall be sufficient so that at the end of testing the remaining volume of unabsorbed and unreacted water is at least 10% of the amount of the tested specimen. The

initial value of water pH shall be 6-8, the maximum water conductivity - 1 mS/m (10 μmho/cm) at 20°C.

b) water with the specimen is heated up to the temperature of 50+/-5°C and held at this temperature during 4 hours;

c) then the specimen is removed and the water activity is determined;

d) the specimen is held in the air at least 7 days at the temperature of 30°C without blowing and at the relative humidity of at least 90%;

e) the specimen is immersed in water with the same characteristics as described in "a", and heated up to the temperature of 50+/-5°C, then the specimen is held at this temperature during 4 hours;

f) finally, the water activity is measured.

3.3.10. For specimens of special radioactive material in capsule or its simulator the leaching test is conducted as follows:

a) the specimen is immersed in water at the room temperature (water shall have 6-8 pH and maximum conductivity 1 mS/m (10 μmho/cm) at 20°C). Water and specimen are heated up to the temperature of 50+/-5°C and held at this temperature during 4 hours;

b) the water activity is measured;

c) the specimen is held in the air at least 7 days at the temperature of 30°C without blowing and at the relative humidity of at least 90%;

d) the steps specified in "a" and "b" are repeated.

Alternatively, the assessment of volumetric leakage can include any test among those established by ISO 9978 "Radiation protection. Sealed radioactive sources. Leak testing method."

3.3.11. Specimens of low dispersible radioactive material or its simulators are subject to the heavy thermal test as specified in It. 3.4.6.3, and collision test according to It. 3.4.6.4. An individual specimen can be used for each test. After each test the specimen is subject to the leaching test described in It. 3.2.1. After each test it is determined whether the relevant requirements stipulated in It. 2.3.1 are fulfilled.

3.4. Testing of transfer packing casks and packages

3.4.1. General provisions

3.4.1.1. Prior to testing all the specimens are inspected to detect and record failures or damages, in particular:

a) design variations from the project;

b) workmanship defect;

c) corrosion and other negative impacts;

d) strains.

3.4.1.2. The containment system being tested, as well as external specimen elements shall be clearly designated.

3.4.1.3. After each test as defined in It. 3.4.2.1 - 3.5.1:

a) failures and damages are detected and recorded;

b) then it is necessary to assess whether the containment system and radiation protection continue to meet the requirements of Section 2 specified for a packing cask being tested;

c) it is necessary to assess whether the assumptions and provisions of It. 2.12.3 - 2.12.12 are fulfilled for the packages containing fissile nuclear material.

3.4.2. Tests demonstrating the package ability to withstand the normal transport conditions

3.4.2.1. The package specimens are subject to the impact tests under its free fall, stacking test and penetration test. Each of these tests shall be preceded by the water spray test. For all the tests it is possible to use one specimen subject to the requirements defined in It. 3.4.2.2 have been fulfilled.

3.4.2.2. The length of time between the end of the water spray test and next test shall be provided so that water can be absorbed without visible drying of the external specimen surface. In the absence of any contraindications this length of time is assumed equal to about 2 hours, if water supplied from four points simultaneously. If water is sprayed sequentially from each direction, the time period before the next test is not required.

3.4.2.3. Water spray test. The specimen shall be subject to the water spray test, which simulates the rain with the intensity of about 5 cm/h during at least 1 h.

3.4.2.4. Free drop test. The specimen shall drop onto the target so that maximum damage is caused to the safety related elements being tested.

In this case:

a) a free fall height to be measured from the lowest point of the specimen to the target plane shall be no less than a distance specified in Table

3.1 for the relevant package mass;

b) for rectangular fiber, wooden, cardboard and polymeric packages with a mass no more than 50 kg, an individual specimen shall be subject to the 0.3 m drop test onto each angle;

c) for cylindrical fiber, wooden, cardboard and polymeric packages with a mass no more than 100 kg, an individual specimen shall be subject to the 0.3 m drop test onto each quarter of the cylinder edge of the both bases.

Table 3.1

The free drop height during the tests proving the package capability to withstand normal transport conditions

Package mass, kg	Free drop height, m
0 < 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

3.4.2.5. Stacking test. If a packing cask form does not eliminate the possibility of stacking, the specimen is subject to 24-hour compression with a force equal to or higher than one of the following values:

a) the force equivalent to a fivefold mass of the package;

b) the force equivalent to the product of 13 kPa (0.13 kgf/cm^2) by the area of the package frontal view.

The load shall be distributed uniformly to the two opposite sides of the specimen, one of which should be a base of the package.

3.4.2.6. Penetration test. The specimen shall be put onto the rigid horizontal flat surface, which does not shift during the tests. A ball-ended rod with the diameter of 3.2 cm and mass of 6 kg shall be dropped vertically to the center of the weakest part of the specimen so that if the rod penetrates the package deeply it touches the containment system. The rod shall not be significantly deformed during the tests. The height of the rod drop to the target point on the external package surface shall be 1 m.

3.4.3. Additional tests of Type A packages designed for liquid radioactive material

3.4.3.1. The specimen of the type A package designed for liquid nuclear material is subject to one of the following tests, which is the most severe for this specimen. If it is impossible to prove that one of the tests is the most severe for a particular package, the specimen is subject to both tests:

a) free fall impact test. The test is dropped onto the target so that to cause maximum damage to the containment system. The drop height to be measured from the lowest part of the specimen to the target surface shall be 9 m;

b) penetration test. The specimen shall be subjected to the test described in It. 3.4.2.6, with the difference that the height drop should be increased to 1.7 m.

3.4.4. Tests demonstrating the package ability to withstand the emergency transport conditions

3.4.4.1. The specimen package shall be subject to the cumulative testing effect described in It. 3.4.4.2 and 3.4.4.3, in the specified sequence. After the tests one or another specimen shall be subject to the water immersion test according to It. 3.4.4.4, and the test, described in It. 3.4.4.5, as appropriate.

3.4.4.2. Mechanical damage test. Each specimen shall be subjected to two impact tests:

- the packages with a mass no more than 500 kg and total density to be defined according to the outer sizes, not more than 1,000 kg/m^3, with the radioactive content more than 1,000A2, which is not special form radioactive material, shall be subject to the tests specified in "b" and "c";

- other packages are subject to the tests specified in "a" and "b".

A sequence of specimen drop shall be so that upon completion of the tests the specimen damage would lead to the maximum damage during the next thermal test:

a) the specimen shall drop onto the target (see It. 3.1.4) so that it suffers maximum damage. The drop height to be measured from the lowest part of the specimen to the target surface shall be 9 m;

b) the specimen shall drop onto the target so that to produce maximum damage, whereas the drop height to be measured from the assumed impact point to the target surface shall be 1 m. The target is a solid rod of circular section with the diameter of 15.0 cm +/- 0.5 cm made of mild steel. The rod end is a flat horizontal surface with rounding edges with the radius of not more than 6 mm. The rod shall be fixed vertically on the base target and have the height of 20 cm. If a heavier damage is produced at a higher height, a rod shall have a sufficient height to produce maximum damage. The base target shall meet the requirements specified in It. 3.1.4;

c) the specimen shall be subjected to the dynamic crush test, under which the maximum damage is produced when the 500 kg mass is dropped onto the specimen from the 9 m height. The plate made of mild steel with 1 x 1 m sizes shall drop horizontally. The drop height shall be measured from the lower plate surface to the highest point of the specimen. The target where the specimen is placed shall meet the requirements given in It. 3.1.4.

3.4.4.3. Thermal test. The specimen shall be completely placed excluding a simple supporting structure into the hydrocarbon fuel combustion source in the air, which has the sufficient dimensions and conditions for the average emission factor (flame) at least 0.9 at the average flame temperature of at least 800°C during 30 min; alternatively, any other test shall be conducted to deliver the equivalent heat flow to the package. The fuel combustion surface shall protrude over the limits of any external surface of the specimen horizontally, at least to 1 m, but not more than 3 m. The specimen shall be located at 1 m distance above the fuel surface. Upon completion of the external fuel supply the specimen shall not be subject to any artificial cooling, and combustion of the specimen material shall continue naturally. For analyses, the surface absorption factor shall be assumed equal to 0.8 or to a

value to be defined for a particular package during the thermal test. The efficient of convective heat exchange shall be deemed equal to a value, which a package designer could justify, if it has been subject to the described thermal test. Initial conditions of the thermal test shall assume that the package is in the steady state at the ambient air temperature of 38°C (with regard to the maximum heat release of radioactive content) and under the influence of insolation, as described in It. 2.9.11, or otherwise these conditions shall be considered in the test analysis.

3.4.4.4. Immersion test. The specimen shall be placed under water with the height of at least 15 m during 8 hours in the position that produces maximum damage.

It is assumed that external gage pressure at least 150 kPa meets these conditions.

3.4.4.5. Water immersion tests of the B(U) Type and B(M) Type packages containing more than 10^5 A2, and Type C packages. The specimen shall be placed under water with the height of at least 20 m during 1 h. It is assumed that external gage pressure at least 2 kPa meets these conditions.

3.4.5. Waterproof tests of packages containing fissile nuclear material

3.4.5.1. Such tests are applied to the packages, in which water leaks into or out of the package have been assumed in the amount that leads to the maximum multiplication properties of fissile nuclear material, during the assessment of nuclear safety according to the provisions of It. 2.12.7.2.

3.4.5.2. Prior to waterproof testing of the specimen as described in It. 3.4.5.3, it shall be subject to the tests specified in It. 3.4.4.2, as well as the tests specified in It. 3.4.4.3.

3.4.5.3. The specimen shall be placed under the water height of at least 0.9 m during at least 8 hours in the position, which ensures maximum leakage.

3.4.6. Testing of Type C packages

3.4.6.1. Specimens shall be subject to the influence of each of the following tests to be conducted as follows:

a) tests provided in It. 3.4.4.2 "a", 3.4.4.2 "c", 3.4.6.2 and 3.4.6.3;

b) test provided in It. 3.4.6.4.

It is allowed to use individual specimens for each of the test sequence.

3.4.6.2. Puncture (rupture) test. The specimen shall be subject to the destructive effect of the solid bar made of mild steel. The rod position with respect to the specimen surface shall be so that to produce maximum damage upon completion of the test sequence described in It. 3.4.6.1 "a".

a) A specimen of the package with a mass of less than 250 kg is placed on the target, and a rod with a mass of 250 kg drops upon the specimen from the height of 3 m above the expected point of impact. For this test, the rod shall be a cylindrical rod with 20 cm diameter, the impact end of which forms a truncated right circular cone with the height of 30 cm and tip diameter of 2.5 cm. The target, the specimen is placed on, shall meet the description given in It. 3.1.4.

b) For packages with a mass of 250 kg and more the rod base shall be fixed on the target, and the specimen drops onto the rod. The drop height to be measured from the specimen impact point to the external surface of the rod shall be 3 m. For this test the properties and sizes of the rod shall meet the characteristics given in It. "a", except that the rod length and mass shall be selected so that to produce maximum damage to the specimen. The target, on which the rod base is fixed, shall meet the description given in It. 3.1.4.

3.4.6.3. Enhanced thermal test. The test conditions shall meet the conditions defined in It. 3.4.4.3, except that thermal effect shall continue 60 min.

3.4.6.4. Impact test. The specimen shall be subject to at least 90 m/s impact onto a target so that to produce maximum damage. The target shall meet the description given in It. 3.1.4.

3.5. Testing of uranium hexafluoride packages

3.5.1. Specimens or simulators of the packing casks designed for uranium hexafluoride in the amount of 0,1 kg or more shall be subject to the flow test under the internal pressure no less than 1.38 MPa. However, if the test pressure is less than 2.76 MPa, it is required to obtain an approval of the package design and transportation by a competent authority of the destination country and transit countries for the international

transport. Any other equivalent method of non-destructive tests can be applied to the packing casks to be retested upon condition of its multiple approvals.

4. CLASSIFICATION AND APPROVAL OF CERTIFICATES

4.1. General provisions

4.1.1. The following certificates (approval certificates) shall be drawn up for the transport of radioactive material within the Russian Federation:

- certificate (approval certificate) for special form radioactive material;
- certificate (approval certificate) for low dispersible radioactive material;
- certificate (approval certificate) for the design of Type A packages;
- certificate (approval certificate) for the design of Type B(U) and B(M) packages;
- certificate (approval certificate) for the design of Type C packages;
- certificate (approval certificate) for the design of all packages containing fissile nuclear material if they are not excepted by It. 2.12.2;
- certificate (approval certificate) for the design of packages containing uranium hexafluoride in the amount of 0,1 kg or more;
- certificate (approval certificate) for the transport of Type C, B(U), B(M), A packages;
- certificate (approval certificate) for the transport of Type IP-2 and IP-3 packages;
- certificate (approval certificate) for the design of all packages containing fissile nuclear material if they are not excepted by It. 2.12.2;
- certificate (approval certificate) for the transport under special conditions.

