

IAEA SAFETY STANDARDS

for protecting people and the environment

Status:	Approved by all Safety Standards Committees.
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Regulations for the Safe Transport of Radioactive Material

DRAFT SAFETY REQUIREMENTS DS345

(Front inside cover)
IAEA SAFETY RELATED PUBLICATIONS

IAEA SAFETY STANDARDS

Under the terms of Article III of its Statute, the IAEA is authorized to establish or adopt standards of safety for protection of health and minimization of danger to life and property, and to provide for the application of these standards.

The publications by means of which the IAEA establishes standards are issued in the **IAEA Safety Standards Series**. This series covers nuclear safety, radiation safety, transport safety and waste safety, and also general safety (i.e. all these areas of safety). The publication categories in the series are **Safety Fundamentals, Safety Requirements and Safety Guides**.

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SAFETY STANDARDS SERIES No. TS-R-1

REGULATIONS
FOR THE SAFE TRANSPORT
OF RADIOACTIVE MATERIAL

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INTERNATIONAL ATOMIC ENERGY AGENCY

VIENNA, 2009

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A-1400 Vienna
Austria
fax: +43 1 2600 29302
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FOREWORD
by Mohamed ElBaradei
Director General

The IAEA's Statute authorizes the Agency to establish safety standards to protect health and minimize danger to life and property — standards which the IAEA must use in its own operations, and which a State can apply by means of its regulatory provisions for nuclear and radiation safety. A comprehensive body of safety standards under regular review, together with the IAEA's assistance in their application, has become a key element in a global safety regime.

In the mid-1990s, a major overhaul of the IAEA's safety standards programme was initiated, with a revised oversight committee structure and a systematic approach to updating the entire corpus of standards. The new standards that have resulted are of a high calibre and reflect best practices in Member States. With the assistance of the Commission on Safety Standards, the IAEA is working to promote the global acceptance and use of its safety standards.

Safety standards are only effective, however, if they are properly applied in practice. The IAEA's safety services — which range in scope from engineering safety, operational safety, and radiation, transport and waste safety to regulatory matters and safety culture in organizations — assist Member States in applying the standards and appraise their effectiveness. These safety services enable valuable insights to be shared and I continue to urge all Member States to make use of them.

Regulating nuclear and radiation safety is a national responsibility, and many Member States have decided to adopt the IAEA's safety standards for use in their national regulations. For the Contracting Parties to the various international safety conventions, IAEA standards provide a consistent, reliable means of ensuring the effective fulfilment of obligations under the conventions. The standards are also applied by designers, manufacturers and operators around the world to enhance nuclear and radiation safety in power generation, medicine, industry, agriculture, research and education.

The IAEA takes seriously the enduring challenge for users and regulators everywhere: that of ensuring a high level of safety in the use of nuclear materials and radiation sources around the world. Their continuing utilization for the benefit of humankind must be managed in a safe manner, and the IAEA safety standards are designed to facilitate the achievement of that goal.

PROMOTIONAL TEXT FOR THE BACK COVER:

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CONTENTS

(Paragraph numbers are given in parentheses)

NOTE: PAGE NUMBERS HAVE BEEN DELETED FOR THIS REVISED DRAFT

SECTION I. INTRODUCTION	
Background (101–103).....	
Objective (104–105).....	
Scope (106–109)	
Structure (110).....	
SECTION II. DEFINITIONS (201–246).....	
SECTION III. GENERAL PROVISIONS	
Radiation protection (301–303)	
Emergency response (304–305).....	
Quality assurance (306).....	
Compliance assurance (307–308)	
Non-compliance (309).....	
Special arrangement (310)	
Training (311–315).....	
SECTION IV. ACTIVITY LIMITS AND MATERIAL RESTRICTIONS.....	
Radioactive Material (401 – 402).....	
Basic radionuclide values (403).....	
Determination of basic radionuclide values (404–408)	
Determination of other material characteristics (409–438).....	
SECTION V. REQUIREMENTS AND CONTROLS FOR TRANSPORT	
Requirements before the first shipment (501).....	
Requirements before each shipment (502).....	
Transport of other goods (503–506)	
Other dangerous properties of contents (507).....	
Requirements and controls for contamination and for leaking packages (508–514).....	
Requirements and controls for transport of excepted packages (515–516)	
Requirements and controls for transport of LSA material and SCO in industrial packages or unpackaged (517–521)	
Determination of transport index (TI) (522–523)	
Determination of criticality safety index (CSI) (524).....	
Limits on transport index, criticality safety index and radiation levels for packages and overpacks (525–527)	
Categories (528).....	
Marking, labelling and placarding (529–543).....	
Consignor’s responsibilities (544–560).....	