4.1.2. Elaboration, agreement and issuance of these certificates (approval certificates) are performed in accordance with the procedure established by a competent authority appointed by the Government of the Russian Federation.

4.2. Types and designations of certificates (approval certificates)

4.2.1. Certificates (approval certificates) are issued for special form radioactive material, low dispersible radioactive material, package design, transportation and special transport conditions. The certificate (approval certificate) for the package design and

certificate (approval certificate) for the transport can be integrated into a single certificate (approval certificate).

4.2.2. The certificate (approval certificate) shall have a date of issuance, validity date, and generalized identification mark:

RUS/number/type code,

where RUS is an international identification code of the motor vehicle registration of the Russian Federation;

number is a number to be assigned during issuance of the certificate (approval certificate) (each design or transport shall have an individual number; a number of identification mark of the transport approval shall meet a number of identification mark of the design approval);

type code is a certificate type designation (approval certificate).

4.2.3. For type designation of the issued certificates (approval certificates) the following type codes are applied:

I - industrial package design (IF for industrial packages of nuclear material);

A - Type A package design (AF for type A packages containing nuclear material);

B(U) - Type B(U) package design (B(U)F for B(U) Type packages containing fissile nuclear material);

B(M) - Type B(M) package design (B(M)F for B(M) Type packages containing fissile nuclear material);

C - Type C package design (CF for type C packages containing nuclear material);

S - special form radioactive material;

T - transport;

X - special transport conditions;

LF - low dispersible radioactive materials.

For the packages containing uranium hexafluoride not relating to fissile nuclear material, when no codes specified above are applied to, the following type codes are used:

H(U) - unilateral approval;

H(M) - multilateral approval.

The certificates (approval certificates) for special form radioactive material, low dispersible radioactive material, and package design that meets the requirements of these regulations, add "-96" to a package type code, which means the compliance of the package design with the IAEA Regulations.

4.2.4. Each certificate (approval certificate) and each package (excluding the excepted packages) shall have an identification mark including codes specified in It. 4.2.3, excluding codes T and X, which are not stamped on the packages. If approvals of the design and transport are combined into a single certificate (approval certificate), the relevant codes shall not be indicated repeatedly.

Examples of identification marks:

RUS/100/B(M)-96 - design of Type B(M) packages, which number of design 100 is assigned to, (to be written both on the package and in the package design certificate (approval certificate));

RUS/100B(M)-96T - transport approval issued for the package having an identification mark described above (to be written only in the package transport certificate (approval certificate) or in in the combined certificate (approval certificate));

RUS/100/X - approval of the package transport in the special conditions (to be written only in the package transport certificate (approval certificate) or in in the combined certificate (approval certificate));

4.2.5. Information about the certificate (approval certificate) revision shall be given in brackets after the identification mark. For example, RUS/100/B(M)-96(Rev.1) means the first revision of the package design certificate (approval certificate).

It is not required to change an identification mark on the package during every review of the certificate (approval certificate) for the particular design, except where the certificate (approval certificate) review involves change of the package design letter codes after the second slash.

4.2.6. Additional symbols can be given in brackets, for example, when a supplement to the certificate (approval certificate) is issued. For example, RUS/100/B(M)-96(Add.1) means Addendum 1 to the package design certificate (approval certificate) and is written only in the document of Addendum 1.

4.2.7. Certificates (approval certificates) are issued for a period of not more than five years.

4.2.8. The certificate (approval certificate) validity is extended on the basis of the reports on operation of a particular package design and transport experience.

4.3. Procedure for use of the developed or manufactured special form radioactive material and packing casks

4.3.1. Previously manufactured special form radioactive material can be continued in use according to the issued certificates (approval certificates) provided the quality assurance program has been accepted under the requirements of It. 1.2.6 and relevant requirements of the regulatory quality assurance documents. When reviewing (extending) the validity of such certificates (approval certificates) according to the established periods, an applicant shall submit the appropriate quality assurance programs.

4.3.2. Pre-manufactured packing casks, for the design of which no certificate (approval certificate) is required in accordance with these Regulations, may be continued in service subject to the mandatory quality assurance program is accepted according to requirements of It. 1.2.6 of these Regulations and relevant requirements of the regulatory quality assurance documents, as well as considering the activity limits and restrictions for radioactive materials as specified in Sections 2 and 5.

4.3.3. Pre-manufactured packing casks, for the design of which the certificate (approval certificate) is required in accordance with these Regulations, may stay operational under the conditions and terms of the certificates (approval certificates) issued, provided the mandatory quality assurance program is accepted according to requirements of It. 1.2.6 of these Regulations and relevant requirements of the regulatory quality assurance documents, as well as considering the activity limits and restrictions for radioactive materials established in Sections 2 and 5. When reviewing (extending) certificates (approval certificates) for the design of such packing casks (packages) an applicant shall submit the documents to confirm the fulfillment of the above requirements, and the relevant quality assurance programs and radiation protection programs.

For packing casks containing fissile materials to be transported by air, the requirements of It. 2.12.11 shall be additionally fulfilled.

In case of modification of the packing cask design or properties and quantity of radioactive contents that have a great impact on safety, the requirements of these Regulations shall be completely fulfilled.

5. REQUIREMENTS FOR THE TRANSPORT AND TEMPORARY (TRANSIT) STORAGE OF RADIOACTIVE MATERIAL

5.1. General provisions

5.1.1. The transport of radioactive material is allowed only if the carrier obtains the license for the transport of nuclear material. The license for the transport of radioactive materials shall be issued in accordance with the applicable legislation of the Russian Federation.

5.1.2. Radioactive materials shall be transported under the instructions and regulations for transport of the goods (dangerous goods) in force for various mode of transport. The radiation and nuclear safety during transportation shall be ensured (by consignor, consignee, and carrier under their competence) according to requirements of these Regulations.

5.1.3. Radioactive materials can be transported by road, rail, air, sea or river according to the Regulations for the transport of dangerous goods in force for a particular mode of transport.

Transport of radioactive material in the public passenger transport tram, trolley bus, bus, taxi, underground, passenger cabins of airplanes and passenger cars of long-distance trains and suburban trains) is not allowed.

5.1.4. Radioactive material can be transported using vehicles and containers designed for the carriage of dangerous goods.

Condition of use of the vehicles and containers for the transport of radioactive material are determined in the regulations for the transport of dangerous goods in force for relevant types of transport. Radioactive material can be transported in the vehicles

designed for the carriage of other goods and people, if it is allowed by the regulations for transport of dangerous goods in force for relevant types of transport.

Special transport vehicles designed for the carriage of radioactive material as a whole and/or specific types of radioactive materials can be used for some shipments of radioactive materials. Special transport vehicles are not allowed for the transport of food and people. Other goods are allowed only after the radiation monitoring to confirm the absence of radioactive contamination.

When using special transport facilities or special additionally equipped vehicles designed for the transport of radioactive materials, the approval of the design of such vehicles and permission to their operation shall be duly done.

5.1.5. The transit of goods in special conditions for all transport type shall be carried out only with the escort personnel and a person responsible for security escort of the goods.

5.1.6. Person responsible for security escort of the goods shall have the consignor's power of attorney for the right to escort the goods, and the duly issued documents confirming the expertize (training) in the field of radioactive material handling.

Person responsible for security escort of the goods shall be trained using a special program, is able to use radiation monitoring and radiometric instruments and to perform the required measurements, as well as to assess properly the radiation environment, which can exist in the transport of radioactive materials.

If a person responsible for security escort of the goods does not know the guidelines for use of radiation monitoring instruments, the consignor (consignee) shall appoint dosimetrist for these purposes.

5.1.7. Package shall not contain any other matters except the matters and documents necessary for use of radioactive material. This requirement does not impede the transport of low specific activity radioactive material or objects with surface radioactive contamination together with other matters. The transport of such matters and documents in the packages or the transport of low specific activity radioactive material or objects with surface radioactive contamination together with other objects can be allowed provided

there is no interaction with the packing cask or just with its radioactive content, which could deteriorate the package safety.

5.1.8. Packing casks used for the transport of radioactive materials shall be not be used for storage or transport of other non-radioactive goods.

5.1.9. Packages with radioactive materials can be transported together with other goods in the transport vehicles according to the regulations for the transport of dangerous goods in force for relevant modes of transport.

5.1.10. Loading of radioactive materials into the packing casks, their preparation for shipping and loading into the transport vehicle, as well as other similar unloading operations shall be performed in accordance with the operating instruction for a particular packing cask and transport vehicle. Person responsible for security escort of the goods has the right to inspect the correct fulfillment of the requirements of such instructions by the consignor.

5.1.11. Scheduled transportations of the goods en route shall be carried out directly from one transport vehicle to another one without their temporary (transit) storage, to the extent practicable.

Unauthorized persons are not allowed in the transshipment points.

For temporary (transit) storage the requirements of Subsection 5.7 shall be fulfilled.

5.1.12. Loading and unloading of special transport vehicles, as well as loading and loading in transit under the exclusive use and special transport conditions shall be carried out by forces and facilities of the consignor (consignee) or under its directions. When involving the forces and facilities of other organizations the handling technology and respectful provisions of the radiation protection program shall be agreed with such organizations.

5.1.13. Packages in transport shall be installed in a transport vehicle to a position conforming to warning signs and marking, and be reliably fixed to avoid an inadvertent movement and turnover of packing casks in turning, rushing, braking, or rolling and other impacts under the ordinary transport conditions (see Table 2.1).

5.1.14. If the average surface heat flux does not exceed 15 W/m^2, and the consignment around the packages or overpacks is not placed in bags or packs, the package

or overpack can be transported among such packaged consignment without observing any special stowage provisions, unless other requirements agreed in the relevant certificate (approval certificate).

5.1.15. Prior to the first shipping of radioactive materials under a particular certificate (approval certificate) for Type B and C packages, as well as packages containing fissile material, the consignor shall send a notice to the organization that approved this certificate (approval certificate).

The consignor shall send a notice of each shipment specified below to the organization that approved the relevant certificate (approval certificate).

a) Type B package containing radioactive material with the activity exceeding 3,000A1 or 3,000A2 (as applicable) or ,1000 TBq;

b) Type C package;

c) special conditions of the transport.

Notices shall be delivered at least 7 days before the shipment.

5.1.16. The notices to be submitted according to It. 5.1.15 shall include:

a) information required for the package identification, including all relevant numbers of certificates (approval certificates), identification marks;

b) information about the shipping date, expected date of arrival and proposed route.

5.1.17. If a consignment cannot be delivered to the consignee, is shall be moved to a place of safety both for the consignment and public, whereof it is necessary to inform the consignor (if the consignor can be identified) and to request the instructions related to the further actions, as well as to inform the government regulatory agencies of safety in atomic energy use.

5.1.18. For transport of consignments by the consignor (consignee) the radiation protection program shall be developed. The nature and scope of measures to be taken within the program shall be connected with doses and probability of personnel and pubic irradiation. The program shall provide for fulfillment of the requirements specified in It. 1.2.2 - 1.2.6, and in Section 6, and shall cover all the transport phases.

5.2. Examination of consignment before shipment

5.2.1. Prior to the first transport of any package, the consignor shall take the following measures:

a) if the design pressure of the containment system exceeds 35 kPa (gage), it is necessary to make sure that the containment system of each package meets the approved design requirements related to the system ability to keep integrity under pressure;

b) for each package of Type B(U), Type B(M), Type C and packages containing fissile material it is necessary to verify that the efficiency of the radiation protection and containment system, and if necessary, the heat transfer performance are within the limits suitable or specified for the approved package design;

c) for packages containing fissile material, wherein neutron absorbers as the package components are placed for nuclear safety, it is necessary to check the availability and distribution of these absorbers before loading of fissile material.

5.2.2. Prior to each transport of any package, the consignor shall fulfill the following requirements:

a) fasteners installed on the package for its movement, which do not meet the requirements given in It. 2.4.2, shall be removed or otherwise brought into a state which does not allow to use them for moving the package according to requirements given in It. 2.4.3;

b) for each package of special form radioactive material and low dispersible radioactive material, all the requirements specified in the certificates (approval certificates) for these packages, materials and transport shall be fulfilled;

c) Type B or Type C packages with fissile nuclear material shall be held until the equilibrium conditions are achieved according to requirements for temperature and pressure in transit;

d) for each package of Type B(U), Type B(M), or Type C it is necessary to check that all the gates, valves, etc. of the containment system, through which a leakage of radioactive contents could occur, are properly closed and their integrity is tested using a method in accordance with requirements described in It. 2.9.5 and 2.11.3.