Transport and storage in transit (561–579)
Customs operations (580).....
Undeliverable consignments (581).....

SECTION VI. REQUIREMENTS FOR RADIOACTIVE MATERIALS
AND FOR PACKAGINGS AND PACKAGES

Requirements for radioactive materials (601–605).....
General requirements for all packagings and packages (606–616).....
Additional requirements for packages transported by air (617–619).....
Requirements for excepted packages (620)
Requirements for industrial packages (621–628).....
Requirements for packages containing uranium hexafluoride (629–632)
Requirements for Type A packages (633–649).....
Requirements for Type B(U) packages (650–664)
Requirements for Type B(M) packages (665–666).....
Requirements for Type C packages (667–670).....
Requirements for packages containing fissile material (671–682)

SECTION VII. TEST PROCEDURES

Demonstration of compliance (701–702).....
Leaching test for LSA–III material and low dispersible radioactive material (703)
Tests for special form radioactive material (704–711)
Tests for low dispersible radioactive material (712).....
Tests for packages (713–737)

SECTION VIII. APPROVAL AND ADMINISTRATIVE
REQUIREMENTS

General (801–802).....
Approval of special form radioactive material and low dispersible
radioactive material (803–804).....
Approval of package designs (805–814).....
Transitional arrangements (815–818)
Notification and registration of serial numbers (819).....
Approval of shipments (820–823).....
Approval of shipments under special arrangement (824–826)
Competent authority approval certificates (827–829).....
Contents of approval certificates (830–833)
Validation of certificates (834)

REFERENCES

ANNEX I: SUMMARY OF APPROVAL AND PRIOR
NOTIFICATION REQUIREMENTS (to be added later).....

ANNEX II: CONVERSION FACTORS AND PREFIXES (to be added later).....

CONTRIBUTORS TO DRAFTING AND REVIEW (to be added later).....

INDEX (to be added later)

LIST OF TABLES

Table 1	Basic radionuclide values
Table 2	Basic radionuclide values for unknown radionuclides or mixtures
Table 3	Activity limits for excepted packages
Table 4	Industrial package requirements for LSA material and SCO
Table 5	Conveyance activity limits for LSA material and SCO in industrial packages or unpackaged
Table 6	Multiplication factors for large dimension loads
Table 7	Categories of packages and overpacks
Table 8	Excerpts from list of United Nations numbers, proper shipping names and descriptions
Table 9	UN marking for packages and overpacks
Table 10	TI limits for freight containers and conveyances not under exclusive use
Table 11	CSI limits for freight containers and conveyances containing fissile material
Table 12	Insulation data
Table 13	Consignment mass limits for exceptions from the requirements for packages containing fissile material
Table 14	Free drop distance for testing packages to normal conditions of transport

1 **Section I**

2 **INTRODUCTION**

3
4 **BACKGROUND**

5 101. These Regulations establish standards of safety which provide an acceptable level of control
6 of the radiation, criticality and thermal hazards to persons, property and the environment that are
7 associated with the transport of *radioactive material*. These Regulations are based on the
8 principles set forth in both the “Radiation Protection and the Safety of Radiation Sources”,
9 Safety Series No. 120 [1] and the “International Basic Safety Standards for Protection against
10 Ionizing Radiation and for the Safety of Radiation Sources”, Safety Series No. 115 [2], jointly
11 sponsored by the Food and Agriculture Organization of the United Nations, the IAEA, the
12 International Labour Organization, the OECD Nuclear Energy Agency, the Pan American Health
13 Organization and the World Health Organization. Thus, compliance with these Regulations is
14 deemed to satisfy the principles of the Basic Safety Standards in respect of transport.