It is also necessary to examine the packages containing fissile nuclear materials, wherein no water leakage into the containment system is allowed for the nuclear safety purposes.

A leakage monitoring method shall be described in the operating manual of the transport cask;

e) for any packages it is necessary to verify the fulfillment of the requirements of It. 5.1.13, for location and attachment of the packages, as well as requirements of Subsection 5.3 for permissible levels of radiation and radioactive contaminations, values of the transport index (TI) and quantity of packages;

f) for packages with fissile nuclear materials it is necessary to verify the conformity of the package quantity in the transport vehicle and the criticality safety index of each package.

5.3. Limits of transport index, criticality safety index, radiation level and radioactive contamination

5.3.1. The TI value for a package, overpack, freight container of unpackaged LSA-I or SCO-I shall be determined as follows:

a) the maximum radiation level in millisievert per hour (mSv/h) shall be determined at the 1 m distance from the external surfaces of the package, overpack, freight container or unpackaged materials LSA-I or SCO-I.

The measured value shall be multiplied by 100 and the result will be the transport index. For uranium and thorium ores and their concentrates the maximum irradiation level at any point at 1 m distance from the external surface of the consignment shall be assumed as follows:

0.4 mSv/h - for ores and physical concentrates of uranium and thorium;

0.3 mSv/h - for chemical thorium concentrates;

0.02 mSv/h - for chemical uranium concentrates except uranium hexafluoride;

b) for vessels, freight containers and unpackaged materials LSA-I and SCO-I the value determined according to "a", shall be multiplied by a relevant conversion factor of the transport index specified in Table 5.1;

c) the value obtained in accordance with "a" and "b" shall be rounded off to a higher figure to one decimal place (for example, 1.13 is rounded to 1.2), therewith value 0.05 or less may be considered equal to zero.

Table 5.1

Conversion factors of the transport index

Size of consignment (measured maximum cross-sectional are), m^2	Conversion factors of TI
Less or equal to 1	1
More than 1 and less or equal to 5	2
More than 5 and less or equal to 20	3
More 20	10

5.3.2. The maximum TI of an individual package or overpack shall not exceed 10 excluding the transport under the exclusive use conditions.

5.3.3. The maximum radiation level at any point of the external surface of the package or overpack shall not exceed 2 mSv/h (200 mRem/h). This is with the exception of the packages and overpacks to be transported by rail, road and water under the exclusive use conditions and subject to requirements given in It. 5.9.4, 5.10.6, 5.11.2, by special vessels according to It. 5.11.3 and air craft according to It. 5.12.2.

5.3.4. The maximum radiation level at any point of the external surface of the package to be transported under the exclusive use conditions shall not exceed 10 mSv/h (1,000 mRem/h).

5.3.5. The criticality safety index (CSI) for the packages containing fissile material is calculated by dividing 50 by N value determined in accordance with It. 2.12.4 (CSI = 50 / N). The CSI value may be equal to zero subject to the unlimited quantity of packages is subcritical (i.e. N is finite).

5.3.6. The CSI for each consignment is determined as the sum of the CSI of all the packages contained in this consignment.

5.3.7. Loading of freight containers and collection of packages, overpacks and freight containers shall be controlled as follows:

a) with the exception of the transports under the exclusive use conditions the total quantity of packages, overpacks and freight containers in one transport vehicle shall be limited so that the total sum of the TIs does not exceed the values given in Table 5.2. For consignments with LSA-1 material, there are no limits of the TI sum.

Table 5.2

Limits of the sum of the TIs for the freight container or transport vehicle beyond the exclusive use conditions

Type of freight container or transport vehicle	Limit of the total sum of the TIs for freight container or transport vehicle
Small freight container	50
Large freight container	50
Transport vehicle	50
Aircraft:	
passenger	50
freight	200
Vessel for inland water-ways	50
Sea vessel**	
1. Hold, compartment or defined deck area:	
packages, overpacks, small freight containers	50
large freight containers	200
2. The whole vessel: packages, overpacks, small freight containers Large freight container	200 Not limited

* Freight containers, one of overall dimensions of which is not less than 1.5 m or the internal volume is not more than 3 m^3, are considered small freight containers.

** Packages or overpacks located in a transport vehicle, which meets the provisions of It. 5.9.4 and 5.10.6 can be transported provided they are not removed from the transport vehicle for the duration of location on board the vessel.

b) for the transport under the exclusive use conditions there no limits for the sum of the TI in the transport vehicle;

c) the TI for each overpack, freight container or transport vehicle is determined either as the sum of the TI of all the available packages or as direct measurement of the radiation level, with the exception of non-rigid overpacks, for which the TI is determined only as the sum of the TI of all the packages;

d) the radiation level under the normal transport conditions shall not exceed 2 mSv/h (200 mRem/h) at any point on the external surface of the transport vehicle, including a hold, compartment or defined deck area, and it shall not exceed 0.1 mSv/h (10 mRem/h) at the 2 m distance from this surface;

e) the total sum of the CSI for a freight container and transport vehicle shall not exceed the values specified in Table 5.3.

f) if the total sum of the CSI in the transport vehicle or freight container exceeds 50, as it is permitted according to Table 5.3. The consignment shall be located so that it can be at least 6 m distant from other groups of packages, overpacks or freight containers with fissile nuclear material, or from other transport vehicles used for the transport of radioactive material.

Table 5.3

Limits of the CSI for freight containers and transport vehicles containing fissile nuclear material

Type of freight container or transport vehicle	Limit of the total sum of the CSI for freight container or transport vehicle	
	Beyond the exclusive use conditions	Under the exclusive use conditions

Small freight container	50	Not applicable
Large freight container	50	100
Transport vehicle	50	100
Air vessel:		
passenger	50	Not applicable
freight	50	100
Inland waterway vessel	50	100
	50	100
Sea vessel:		
1. Hold, compartment or defined deck area:		
packages, packs, small freight		
containers	50	100
large freight container	50	100
2. The whole vessel:		
packages, overpacks, small freight containers		
	200**	200**
Large freight containers	Not limited**	Not limited**

<*> Packages or overpacks placed in a transport vehicle, which meets the provisions of It. 5.9.4 and 5.10.6 can be transported on board provided they are not removed from the transport vehicle for the duration of location on board the vessel. In this case the limits specified in the column "Under the exclusive use conditions".

<**> The consignment shall be handled and stacked so that the total sum of the CSI in any individual group does not exceed 50 and the loading and stowing of each individual group are carried out with keeping the distance between the groups at least 6 m.

<***> The consignment shall be handled and stacked so that the total sum of the CSI in any individual group does not exceed 100 and the loading and stowing of each individual group are carried out with keeping the distance between the groups at least 6 m. The space formed between the groups can be occupied with other consignment.

5.3.8. Any package or overpack with the TI higher than 10, or any consignment with the CSI higher than 50 shall be transported only under the exclusive use or special conditions.

5.3.9. Packages, overpacks, freight containers fall into one of the following categories: "I - WHITE", "II - YELLOW" or "III - YELLOW" according to the conditions of Table 5.4 and the following requirements:

a) when defining the relevant category both the TI and radiation level on the surface are considered.

If the TI meets the conditions of one category, and the surface radiation level meets a condition of the other category, a higher category is selected.

b) when transporting under the special conditions the "III - YELLOW" category is used.

Table 5.4

Categories of packages, overpacks, tanks, and freight containers

Characteristics of packages, overpacks, tanks, and freight containers		Category
TI	Maximum radiation level at any point of the external surface	
TI = 0	Not more than 0,005 mSv/h (0,5 mRem/h)	I - White
TI <= 1	More than 0,005 mSv/h (0,5 mRem/h), but not more than 0,5 mSv/h (50 mRem/h)	II - Yellow
1 < TI <= 10	More than 0,5 mSv/h (50 mRem/h), but not more than 2 mSv/h (200 mRem/h)	III – Yellow
TI > 10	More than 2 mSv/h (200 mRem/h), but not more than 10 mSv/h (1,000 mRem/h)	III - Yellow under the exclusive use conditions

5.3.10. For special-purpose vessels the maximum sum of the package TI can be established higher than 200.

5.3.11. Non-fixed radioactive contamination of the external surface of any package, freight containers, overpacks, tanks and intermediate bulk container (IBC) shall be as low

as reasonably practicable, and it shall not exceed the following limits under the normal transport conditions:

a) 4 Bq/cm^2 for beta and gamma emitters and for low toxicity alpha emitters, and

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

These limits are used in averaging any part of the surface at any section of 300 cm^2 area.

When transporting only excepted packages beyond the exclusive use conditions or in the special transport vehicles, and packages to be sent by post, the non-fixed radioactive contamination of the package external surfaces shall not exceed 0.4 Bq/cm^2 for beta, gamma, and low toxicity alpha emitters and 0.04 Bq/cm^2 for all other alpha emitters.

5.3.12. Any transport vehicle, equipment or their part, which were exposed to contamination during transport beyond the permissible values, shall be de-contaminated by the consignee, and they cannot be re-used as long as the non-fixed contamination and the resulting radiation level exceed the established values.

5.3.13. Requirements stipulated in It. 5.3.12 do not apply to the overpack, freight container, IBC or transport vehicle used for the transport of LSA and SCO materials under the exclusive use conditions. These requirements apply only to their internal surfaces and only as long as they are kept under the exclusive use conditions.

5.4. Marking, labeling, placarding and warning signs

5.4.1. Each package excluding excepted ones shall have a UN number, which is preceded by "UN" letters, as well as clear and indelible marking including the proper shipping name. Only the UN numbers preceded by UN letters are required for excepted packages excluding the packages accepted for international transfer by mail.

5.4.2. Each package with the gross weight of more than 50 kg shall have clear and indelible marking of its permissible gross weight on the external surface of the packing cask.

5.4.3. Each package shall have the clear and indelible marking with the indication of consignor, or consignee, or both on the external surface of the packing cask.

5.4.4. Each package, which meets:

a) the design of Type 1 industrial package, Type 2 industrial package, or Type 3 industrial package, shall gave the clear and indelible marking of "IP-1" ("TYPE IP-1"), "IP-2" ("TYPE IP-2") or "IP-3" ("TYPE IP-3") correspondingly on the external surface of the packing cask;

b) the design of Type 2 industrial package and Type 3 industrial package shall have the clear and indelible marking on the external surface of the packing cask including the international vehicle registration identification code (VRI) of the country, where the design has been engineered, as well as the manufacturer name or other identification of the packing cask.

5.4.5. Each package, the design of which requires the certificate (approval certificate), shall have the clear and indelible marking on the external surface of the packing cask as follows:

a) identification mark of a particular design according to It. 4.2.2;

b) serial number for individual designation of each packing cask for a particular design, as well as manufacturer name;

c) the design of the Type A package to be marked "TYPE A";

d) the design of the Type B(U) or B(M) package to be marked "TYPE B(U)" or "TYPE B(M)";

e) the design of the Type C package to be marked "TYPE C".

5.4.6.

For each package that meets the design of Type B(U), Type B(M), or Type C the flame and water resistant, clear and indelible marking shall be made on the external surface of the external container by embossing, stamping or other flame and water resistant method including the radiation hazard sign in the form of trefoil (Fig. 1 of Appendix 3) <*>.

<*> Appendix 3 is not given.

5.4.7. If LSA-I or SCO-I materials are contained in tanks or packages and transported under the exclusive use conditions in accordance with the provisions of It.

5.6.4, the external surface of such tanks or packaging can be marked as follows "RADIOACTIVE LSA-I" or "RADIOACTIVE SCO-I".

5.4.8. Each package, overpack and freight container shall be labeled according to the examples given in Fig. 2, 3 or 4 of Appendix 3, in compliance with a category, except large freight containers and tanks, for which it is permitted to use the signs described in alternative provisions of It. 5.4.11.

Besides, each package, overpack and freight container with fissile materials other than fissile materials excepted under It. 2.12.2 shall be labeled according to the example given in Fig 5 of Appendix 3.

Any other labels not associated with the contents shall be removed or closed.

5.4.9. The labels that meet the examples in Fig. 2, 3 or 4 of Appendix 3 shall be attached to two opposite external surfaces of the package or overpack or to the external surfaces of all the four sides of the freight container or tank. In appropriate cases the labels that meet the example given in Fig. 5 of Appendix 3 shall be attached near the labels that meet the examples given in Fig. 2, 3, and 4 of Appendix 3.

5.4.10. Each label that meets the examples given in Fig. 2, 3 and 4 of Appendix 3 shall include the following information:

a) the contents: name of material or radionuclide as specified in Table I of Appendix 1 including the recommended symbol, except LSA-I material. For radionuclide mixtures the radionuclides in relation to which the severe restrictions are applied to, shall be listed as far as the line size allows for. A group of LSA or SCO materials shall be indicated after the radionuclide name(s).

For these purposes the "LSA-II", "LSA-III", "SCO-I, or "SCO-II" designations are used. For LSA-I materials the "LSA-I" designation is quite sufficient, and no radionuclide name is required;

b) activity: the maximum activity of radioactive contents expressed in Becquerel (Bq) or Curie (Ci) or their SI derivatives (kCi, mCi, etc.). Mass in grams (g) or multiples of gram can be indicated for fissile nuclear material;

c) for overpacks and freight containers the "Contents" and "Activity" lines on the hazard sign shall include information required in accordance with "a" and "b" of It. 5.4.10,

integrated for all the contents of the overpack or freight container. The hazard signs on the overpacks or freight containers containing packages with various radionuclides can include the following: "See the consignment note";

d) TI (TI for the "I - WHITE" category is not required).

5.4.11. Large freight containers used for transporting the packages excluding the excepted ones, and tanks shall have four signs according to the example in Fig. 6 of Appendix 3. The signs shall be vertically attached to each lateral side and to the front and back walls of the large freight container or tank. Any other labels not associated with the contents shall be removed. As an alternative to the parallel use of labels and signs it is permitted to use only enlarged labels that meet the examples in Fig. 2, 3, 4 and 5 of Appendix 3 with the minimum sizes specified in Fig. 6 of Appendix 3.

5.4.12. If the contents of a freight container or a tank is the unpackaged LSA-I or SCO-I materials, or if the consignment to be transported in the freight container under the exclusive use conditions is the packaged radioactive material with the same UN number, such consignment shall be provided with the relevant UN number as black digits with a higher no less than 65 mm:

a) either on a white background in the lower half of the sign shown in Fig. 6 of Appendix 3 preceded by the UN letters;

b) or on the sign shown in Fig. 7 of Appendix 3 preceded by the UN letters.

When using "b", an additional sign shall be attached near to the main sign in all the four sides of a freight container or tank.

5.4.13. For interstate transport of radioactive material within the territory of the Russian Federation it is permitted to use marks, labels and placards (warning signs) in English according to the IAEA Regulations (see Appendix 4 <*> and 5).

<*> Appendix 4 is not given.

5.5. Requirements for transport of excepted packages

5.5.1. The following requirements shall be fulfilled for the transport of excepted packages:

a) requirements specified in It. 5.3.11, 5.4.1, 5.4.2, 5.4.3, 5.5.2 - 5.5.6, 5.14.1, 5.14.2 and Section 7;

b) general requirements for the design of all packing casks and packages as specified in It. 2.4.1 - 2.4.11.

5.5.2. The radiation level at any point of the external surface of the package shall not exceed 5 μSv/h (0.5 mRem/h).

5.5.3. Packages shall not contain fissile nuclear material excluding materials specified in It. 2.12.2.

5.5.4. For transport of excepted packages, where the radioactive material is enclosed in or forms a component part of an instrument or other manufactured article with the activity not exceeding the limits established for individual articles and packages in columns 2 and 3 of Table 5.5, the following conditions shall be met:

a) the radiation level at 10 cm from any point of the external surface of any unpackaged instrument or article shall not exceed 0.1 mSv/h (10 mRem/h);

b) each instrument or article shall be marked as "radioactive";

c) radioactive material shall be completely sheathed with non-radioactive components;

d) device, a single function of which is to contain radioactive material, is not considered as an instrument or manufactured article.

Table 5.5

Activity limits for excepted packages

Physical state of the content	Activity limits		
	Instruments or items		Materials
	For objects	For packages	For packages
1	2	3	4
Solids			
special form	10^{-2} A1	A1	10^{-3} A1
other forms	10^{-2} A2	A1	10^{-3} A2
Liquids	10^{-3} A2	10^{-1} A2	10^{-4} A2
Gases:			

Tritium	2×10^{-2} A2	2×10^{-1} A2	2×10^{-2} A2
special form	10^{-3} A1	10^{-2} A1	10^{-3} A1
other forms	10^{-3} A2	10^{-2} A2	10^{-3} A2

5.5.5. The radioactive material other than those specified in It. 5.5.4, with the activity not exceeding the limit given in column 4 of Table 5.5 can be transported in the excepted packages under the following conditions:

a) the package shall keep the contents under the normal transport conditions;

b) the package shall be marked "radioactive" on the internal surface so that the warning of radioactive material can be seen when opening the package.

5.5.6. A manufactured article, where a single radioactive material is unirradiated natural uranium, unirradiated depleted uranium, or unirradiated natural thorium, can be transported as an excepted package subject to the external surface of uranium is sheathed with non-radioactive metal or any other non-radioactive hard metal.

5.6. Requirements for the transport of LSA and SCO materials

5.6.1. The quantity of LSA and SCO materials in an individual package of IP-1, IP-2, or IP-3 Type or in an object or a group of objects shall be limited so that the external radiation level at 3 m from the unshielded material or object or group of objects does not exceed 10 mSv/h (1 Rem/h).

5.6.2. Requirements for contamination levels specified in It. 5.3.11 and 5.3.12 shall be applied to the packages, tanks and freight containers containing the LSA and SCO materials.

5.6.3. The LSA and SCO materials except the cases specified in It. 5.6.4 are placed in packages according to Table 5.6 so that under the normal transport conditions no leak of the package contents occurs and the protection ensured by the packing cask is maintained.

Table 5.6

Types of industrial packages for LSA and SCO materials

Radioactive content of industrial package	Type of industrial package	
	Exclusive use	Non-exclusive use
LSA-I		
solid	IP-1	IP-1
liquid	IP-1	IP-2
LSA-II:		
solid	IP-2	IP-2
liquid	IP-2	IP-3
LSA-III	IP-2	IP-3
SCO-I	IP-1	IP-1
SCO-II	IP-2	IP-2

5.6.4. The LSA and SCO materials of LSA-I and SCO-I groups can be transported without package under the normal conditions when adhering to the following provisions:

a) all unpackaged materials containing only natural radionuclides, excluding ores, shall be transported so that any leak of radioactive contents from the transport vehicle and/or deterioration of the radiation protection are prevented under the normal transport conditions;

b) each transport vehicle is under the exclusive use conditions, except where only SCO-I materials are transported, when contamination of both the accessible and inaccessible surfaces of SCO-I does not exceed 10 times the levels specified in It. 23 of the Terms and Definitions.

5.6.5. The activity limits of LSA and SCO materials for any transport vehicle shall not exceed the limits given in Table 5.7.

Table 5.7

Activity limits of LSA and SCO materials for transport vehicles

Type of LSA and SCO materials	Activity limit	
	For a transport vehicle, except inland transport vessel	For a hold or inland transport vessel
LSA-I	Not limited	Not limited
LSA-II and LSA-III noncombustible solids	Not limited	100A2
LSA-II and LSA-III combustible solids, liquids and gases	100A2	10A2
SCO	100A2	10A2

5.6.6. For transport of LSA and SCO materials that contain or are fissile substances, the relevant requirements for transport of fissile nuclear materials shall be fulfilled.

5.7. Temporary (transit) storage

5.7.1. Temporary (transit) storage of packages, freight containers, tanks, and overpacks can be implemented using dedicated places of the general-purpose storage facility and specially equipped storage facilities of railroad stations, ports, airports, and consolidating terminals.

5.7.2. For temporary (transit) storage the packages, freight containers, tanks and overpacks shall be separated from:

a) the places occupied with photosensitive materials according to Appendix 2;

b) other dangerous goods considering the relevant transport and storage regulations.

5.7.3. The quantity of packages, overpacks and freight containers in the group containing fissile materials, which are located at a single location during storage in transit (temporary storage), shall be limited so that the total sum of CSIs of any group of such packages, overpacks or freight containers does not exceed 50. Groups of such packages,

transport casks or freight containers shall be distanced at least 6 m from other groups of such packages, overpacks or freight containers.

5.7.4. If the sum of CSIs related to several groups of packages in a transport vehicle or freight container exceeds 50, the storage is arranged so that they are distanced at least 6 m from other groups of packages, overpacks or freight containers containing fissile materials, or from other vehicles transporting radioactive materials.

5.7.5. Joint location and transport of packages with various types of radioactive materials, as well as joint location of various types of packages with different TIs are allowed considering the instructions given in Table 5.2 and 5.3.

For transport under special conditions, no joint placement of packages is allowed unless otherwise specified in special conditions.

5.7.6. Temporary (transit) storage facilities are equipped with fire detectors and fire-extinguishing devices according to the requirements in the field of fire safety.

5.8. Transport of empty transfer packing casks

5.8.1. An empty packing cask, which contained radioactive material, can be transported as an excepted package. For the transport of empty packing casks, which previously contained radioactive material, the following requirements shall be met:

a) the packing cask shall be transportable, reliably closed and sealed;

b) total activity of the packing cask contents shall not exceed the values given in Table

5.5 for excepted packages;

c) the level of non-fixed radioactive contamination of the internal surfaces of the packing cask shall not exceed 10 times the values given in It, 5.3.11;

d) the radiation level at any point of the external surface of the packing cask shall not exceed 5 μSv/h (0.5 mRem/h). Regulations for carriage of dangerous goods in force for relevant modes of transport may establish the irradiation limit less than 5 μSv/h (0.5 mRem/h).

The packing casks, which include natural uranium, unirradiated depleted uranium, or unirradiated natural thorium, with the exception of the above requirements, shall meet the provisions of It. 5.5.6.

5.8.2. To meet the requirements specified in It. 5.8.1 of these Regulations the labels (placards) shall be closed or removed.

5.8.3. If the requirements specified in "b", "c", "d" of It. 5.8.1 are not fulfilled, the empty packing casks are transported as the packages of relevant category in compliance with requirements of These Regulations.

5.8.4. For transport of empty packing casks the minimum radioactive contamination level of their external surfaces shall be provided as far as possible, which in all cases should not exceed the values given in It. 5.3.11.

5.9. Requirements for the transport of radioactive materials by road

5.9.1. In addition to general requirements and provisions of Subsections 5.1 - 5.8, 5.14, the requirements of this section shall be fulfilled for the transport by road.

5.9.2. Organizations that use in their practice the radioactive pharmacological compounds, ionizing radiation sources and products containing them, are allowed to deliver the packages by their own motor vehicles from the place of cargo receipt (airport, railroad station, dedicated terminal, etc.) to an enterprise or company-consignee subject to fulfillment of the following additional conditions:

a) transported packages relate to excepted, industrial packages or Type A packages;

b) package category not higher than II;

c) packages are placed in an additional shipping pack (box, chest, plastic bag, etc.);

d) the transport shall be escorted by a person - a consignor representative permitted to cargo handling operations and duly trained;

e) no other passenger or other consignments are allowed in the transport vehicle except the driver and escort.

5.9.3. For transport of unpackaged LSA-I and SCP-I materials, packages with the irradiation level on the surface more than 2 mSv/h (200 mRem/h) and/or with the TI more than 10 the motor vehicles shall be used under the exclusive use conditions.

5.9.4. For the exclusive use consignments, the radiation level shall not exceed the following values:

5.9.4.1. 10 mSv/h at any point of the external surface of a package or overpack and can exceed 2 mSv/h provided that:

a) the vehicle body is equipped with an enclosure, which under the normal transport conditions prevent an access of unauthorized persons into the enclosure;

b) measures are provided to fasten the package or overpack so that their positions inside the vehicle remain unchanged under the normal transport conditions;

c) no loading or unloading operations are performed during the transport.

5.9.4.2. 2 mSv/h at any point of the external surface of a vehicle, including the upper and lower surfaces, or as for an open transport vehicle - at any point of the vertical plains passing through the external edges of the vehicles, on the external surface of the consignment and on the lower external surface of the vehicle.

5.9.4.3. 0.1 mSv/h at any point at 2 m from the vertical planes formed by the external lateral surfaces of a vehicle, or as for an open transport vehicle - at any point at 2 m distance from the vertical planes passing through the external edges of the vehicle.

5.9.5. No one except the driver, loader, and forwarding agent shall be stay in the vehicles transporting the packages, overpacks or freight containers, which are provided with warning signs of the "II - YELLOW" or "III - YELLOW" category. No people except the escort personnel are allowed to stay in the vehicle body transporting the packages and overpacks of categories II and III. Such packages and overpacks shall be distanced form the driver cabin wherever possible for transporting in a vehicle without special equipment.

5.9.6. A driver and/or a person escorting the consignment (or responsible for the escort of the consignment) shall have the covering documentation considering the requirements given in It. 5.14.4 and emergency card.

5.9.7. Placement and attachment of the consignment shall be carried under the control of the driver and/or person responsible for the escort of the consignment.

5.9.8. A person responsible for escorting the consignment shall ensure that no unauthorized people stay near the motor vehicle.

5.9.9. For transport of packages, overpacks, tanks or freight containers marked with warning signs as shown in Fig. 2, 3 or 4 of Appendix 3, the placards as illustrated in Fig. 6 of Appendix 3 shall be provided on the two external sidewalls and on the external back wall of the vehicle.

If a consignment is unpackaged LSA-I and SCO-I material or an exclusive use consignment is unpackaged radioactive material consisting of one object related to the same UN number, the relevant UN number shall be also written (see Appendix 5) in black digits with a height of at least 65 mm:

a) either on a white background in the lower half of the sign shown in Fig. 6 of Appendix 3;

b) or on the sign shown in Fig. 7 of Appendix 3.

When using the "b" variant, an additional sign is included near the main sign on the two sidewalls and external back wall of the vehicle body.

5.9.10. In all other respects not specified or not contradict these Regulations, one should be guided by the Regulations for the transport of dangerous goods by road, as regards the transport of radioactive materials.

5.10. Requirements for the transport of radioactive materials by rail

5.10.1. For shipment by rail, the requirements of this section shall be fulfilled in addition to the general requirements specified in Subsections 5.1 - 5.8, 5.14 of these Regulations.

5.10.2. Shipment can be implemented by freight trains, including carload, part load and container shipments in the covered trucks (without brake platforms), in the open box cars and on the platforms, in the freight containers, as well as postal-baggage cars and trains.

For continuous shipment of the packages, the specially equipped cars (container cars, etc.) can be used in any combination, which are owned by consignors (consignees).

5.10.3. The consignment should be transported by designated purpose trains where applicable.

Shipments of some radioactive materials can be implemented by special trains consisting of only the cars with radioactive materials and, if necessary, the escorting cars.

Branch railways of the consignor (consignee) shall ensure the arrival and departure of the trains completely, making up and breaking down of the trains, safe shunting operations, as well as safe access pass of special-purpose cars for transport of radioactive materials, servicing and maintenance of these cars.

5.10.4. Uranium and thorium ores shall be transported in the cars and open box cars, in the container which exclude any ingress of the consignment into the car or environment under the normal transport conditions.

5.10.5. Part load and container shipment of all package categories is allowed except the packages with the radiation level on the surface more than 2 mSv/h (200 mRem/h) and/or TI mode than 10.

The accumulation of packages containing fissile material is required to be controlled according to It. 5.3.7.

5.10.6. For transport under the exclusive use conditions the radiation level shall not exceed the values specified in It. 5.9.4 considering additional measures according to It. 5.9.4.1.

5.10.7. Persons escorting radioactive materials in transport shall submit the radiation measurement data sheets related to transfer packing casks and railway vehicles prepared in accordance with the established requirements, to representatives of the agencies responsible for State sanitary and epidemiological supervision in the railroad facilities and for proper radiation monitoring in the railroad vehicles.

5.10.8. Methods of loading, stowing and attachment of the consignments in the railway vehicles shall be elaborated by the consignor and shall meet the loading and stowing specifications applicable for the railway vehicles.

5.10.9. Placards shall be installed on the sidewalls of the railway vehicle according to It. 5.9.9, with the exception of end walls.

In specific cases, if it is not provided in the shipment certificate (approval certificate) it is not required to install the radiation hazard signs on the external surfaces of

the railway vehicle. Such shipments shall be escorted by the personnel in a mandatory manner.

Maintenance of the railway vehicle en route shall be performed only under supervision of the escorting personnel, who should exclude the presence of railroad workers near the railway vehicle with the consignment if it is not dedicated by the operational need.

5.10.10. For transport under the exclusive use conditions, the transshipment from a faulty railway vehicle of the consignor (consignee) shall be carried out by the consignor (consignee), if required.

For performance of the specified activities, the consignor (consignee) shall send a working crew within 24 hours. Railway organizations can duly provide loading-and-unloading machines and mechanisms for transshipment.

5.10.11. In addition to the relevant requirements of this Subsection, the conditions specified in the sanitary regulations shall be fulfilled in transport of radioactive materials.

The transport of radioactive materials in the movable storage rooms is carried out as agreed upon with the agencies authorized for State sanitary and epidemiological supervision on the railway transportation objects.

5.10.12. The possibilities and conditions of the transport of packages in the separate compartment of the passenger train with the escort personnel shall be regulated by the Sanitary Regulations for transport of radioactive materials implemented by the federal executive authority of the State sanitary and epidemiological supervision.

5.10.13. For the transport of fissile material by rail, the following requirements shall be fulfilled in addition to the relevant requirements of It. 5.10.1 - 5.10.12:

5.10.13.1. The escort personnel, including the guard shall be stay in the service rooms isolated from the consignment or in the separate cars specially equipped for these purposes.

5.10.13.2. The maneuvers with the railway vehicles loaded with fissile nuclear materials shall be carried out with extreme caution. No clearing of such railway vehicles, as well as maneuvers by starts or jolts is allowed through the gravity hump yards without the railroad engine.

5.10.13.3. The consignee shall accept the arriving railway vehicles containing fissile material without any delay.

5.10.14. The design of transfer packing cask shall ensure the package stability in transport, reliable attachment to the railway vehicles according to the loading and attachment specifications, as well as the load upon the car floor no more than 2200 kgf/cm^2, and the load upon the universal container floor no more than 1,000 kgf/cm^2.

5.11. Requirements for the transport of radioactive materials on the sea and river vessels

5.11.1. In addition to general requirements, provisions of Subsections 5.1 - 5.8, 5.14, the requirements of this Subsection shall be fulfilled for the shipment on the sea and river vessels.

5.11.2. The freight and freight-passenger sea and river vessels shall have the relevant class of the Russian Maritime Register of Shipping or the Russian River Register of Shipping (for the vessels tripping in the navigable waterways).

Packages of Types I, II and III are allowed to shipment on the freight and freight-passenger sea and river vessels. Shipment of packages with the surface radiation level more than 2 mSv/h (200 mRem/h) shall be carried out only under the exclusive use conditions or special conditions with due regard to the sanitary regulations for transport of radioactive materials.

5.11.3. The shipment of packages on the special purpose shipboard, which due to its design or freight terms is intended for the transport of only radioactive materials, is not covered by the requirements for limitation of the radiation level and total value of CSI as specified in It. 5.3.7, subject to the following conditions:

a) for the transport by the foreign shipping companies the radiation protection program shall be approved by a competent authority of the ship home country and, if necessary, by a competent authority of the country of each call port;

b) for the transport by the Russian shipping countries, the radiation protection program shall be approved by a relevant regulatory authority of atomic energy use and authorities of safety regulation in atomic energy use;

c) consignment disposition conditions shall be defined in advance for the whole voyage, including any consignments to be loaded at the call ports on route;

d) loading, disposition, attachment and unloading are controlled by a consignor (consignee) representative duly skilled in the field of radioactive material shipment, and by the carrier surveyor.

5.11.4. The location of the packing casks containing radioactive material shall be designated by the radiation hazard mark according to Fig. 6 of Appendix 3. These places shall be separated from the consignment containing photosensitive materials by a distance not less than specified in Appendix 2.

Except the consignments containing fissile materials, it is appropriate, whenever possible, to place other consignments between the pieces of the goods with radioactive materials and people places, as well as places of the goods with photosensitive materials, to attenuate radiation.

5.11.5. Prior to originating the goods the consignor shall submit to the carrier the proper shipping order, including:

- name of radioactive material;
- activity;
- TI (sum and individual packages);
- CSI (sum and individual packages);
- designation of the group for LSA and SCO materials;
- mass (sum and individual packages);
- other data listed in It. 5.14.1.

If necessary, when submitting the short-lived isotopes for shipment the consignor shall indicate the permissible duration of the consignment in transit in the shipping order.

5.11.6. The consignor may put into the port and deliver the packages not later than 2 hours before the vessel departure, except as otherwise provided in the shipping order or other transport documents.

5.11.7. The escort personnel shall submit the dosimetry reports made by the consignor (consignee) to the sanitary authorities on request.

5.11.8. Upon arrival to the destination port, the port captain shall immediately notify the consignee thereof, who should take out the consignment from the port territory as soon as possible. For the consignment containing fissile materials, by the time of consignment arrival the consignee shall provide the vehicles for clearing the port.

5.11.9. Excepted packages and Category I packages can be transported in the hand luggage in a separate state cabin of the passenger maritime and river ship with the escort. Total weight of such baggage in a state cabin shall not exceed 200 kg.

A person escorting the packages shall come early to the port captain and submit the documents confirming that the presenter is charged to transport the packages. The documents shall also include the departure and destination points, category of the packages, numbers of pieces and weight of the packages.

5.11.10. When transporting the packages, overpacks and freight containers requiring for special methods of placement and attachment, the process list of the radioactive material arrangement on board ship shall be developed to fulfill the requirements of the International Convention of the Safety of Life at Sea (with amendments), Code of Safe Practice for Cargo Stowage and Securing (IMO Edition), and International Maritime Dangerous Goods Code.

5.11.11. In all matters not covered by these Regulations and without prejudice to them one should be guided by the Regulations for Maritime Dangerous Goods (RD 31.15.01-89) and requirements of the International Maritime Dangerous Goods Code.

5.12. Requirements for the transport of radioactive materials by air

5.12.1. In addition to the general requirements and provisions of Sections 5.1 - 5.8, 5.14, the requirements of this Subsection shall be fulfilled for the transport of all types of radioactive material by air.

5.12.2. Packages of Categories I, II, and III can be transported in the passenger and freight air transport.

The exposure rate from the packages in the crew workplaces and passenger area shall not exceed the values given in the sanitary regulations for the transport of radioactive materials and quoted according to It. 5.12.7.

5.12.3. The transport of radioactive material in the passenger baggage is not allowed.

5.12.4. Type B (M) packages and consignment under the exclusive use conditions shall not be transported by the passenger air transport.

5.12.5. The Type B(M) packages with the excessive pressure release, which require the external cooling using an auxiliary system, the packages requiring the operation inspection during the transport, the packages containing liquid pyrophoric substances, as well as radioactive material self-igniting in the air shall not be transported by air.

5.12.6. The shipment of radioactive materials by the air transport mode shall be carried out by the direct flight and with the minimum permissible quantity of landings.

5.12.7. Radioactive materials shall be separated from the crew workplaces, escort personnel and passenger areas as far as possible. Minimum distances are determined in the Technical Instructions for the Safe Transport of Dangerous Goods by Air (the International Civil Aviation Association document, 9284-AN/905).

5.12.8. For the transport of packages in the baggage compartments, they shall be separated from the hand luggage by a distance specified in Appendix 2.

5.12.9. The total weight and summarized TI for the transport of packages by air shall be agreed with the carrier on a case-by-case basis.

5.12.10. For the transport of packages having the specific load per craft premise floor area exceeding the permissible one, special facilities shall be used to distribute the package load.

5.12.11. When delivering one or several packages and overpacks with a weight of more than 90 kg (each) for shipment, the consignor shall agree with the carrier the loading and unloading procedure.

The center-of-gravity position shall be marked with the waterproof method on the packages, overpacks, freight containers and tanks with a weight more than 50 kg.

5.12.12. If radioactive materials cannot be transported at the lower (to -40°C) and higher temperatures (to 55°C), and lower pressure (up 5 kPa), the consignor shall indicate it in the column "Special notes" of the airway bill and on the category label, and agree it

with the carrier. If these conditions cannot be fulfilled, the consignment shall not be accepted for shipment.

5.12.13. The transport of radioactive materials by air shall be carried out according to a single order. The order to be submitted by the consignor to the carrier shall include information specified in It. 5.14.1.

5.12.14. Radioactive materials shall be delivered to:

- airports equipped with storage facilities for the packages containing relevant radioactive materials, not later than 3 hours before the aircraft departure;

- airports not equipped with such storehouse, directly at the time established by the airport director.

The time of delivery for loading to the freight aircrafts, including dedicated ones shall be agreed with the airport director.

5.12.15. If the flight is canceled due to unfavorable meteorological conditions or other reasons, when it is impossible to deliver radioactive materials to the destination point within a tome period specified by the consignor (in the order or airway bill), the airport director shall timely notify the consignor about the need for calling back radioactive material from the airport and about the shipment renewal date.

5.12.16. For the transport of radioactive materials, the consignor shall fill in the airway bill used for transport of dangerous goods (with the red diagonal stripe).

The word "radioactivity" shall be stamped in the upper part of the airway bill. For the transport of short-lived isotopes, the consignor shall stamp "Short-lived isotopes. Time of delivery... hour," in the upper part of the airway bill. "Short-lived isotopes. Delivery period... hour."

5.12.17. Prior to loading (unloading) the packages of Category III, the Airport Administration or a person responsible for radiation safety shall notify the employees of the Aviation Engineering Service, instruct the aircraft crew and loading crew about the package handling procedure, and indicate, where and at what distance from the crew workplace, passengers, baggage and hand-luggage, as well as from the photosensitive material consignments the packages should be placed, and how they should be fastened.

When loading (unloading) to the dedicated aircrafts these directions shall be fulfilled with due regard to the consignor's instructions.

5.12.18. After loading of the dedicated aircraft, the consignor shall measure the radiation dose rate in accordance with the requirements of these Regulations. The measuring results shall be recorded in the statement to be signed by the consignor's radiation supervisor and a person responsible for radiation safety in the airport.

5.12.19. The systematic radiation monitoring of packages, transport vehicles, personnel and activities shall be carried out in the airports with massive departure and arrival of radioactive materials.

5.12.20. For the transport of fissile nuclear material by air, the following requirements shall be fulfilled in addition to requirements of It. 5.12.1 - 5.12.19 and 5.12.21:

5.12.20.1. Fissile materials shall be transported only with the escort of the consignor (consignee) personnel.

5.12.20.2. For the transport of fissile nuclear materials, the plan of accident preventive and mitigation measures shall be developed in accordance with It. 1.2.5. The plan shall be agreed with the State Defence Committee, State agencies for safety regulation in atomic energy use, State supervision body of nuclear and radiation safety of RF Ministry of Defense (for the transport of military-oriented radioactive materials), as well as with the dedicated federal executive agency in the field of civil aviation.

5.12.21. In all matters not covered by these Regulations and not contradict them, for the transport of radioactive materials by air one should be guided by the Technical Instructions for the Safe Transport of Dangerous Goods by Air.

5.13. Requirements for the transport of radioactive materials by postal enterprises

5.13.1. The possibility and conditions of sending radioactive materials by postal enterprises shall be regulated by the Sanitary Regulations for the transport of radioactive materials.

5.14. Specific features of shipping document execution for the transport of radioactive materials

5.14.1. A shipping document shall be drawn up by the consignee per each consignment (in accordance with the Regulations for transport of dangerous goods in a particular mode of transport), which should include the following information:

a) shipping name as specified in Appendix 5;

b) UN number for dangerous goods - "7";

c) UN number assigned to the material as specified in Appendix 5;

d) name or symbol of each isotope or relevant general description or list of the most limiting radionuclides for the mixture of radionuclides;

e) description of the physical and chemical material form or a record that the material is special form radioactive material or low dispersible radioactive material. General chemical description is permissible for the chemical form;

f) maximum activity of radioactive contents in transport, expressed in Becquerel (Curie) with the relevant SI prefix (see Appendix 6); weight in grams (g) or in multiples of gram;

g) package category;

h) TI (only for categories "II-YELLOW" and "III-YELLOW");

i) CSI for fissile nuclear material;

j) identification mark of certificates (approval certificates) applied to this consignment;

k) the contents of each package shall be included for the consignment containing packages in the freight container or overpack.

If the packages shall be removed from the freight container or overpack in the intermediate unloading point the relevant documentation shall be prepared.

l) if the consignment shall be transported under the exclusive use conditions, the following record shall be made: "Transport under the exclusive use conditions" or "carload shipment" for the railroad transport;

m) for LSA-II, LSA-III, SCO-I and SCO-II the total activity shall be indicated in multiples of A2;

n) number of the emergency card for a particular freight and the instruction where it should be located;

o) consignor's certification including the following text: "I hereby affirm that the freight contents are completely and accurately described in the proper shipping name, classified, packaged, marked, and supplied with danger signs according to the Safety Regulations for the transport of radioactive material and instruction..." (a proper document in force for a particular mode of transport shall be indicated).

The certification shall be dated and signed by a consignor's designated representative including his/her name and position;

p) supplementary operation requirements for loading, stowage, handling and unloading of the package, overpack, freight container, including special stowage measures to ensure safe heat removal, or a notice that no such requirements are imposed;

q) limitations related to a transport mode or vehicle, and any necessary routing instructions.

5.14.2. The waybill shall include information according to "a", "d", "f", "g", "k", "l", "m" and brief information about the availability of the consignor certification according to "o" of It. 5.14.1. The waybill shall be stamped "radioactive".

5.14.3. For all the package types (except where certificates (approval certificates) are not required) the consignor shall submit (deliver) certificates (approval; certificates) by the request of the carrier and/or transshipment terminal, etc., where the loading, unloading and any transshipment operations are performed, prior to the performance of such operations.

Before loading and shipment of packages the consignor shall obtain the copy of each certificate (approval; certificate) required in accordance with provisions of Section 4, and copies of the operating manuals for packing casks.

6. RADIATION MONITORING

6.1. The radiation monitoring shall ensure the receipt of required information based on which one can judge about:

a) the conformity of the radiation parameters of vehicles and consignment with the values specified by these Regulations;

b) change in the consignment radiation parameters in transport, including any incidents and emergencies;

c) irradiation level of the persons engaged in the activities in transport and possible irradiation levels of public.

6.2. The radiation monitoring includes:

a) monitoring of the neutron and gamma emission dose rate on the consignment (transport vehicle) surface at various distances from it, as well as at the personnel, guard and public places;

b) control of radioactive contamination of the external surfaces of the consignment and transport vehicles, and internal surfaces of transport vehicles after unloading;

c) measurement of radioactive contamination of the external and internal surfaces of empty vehicles, packing casks, overpacks, freight containers prior to shipping by the consignor;

d) control of individual exposure doses and radioactive contamination of the personnel involved in the shipping and guard.

6.3. Based on the radiation monitoring:

a) the radiation protection is optimized;

b) the procedure of work related to potential irradiation of the personnel in transport is determined;

c) categories of irradiated persons involved in the shipment of radioactive materials, are established;

d) decisions on intervention in case of radiation accident are taken.

6.4. The radiation monitoring in transport shall be performed by:

a) consignor prior to delivering the consignment and empty packing casks (before each shipment);

b) consignee when the consignment and empty packing casks are accepted (for each acceptance).

c) carrier or person escorting the consignment en route, if any incidents or accidents occurred.

6.5. The radiation monitoring to be implemented by the consignor (consignee) shall be conducted by the radiation safety service or a person assigned by the consignor (consignee).

The consignor (consignee) shall submit the radiation monitoring results to the carried at its request.

7. EMERGENCY RESPONSE IN THE TRANSPORT OF RADIOACTIVE MATERIAL

7.1. General provisions and requirements

7.1.1. Failures and breaks of a transport vehicle not affecting the consignment shall be duly eliminated in each vehicle subject to observance of the specified requirements for ensuring the radiation safety. The work for elimination of failures and breaks shall be performed under the supervision of a person responsible for escort of the consignment and with regard to information on the danger placards marked on the consignment and transport vehicle, as well as requirements of the sanitary regulations in transport of radioactive materials.

7.1.2. Measures for accident mitigation in transport of the consignment shall be taken by the Emergency Response Team of the emergency technical center under the jurisdiction of the regulatory body of atomic energy use and special emergency teams of operating organizations.

7.1.3. The regulatory body of atomic energy use shall approve emergency cards for various types of the radioactive material consignments and determine the procedures for their use.

7.1.4. Prior to shipping, the consignor (consignee) shall have a plan of work on mitigation of accidents when shipping with due regard to specific shipment conditions and regulated requirements. This plan shall be duly agreed.

7.1.5. For timely implementation of emergency response, actions in transit the consignor (consignee) shall ensure the systematic control of the freight traffic, excluding the excepted packages.

7.2. Accident classification and main requirements for emergency response measures

7.2.1. To determine primarily the degree of radiation hazard in a timely manner, which occur as the result of accidents in the consignment of radioactive materials, and to take the relevant primary measures there are three hazard categories.

7.2.1.1. Accidents of Category I are the accidents, when the consignment of radioactive materials does not suffer visible damages as the result of mechanical actions, or minor damages, unfastening or break of attachment elements occur on a transport vehicle, or the consignment is subjected to a small heat impact (without direct contact with fire) as the result of fire beyond the freight area or transport vehicle.

Under such accidents, the release of radioactive contents from the packages does not exceed the values permissible for the normal transport conditions, whereas the irradiation level can increase no more than by 20%.

7.2.1.2. Category II accidents are the accidents during which:

a) the consignments containing Type B and Type C packages or packages with fissile materials suffer heavy mechanical damages and/or the packages are in the fire seat in the results of which the increase in the irradiation levels and release of radioactive materials from the packages should not exceed the limits established by these Regulations for the emergency transport conditions;

b) the consignments with industrial packages and Type A packages not containing fissile materials suffer heavy mechanical damages or such packages are in the fire sear or completely destroyed.

7.2.1.3. Category III accidents are the accidents during which the Type B and Type C packages or packages containing fissile materials are partly or completely destroyed, the irradiation levels and release of radioactive materials from the packages may exceed the

limits established by these Regulations for the emergency transport conditions (beyond design basis accident).

7.2.2. A person escorting the consignment, who is duly trained and has relevant instructions of the consignor (consignee) shall be responsible for the primary determination of the accident hazard degree and arrangement of works. Before arrival of a consignor (consignee) representative or emergency response team or a representative of atomic energy use regulatory body or regional emergency team, this person shall manage the emergency response activities.

If after the accident the escorting personnel cannot perform its duties or is absent, a carrier representative, staff of internal affairs agencies or fire rescue team shall determine the hazard degree and perform the high priority work according to the emergency card, hazard placards on the consignment and transport vehicles and results of the visual inspection.

7.2.3. For Category I accidents, the emergency response activities shall be performed by the escort personnel subject to its presence and capability, together with the transport employees and internal affairs agencies. As soon as the transport vehicles and consignment have been brought into the serviceable condition and the statement of accident has been drawn up, the decision on the further transport shall be taken by the escort personnel together with the carrier employees.

7.2.4. For Category I accidents, in case of disablement or absence of the escort personnel the emergency response activities shall be performed by the carrier and internal affairs agencies' employees according to requirements of the emergency card. Information specified in the labels and placards on the consignment and transport vehicles shall be considered.

To determine the possibility of the further transport a consignor's (consignee) representative shall be called, who draws up the statement of accident and takes decision on the onward transport.

7.2.5. For accidents of Categories II and III, the following activities shall be performed with due regard to requirements of the emergency card:

- rescue of people who are exposed to danger, and immediate medical treatment to the sufferers;

- fire extinguishing if any;

- communication of the accident information;

- removal of people from the potential hazardous area to a distance specified in the emergency card and according to instructions of the escort personnel. If no emergency card and escort personnel are available, people shall be removed to the windward direction at 100 - 200 m distance until assistance arrives;

- marking by means of the danger signs;

- cordoning the emergency area and arrangement of the additional protection, if necessary;

- peace keeping on accident site;

- visual inspection of the consignment and communication of the detailed emergency information according to the emergency card;

- taking primary immediate measures to eliminate and mitigate the consequences of the accident;

- record of people that could be exposed to radiation during the accident (irradiation, contamination) and their keeping until arrival of the radiation monitoring specialists with the relevant instruments (except persons requiring the immediate medical emergency care in the hospital);

- supervision of the environment radiation whenever possible.

7.2.6. The personnel escorting the consignment or in their absence, the carrier personnel shall immediately communicate the information about location of Category II and III accidents, time and hazard degree (accident category) to the consignor, consignee, carrier, internal affairs agencies, territorial authorities of Minister of Civil Defence and emergencies, self-governing authorities, State safety regulatory authorities in atomic energy use, office for nuclear facility safety.

7.2.7. Upon arrival of the carrier's emergency response and rescue teams, the activity shall be performed considering the instructions of the escort personnel or, in their absence, according to the emergency card. The activities related to movement of Type B,

Type C packages and packages containing fissile materials shall be performed only according to instruction of the escort personnel, representative of the atomic energy use regulatory authority, head of the emergency response team or regional emergency response team upon their arrival.

7.2.8. The decision of further transport of the damaged consignment shall be made by the consignor (consignee). For the transport in question, these Regulations shall be fulfilled or measures ensuring the safety level required by these Regulations shall be taken. The further transport conditions shall be agreed with the atomic energy use regulatory authority and State safety regulatory authority, as well as with the federal executive authority (for the transport by rail) in the field of railway transportation.

7.2.9. The radiation accident recovery activities shall be deemed completed upon elimination of the radioactive contamination confirmed by the radiation and sanitary certificate of the State sanitary and epidemiological supervision and safety of vehicle traffic authorities including the commission statement of the rectification of the accident consequences. Reports on radiation monitoring of the territory and facilities exposed to contamination shall be enclosed to the statement.

7.3. Additional requirements for emergency response in the transport by river

7.3.1. Prior to loading to the vessel, the captain and dedicated representative of the port shall be familiarized with the emergency card related to a particular consignment.

7.3.2. Persons shall be selected and trained for performance of the activities in case of any accident related to the radioactive material consignment on the vessel.

7.3.3. The emergency response activities associated with the radioactive material consignment on the vessel shall be performed under the supervision of the captain or a dedicated person according to the carrier's instructions and requirements of the emergency card.

8. REQUIREMENTS FOR PHYSICAL PROTECTION OF RADIOACTIVE MATERIALS

8.1. To ensure physical protection in transport of radioactive substances one should be guided by the general requirements given in this Section.

8.2. For physical protection in transport of nuclear materials it is necessary to observe the general requirements stipulated in It. 8.3, and requirements of the Regulations for physical protection of nuclear materials, nuclear facilities and nuclear material storage facilities approved by RF Government Decree No. 264 of March 7, 1997, Convention on the Physical Protection of Nuclear Material (IAEA document, INF.CIRC /274/, Rev. 1, signed by USSR on 21 May, 1980, ratified by USSR on 4 May 1983, effective from February 8, 1987) with due regard to the IAEA recommendations "Physical protection of nuclear material" (INF CIRC / 225/. Rev. 3) accepted at the meeting of the IAEA Technical Committee on the physical protection of nuclear material, 25 June 1993.

8.3. To ensure the Physical Protection in transport of radioactive material, it is necessary:

- to limit the total duration of radioactive material in transit as much as possible;
- to minimize the number of transshipments from one transport vehicle to another, as well as the time of package storage when waiting for a transport vehicle;
- to arrange the traffic of vehicles carrying nuclear material subject to the availability of the options of traffic schedules and routes;
- to notify a consignee about the cargo shipment and a consignor about the cargo receipt;
- to select the routes beyond the emergency area, disaster area, and other extreme situations, etc.;
- to limit the number of officials aware of the route and time period of radioactive material transport, as much as possible;
- to grant permits to persons subjected to the pass-through validation for transporting, escorting and guarding radioactive materials.

Appendix 1
to Safety Regulations for the transport
of radioactive material

ACTIVITY LIMITS AND RESTRICTIONS IMPOSED ON MATERIALS BASIC VALUES FOR RADIONUCLIDES

1. Table I includes the following basic values for individual radionuclides:

a) A1 and A2, TBq;

b) activity concentration for the substances, to which these Regulations do not apply, Bq/kg;

b) activity limits for the freight, to which these Regulations do not apply, Bq/freight.

DETERMINATION OF THE BASIC VALUES FOR RADIONUCLIDES

2. For individual radionuclides not listed in Table I the determination of the basic values mentioned in It. 1 shall be approved the atomic energy use regulatory authority, and for international transport it shall be required at the multilateral level. When the chemical form of each radionuclide is known, it is allowed to use the A2 value related to its solubility class according to recommendations of the International commission for radiation protection, subject to the chemical forms are considered both under the normal and emergency transport conditions. As an alternative the radionuclides values given in Table II may be used without approval.

3. For calculation A1 and A2 as regards the radionuclide not specified in Table I, with a single radioactive decay chain, where radionuclides are present in a proportion occurring in nature, and there is no daughter nuclide with a half-life period more than 10 days or more than a half-life period of the parent nuclide, it shall be deemed as one radionuclide, and it is necessary to consider the activity and to use A1 and A2 values that meet the parent nuclide of this chain.

4. Basic values for the radionuclide mixtures mentioned in It. 1, can be calculated by the following formula:

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

where:

f(i) - the fraction of activity or concentration of activity of radionuclide i in the mixture

X(i) - the appropriate value of A1 or A2 or the concentration of activity for the radionuclide, to which these Regulations do not apply, or the limit of activity for the consignment, to which these Regulations do not apply, in respect to radionuclide i;

X(i) - the derived value of A1 or A2, or the concentration of activity for the radionuclide, to which these Regulations do not apply, or the limit of activity for the consignment, to which these Regulations do not apply, in respect to the mixture.

5. If each radionuclide is known, but individual activities of some radionuclides are not known, these radionuclides can be integrated into groups and formulas given in It. 4 of Appendix 1 and It. 1.3.3.3 of these Regulations, the least values for radionuclides in each group shall be used correspondingly. Groups can be selected on the basis of the total alpha and total beta and gamma activities if they are known using the least values for alpha or beta and gamma emitters correspondingly.

6. For individual radionuclides or their mixtures, which the relevant values are not known, the values given in Table II should be used.

Table I

BASIC VALUES FOR RADIONUCLIDES

Radionuclide	A_1, TBq	A_2, TBq	Activity concentration for materials, to which these Regulations do not apply, Bq/kg	Activity limit for the consignment, to which these Regulations do not apply, Bq/consignment
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}
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}
AI-26	1×10^{-1}	1×10^{-1}	1×10^{1}	1×10^{5}
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)
Ar-37	4×10^{1}	4×10^{1}	1×10^{6}	1×10^{8}
Ar-39	4×10^{1}	4×10^{1}	1×10^{7}	1×10^{4}
Ar-41	3×10^{-1}	3×10^{-1}	1×10^{2}	1×10^{9}
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}
At-211(a)	2×10^{1}	5×10^{-1}	1×10^{3}	1×10^{7}
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}
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	1×10^{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)
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}
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)
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}
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}
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}
Ca-41	Not limited	Not limited	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}
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}
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)
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	5×10^{-2}	3×10^{-3}	1×10^{1}	1×10^{4}
Cf-253(a)	4×10^{1}	1×10^{-2}	1×10^{2}	1×10^{5}
Cf-254	1×10^{-3}	1×10^{-3}	1×10^{0}	1×10^{3}
CI-36	1×10^{1}	6×10^{-1}	1×10^{4}	1×10^{6}
CI-38	2×10^{-1}	2×10^{-1}	1×10^{1}	1×10^{5}
m-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}
Co-55	5×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{5}
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}
Cr-51	3×10^{1}	3×10^{1}	1×10^{3}	1×10^{7}
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)
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}

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}
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}
Eu-147	2×10^{0}	1×10^{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 (short-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}
F-18	1×10^{0}	6×10^{-1}	1×10^{1}	1×10^{6}
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}
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}
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}
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}
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	Not limited	Not limited	1×10^{2}	1×10^{6}
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}
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}
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	Not limited	Not limited	1×10^{2}	1×10^{5}
I-131	3×10^{0}	7×10^{-1}	1×10^{2}	1×10^{6}
I-132	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}
I-133	7×10^{-1}	6×10^{-1}	1×10^{1}	1×10^{6}
I-134	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}

l-135(a)	6×10^{-1}	6×10^{-1}	1×10^{1}	1×10^{6}
ln-111	3×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
ln-113m	4×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
ln-114m(a)	1×10^{1}	5×10^{-1}	1×10^{2}	1×10^{6}
ln-115m	7×10^{0}	1×10^{0}	1×10^{2}	1×10^{6}
lr-189(a)	1×10^{1}	1×10^{-1}	1×10^{2}	1×10^{7}
lr-190	7×10^{-1}	7×10^{-1}	1×10^{-1}	1×10^{6}
lr-192	1×10^{0}(c)	6×10^{-1}	1×10^{1}	1×10^{4}
lr-194	3×10^{-1}	3×10^{-1}	1×10^{2}	1×10^{5}
K-40	9×10^{-1}	9×10^{-1}	1×10^{2}	1×10^{6}
K-42	2×10^{-1}	2×10^{-1}	1×10^{2}	1×10^{6}
K-43	7×10^{-1}	6×10^{-1}	1×10^{-1}	1×10^{6}
Kr-81	4×10^{1}	4×10^{1}	1×10^{4}	1×10^{7}
Kr-85	1×10^{1}	1×10^{1}	1×10^{5}	1×10^{4}
Kr-85m	8×10^{0}	3×10^{0}	1×10^{3}	1×10^{10}
Kr-87	2×10^{-1}	2×10^{-1}	1×10^{2}	1×10^{9}
La-137	3×10^{1}	6×10^{0}	1×10^{3}	1×10^{7}
La-140	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}
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}
Mq-28(a)	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
Mn-52	3×10^{-1}	3×10^{-1}	1×10^{1}	1×10^{5}
Mn-53	Not limited	Not limited	1×10^{4}	1×10^{9}
Mn-54	01 $\times 10^{0}$	1×10^{0}	1×10^{1}	1×10^{6}
Mn-56	3×10^{-1}	3×10^{-1}	1×10^{-1}	1×10^{5}
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}
N-13	9×10^{-1}	6×10^{-1}	1×10^{2}	1×10^{9}
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}
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}
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}
Ni-59	Not limited	Not limited	1×10^{4}	1×10^{8}
Ni-63	4×10^{1}	3×10^{1}	1×10^{5}	1×10^{8}
Ni-65	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{6}
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 (short-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)	$1\text{-}10^{3}$(b)
Np-239	7×10^{0}	4×10^{-1}	1×10^{2}	1×10^{7}
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}
0s-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}
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}
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}
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	Not limited	Not limited	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)
Pd-103(a)	4×10^{1}	4×10^{1}	1×10^{3}	1×10^{8}
Pd-107	Not limited	Not limited	1×10^{5}	1×10^{8}
Pd-109	2×10^{0}	5×10^{-1}	1×10^{3}	1×10^{6}
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}
Po-210	4×10^{1}	2×10^{-2}	1×10^{1}	1×10^{4}
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}
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}
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}
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^{-3}	1×10^{1}(b)	1×10^{5}(b)
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}	1×1^{1}	1×10^{6}
Rb-86	5×10^{-1}	5×10^{-1}	1×10^{2}	1×10^{5}
Rb-87	Not limited	Not limited	1×10^{4}	1×10^{7}

Rb-87(nat.)	Not limited	Not limited	1×10^{4}	1×10^{7}
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	Not limited	Not limited	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.)	Not limited	Not limited	1×10^{6}	1×10^{9}
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}
Rn-222(a)	3×10^{-1}	4×10^{-3}	1×10^{2}(b)	1×10^{6}(b)
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)
S-35	4×10^{1}	3×10^{0}	1×10^{5}	1×10^{8}
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}
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}
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}
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}
Sm-145	1×10^{1}	1×10^{1}	1×10^{2}	1×10^{7}
Sm-147	Not limited	Not limited	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}
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}
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}
T(H-3)	4×10^{1}	4×10^{1}	1×10^{6}	1×10^{9}
Ta-178 (ling-lived)	1×10^{1}	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}
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}
Tc-95m(a)	1×10^{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	Not limited	Not limited	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}
Te-121	2×10^{0}	2×10^{0}	1×10^{1}	1×10^{6}
Te-121m	8×10^{0}	1×10^{0}	1×10^{2}	1×10^{7}
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}
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^{0}(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	Not limited	Not limited	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.)	Not limited	Not limited	1×10^{0}(b)	1×10^{3}(b)
TI-44(a)	5×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{5}
TI-200	9×10^{-1}	9×10^{-1}	1×10^{1}	1×10^{6}
TI-201	1×10^{1}	4×10^{0}	1×10^{2}	1×10^{6}
TI-202	2×10^{-0}	2×10^{0}	1×10^{2}	1×10^{6}
TI-204	1×10^{1}	7×10^{-1}	1×10^{4}	1×10^{4}
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	1×10^{1}	1×10^{1}	1×10^{4}	1×10^{8}
U-230 (high rates of pulmonary absorption) (a), (d)	4×10^{1}	1×10^{-1}	1×10^{1}(b)	1×10^{5}(b)
U-230 (medium rates of pulmonary absorption) (a), (d)	4×10^{1}	4×10^{-3}	1×10^{1}	1×10^{4}
U-230 (low rates of pulmonary absorption	3×10^{1}	3×10^{-3}	1×10^{1}	1×10^{4}

(a), (f)				
U-232 (high rates of pulmonary absorption) (d)	4×10^{1}	1×10^{-2}	1×10^{0}(b)	1×10^{3}(b)
U-232 (medium rates of pulmonary absorption) (a)	4×10^{1}	7×10^{-3}	1×10^{1}	1×10^{4}
U-232 (low rates of pulmonary absorption) (f)	1×10^{1}	1×10^{-3}	1×10^{1}	1×10^{4}
U-233 (high rates of pulmonary absorption) (d)	4×10^{1}	9×10^{-2}	1×10^{1}	1×10^{4}
U-233 (medium rates of pulmonary absorption) (e)	4×10^{1}	2×10^{-2}	1×10^{2}	1×10^{5}
U-233 (low rates of pulmonary absorption) (f)	4×10^{1}	6×10^{-3}	1×10^{1}	1×10^{5}
U-234 (high rates of pulmonary absorption) (d)	4×10^{1}	9×10^{-2}	1×10^{1}	1×10^{4}
U-234 (medium rates of pulmonary absorption) (e)	4×10^{1}	2×10^{-2}	1×10^{2}	1×10^{5}
U-234 (low rates of pulmonary absorption) (f)	4×10^{1}	6×10^{-3}	1×10^{1}	1×10^{5}
U-235 (all types of pulmonary absorption) (a), (d), (e), (f)	Not limited	Not limited	1×10^{1}(б)	1×10^{4}(b)
U-236 high rates of pulmonary absorption) (d)	Not limited	Not limited	1×10^{1}	1×10^{4}
U-236 (medium rates of pulmonary absorption) (e)	4×10^{1}	2×10^{-2}	1×10^{2}	1×10^{5}
U-236 (low rates of pulmonary absorption) (f)	4×10^{1}	6×10^{-3}	1×10^{1}	1×10^{4}
U-238 (all types of pulmonary absorption) (d), (e), (f)	Not limited	Not limited	1×10^{1}(б)	1×10^{4}(б)
U (nat.)	Not limited	Not limited	1×10^{0}(b)	1×10^{3}(b)
U (enriched to 0% or less) (g)	Not limited	Not limited	1×10^{0}	1×10^{3}
U (depleted)	Not limited	Not limited	1×10^{0}	1×10^{3}
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}
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}	б $\times 10^{-1}$	1×10^{2}	1×10^{6}
W-188(a)	4×10^{-1}	3×10^{-1}	1×10^{2}	1×10^{5}
Xe-122(a)	4×10^{-1}	7×10^{-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}
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}
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}
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}
Zr-88	3×10^{0}	3×10^{0}	1×10^{2}	1×10^{6}
Zr-93	Not limited	Not limited	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> Values A1 and /or A2 are limited by the decay of radioactive daughters.

<b> Parent nuclides and their secondary particles included in the secular equilibrium are listed below:

Sr-90	Y-90
Zr-93	Nb-93m
Zr-97	Nb-97
Ru-106	Rh-106
Cs-137	Ba-137m
Ce-134	La-134
Ce-144	Pr-144
Ba-140	La-140
Bi-212	TI-208 (0.36), Po-212 (0.64)
Pb-210	Bi-210, Po-210
Pb-212	Bi-212, TI-208 (0.36), Po-212 (0.64)
Rn-220	Po-216
Rn-222	Po-218, Pb-214, Bi-214, Po-214
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, TI-207
Ra-224	Rn-220, Po-216, Pb-212, Bi-212, TI-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-226	Ra-222, Rn-218, Po-214
Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, TI-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, TI-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, TI-208 (0.36), Po-212 (0.64)
U-235	Th-231
U-238	Th-234, Pa-234m
U (nat.)	Th-234, Pa-234m, U-234, Th-230, Ra-226, Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210
U-240	Np-240m
Np-237	Pa-233
Am-242m	Am-242
Am-243	Np-239

(c) The quantity can be determined by measuring the decay rate or irradiation level at a given distance from the source.

(d) These values are applied only to the uranium compounds assuming the chemical formula UF_6, UO_2F_2 and $UO_2(NO_3)_2$, both under the normal and emergency transport conditions.

(e) These values are applied only to the uranium compounds assuming the chemical formula UO UO_3, UF_4, UCl_4, and to the hexavalent compounds both under the normal and emergency transport conditions.

(f) These values are applied to all the uranium compounds excluding those specified in It. (d), (e).

(g) These values are applied only to unirradiated uranium.

Table II

Basic values for unknown radionuclides or mixtures

Radionuclide	A_1, TBq	A_2, TBq	Activity concentration for materials, to which these Regulations do not apply, Bq/kg	Activity limit for the consignment, to which these Regulations do not apply, Bq/consignment
It is known that only beta and gamma emitters are present.	0.1	0.02	1×10^{1}	1×10^{4}
It is known that alpha emitters are present	0.2	9×10^{-5}	1×10^{-1}	1×10^{3}
No applicable data	0.001	9×10^{-5}	1×10^{-1}	1×10^{3}

Appendix 2

to the Safety Regulations for the transport

of radioactive material

MAXIMUM PERMISSIBLE DISTANCES FROM PACKAGES TO PHOTOSENSITIVE MATERIALS

Transport index	Distance, m Duration of joint storage, h (day)									
	1	2	3	4	5	8	10	12	15	20
1	-	0.4	0.5	0.6	0.7	0.9	1.0	1.1	1.2	1.4
2	0.5	0.6	0.8	0.9	1.0	1.2	1.4	1.5	1.7	2.0
5	0.7	1.0	1.2	1.4	1.6	2.0	2.2	2.4	2.8	3.2
10	1.0	1.4	1.7	2.0	2.2	2.8	3.2	3.5	3.9	4.5
20	1.4	2.0	2.4	2.8	3.2	4.0	4.5	4.9	5.5	6.3
30	1.7	2.4	3.0	3.5	3.9	4.9	5.5	6.0	6.7	7.7
40	2.0	2.8	3.5	4.0	4.5	5.7	6.3	6.9	7.7	8.9
50	2.2	3.2	3.9	4.5	5.0	6.8	7.0	7.7	8.7	10.0
60	2.4	3.5	4.3	5.0	5.5	6.9	7.7	9.3	10.0	11.0
80	2.8	4.0	5.0	5.7	6.3	8.0	8.9	10.0	11.0	13.0
100	3.2	4.5	5.6	6.3	7.0	8.9	10.0	11.0	12.0	14.0
150	3.9	5.5	6.7	7.7	8.9	11.0	12.0	13.0	15.0	17.0
200	4.5	6.3	7.7	8.9	10.0	13.0	14.0	16.0	17.0	20.0

Continuation of the table

Transport index	Distance, m Duration of joint storage, h (day)								
	24 1	48 2	72 3	120 5	240 10	360 (15)	480 (20)	720 (30)	960 (40)
1	1.5	2.2	2.7	3.5	4.9	6.0	6.9	8.5	10.0
2	2.2	3.1	3.8	4.9	6.9	8.5	10.0	12.0	14.0
5	3.5	4.9	6.0	7.7	11.0	14.0	16.0	19.0	22.0
10	4.9	6.9	8.5	11.0	16.0	19.0	22.0	27.0	31.0
20	6.9	10.0	12.0	15.0	22.0	27.0	31.0	38.0	45.0
30	8.5	12.0	15.0	19.0	27.0	33.0	38.0	45.0	55.0
40	10.0	15.0	17.0	22.0	31.0	38.0	45.0	55.0	65.0
50	11.0	16.0	19.0	25.0	35.0	45.0	50.0	60.0	70.0
60	12.0	17.0	21.0	27.0	38.0	48.0	55.0	65.0	75.0
80	14.0	20.0	24.0	31.0	45.0	55.0	60.0	75.0	90.0
100	16.0	22.0	27.0	35.0	50.0	60.0	70.0	85.0	100.0
150	19.0	22.0	33.0	42.0	60.0	75.0	85.0	-	-
200	22.0	31.0	38.0	50.0	70.0	85.0	95.0	-	-

Explanations

1. It is necessary to consider possible irradiation of photosensitive materials during storage or particular transport. In this case the values from the table shall be used to ensure

that the total irradiation dose of photosensitive materials does not exceed 0.1 mSv with due regard to the previous shipments.

2. The various transport indexes in the Table have the relevant minimum distances at which the irradiation dose equal to 0.1 mSv is received, if the radiation duration has a specified value.

3. When compiling the table it has been supposed that packages are located closely to each other on the plane. It has been assumed that all the packages are spherical with the radius of 0.22 m and the radioactive material in each package is concentrated in its central point.

4. Distances given in the table are maximum permissible. Other mathematical models are possible in addition to the above provided that separation distances are not less than the values, which have been calculated using the above mathematical model. In particular, if the TIs are used, the separation distance can be calculated as follows:

- it may be assumed that all radioactive materials are concentrated in one point irrespective of the number of packages and their sizes. That's why the transport index of the group of packages can be assumed as the sum of transport indexes of all individual packages that form a group;

- it may be assumed that the inverse law is applied.

5. All the separation distances calculated using the Table shall be measured from the surface of the package or group of packages.

Note. When determining permissible distances one should consider that the shielding by ordinary consignments, the average density of which is close to water density, decreases the irradiation degree by 10 times at the consignment thickness of 70 cm and by 100 times at the consignment thickness of 115 cm.

Appendix 5

to the Safety Regulations for the transport

of radioactive material

Extract from the list of UN numbers, proper shipping names, description of consignment and extra hazards

UN Number	Shipping name and description of consignment	Extra hazards
2910	Radioactive material, excepted package - limited quantity of material	-
2911	Radioactive material, excepted package - instruments or articles	-
2909	Radioactive material, excepted package - articles manufactured from natural uranium or depleted uranium or natural thorium	-
2908	Radioactive material, excepted package - empty packaging	-
2912	Radioactive material, low specific activity (LSA-I) non fissile or fissile-excepted a)	-
3321	Radioactive material, low specific activity (LSA-II) non fissile or fissile-excepted a)	-
3322	Radioactive material, low specific activity (LSA-III) non fissile or fissile-excepted a)	-
2913	Radioactive material, surface contaminated objects (SCO-I or SCO-II) non fissile or fissile-excepted a)	-
2915	Radioactive material, type a package, non-special form, non-fissile or fissile-excepted a)	-
3332	Radioactive material, type a-package, special form non fissile or fissile-excepted a)	-
2916	Radioactive material, type b(u) package, non-fissile or fissile-excepted a)	-
2917	Radioactive material, type b(m) package, non-fissile or fissile-excepted al	-
3323	Radioactive material, type c package, non-fissile or fissile-excepted a)	-
2919	Radioactive material, transported under special arrangement, non-fissile or fissile-excepted a)	-
2978	Radioactive material, uranium hexa-fluoride non fissile or fissile-excepted a)	Corrosive (UN Class 8)
3324	Radioactive material, low specific activity (LSA-II), fissile	-
3325	Radioactive material, low specific activity (LSA-III) fissile	-
3326	Radioactive material, surface contaminated objects (SCO-I or SCO-II), fissile	-
3327	Radioactive material, type a package, fissile non-special form	-
3333	Radioactive material, type a package, special form, fissile	-
3328	Radioactive material, type b(u) package, fissile	-
3329	Radioactive material, type b(m) package, fissile	-
3330	Radioactive material, type c package, fissile	-
3331	Radioactive material, transported under special arrangement, fissile	-
2977	Radioactive material, uranium hexafluoride, fissile	Corrosive (UN Class 8)

a) The term "fissile excepted" is applied only to the packages that meet the requirements of It. 2.12.2.

Appendix 6
to the Safety Regulations for the transport
of radioactive material

CONVERSION FACTORS AND SI PREFIXES

These Regulations use the international system of units (SI). Conversion factors for off-system units have the following values:

RADIATION UNITS

Activity in Becquerel (Bq) or Curie (Ci)

1 Ci = 3.7 x 10^{10} Bq

1 Bq = 2.7 x 10^{-11} Ci.

The equivalent dose in Sievert (Sv) or rem.

1 rem = 1.0 x 10^{-2} Bq

1 Sv = 100 rem

PRESSURE

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

1 kgf/cm^2 = 9.806 x 104 Pa

1 Pa = 1.020 x 10^{-5} kgf/cm^2

CONDUCTIVITY

Conductivity in Siemens per meter (S/m) or

in reciprocal ohm per centimeter (mho/cm)

10 μmho/cm = 1 mS/m or

1 mho/cm = 100 S/m

1 S/m = 10^{-2} mho/cm

SI PREFIXES

For SI units the following prefixes are used:

Multiplier	Prefix	Symbol
1,000 000 000 000 000 000 = 10^{18}	exa	E
1,000 000 000 000 000 = 10^{15}	peta	P
1,000 000 000 000 =10^{12}	tera	T
1,000 000 000 = 10^{9}	giga	G
1,000 000 = 10^{6}	mega	M
1,000 = 10^{3}	kilo	k
100 10^{2}	hecto	h
10 = 10^{1}	deca	da
0,1 =10^{-1}	deci	d
0.01 = 10^{-2}	centi	c
0.01 = 10^{-3}	milli	m
0.000 001 = 10^{-6}	micro	μ
0.000 000.001 = 10^{-9}	nano	n
0.000 000.000.001 = 10^{-12}	pico	p
0.000 000.000.000.001 = 10^{-15}	femto	f
0.000 000.000.000.000.001 = 10^{-18}	atto	a

*The document is given with due regard to the source spelling and punctuation.