15 102. This Safety Standard is supplemented by a hierarchy of Safety Guides including “Advisory
16 Material for the IAEA Regulations for the Safe Transport of Radioactive Material”, IAEA Safety
17 Standards Series No. TS-G-1.1 (2007 Edition) [3], “Planning and Preparing for Emergency
18 Response to Transport Accidents Involving Radioactive Material”, IAEA Safety Standards Series
19 No. TS-G-1.2 (ST-3) [4], IAEA Safety Standard Series No. TS-G-1.X [5] “Compliance
20 Assurance for the Safe Transport of Radioactive Material” (Currently DS 327) and IAEA Safety
21 Standard Series No. TS-G-1.Y [6] “Management Systems for the Safe Transport of Radioactive
22 Material” (Currently DS 326).

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

29 **OBJECTIVE**

30 104. The objective of these Regulations is to protect persons, property and the environment from
31 the effects of radiation during the transport of *radioactive material*. This protection is achieved
32 by requiring:

- 33 (a) containment of the *radioactive contents*;
34 (b) control of external *radiation levels*;
35 (c) prevention of criticality; and
36 (d) prevention of damage caused by heat.

37 These requirements are satisfied firstly by applying a graded approach to contents limits for
38 *packages* and *conveyances* and to performance standards applied to *package designs* depending
39 upon the hazard of the *radioactive contents*. Secondly, they are satisfied by imposing
40 requirements on the *design* and operation of *packages* and on the maintenance of *packagings*,

1 including a consideration of the nature of the *radioactive contents*. Finally, they are satisfied by
2 requiring administrative controls including, where appropriate, *approval by competent*
3 *authorities*.

4 105. In the transport of radioactive material the safety of persons and protection of property and
5 the environment is assured when these Regulations are complied with. Confidence in this regard
6 is achieved through quality assurance and *compliance assurance* programmes.

7 SCOPE

8 106. These Regulations apply to the transport of *radioactive material* by all modes on land, water
9 or in the air, including transport which is incidental to the use of the *radioactive material*.
10 Transport comprises all operations and conditions associated with and involved in the movement
11 of *radioactive material*; these include the *design*, manufacture, maintenance and repair of
12 *packaging*, and the preparation, consigning, loading, carriage including in-transit storage,
13 unloading and receipt at the final destination of loads of *radioactive material* and *packages*. A
14 graded approach is applied to the performance standards in these Regulations that are
15 characterized by three general severity levels:

- 16 (a) routine conditions of transport (incident free);
- 17 (b) normal conditions of transport (minor mishaps);
- 18 (c) accident conditions of transport.

19 107. These Regulations do not apply to:

- 20 (a) radioactive material that is an integral part of the means of transport;
- 21 (b) radioactive material moved within an establishment which is subject to appropriate safety
22 regulations in force in the establishment and where the movement does not involve
23 public roads or railways;
- 24 (c) radioactive material implanted or incorporated into a person or live animal for diagnosis
25 or treatment;
- 26 (d) radioactive material in consumer products which have received regulatory approval,
27 following their sale to the end user;
- 28 (e) natural material and ores containing naturally-occurring radionuclides which are either in
29 their natural state, or have only been processed for purposes other than for extraction of
30 the radionuclides, and which are not intended to be processed for use of these
31 radionuclides, provided the activity concentration of the material does not exceed 10
32 times the values specified in paras 403(b), or calculated in accordance with paras 404–
33 408;
- 34 (f) non-radioactive solid objects with radioactive substances present on any surfaces in
35 quantities not in excess of the levels defined in para. 214.

36 108. These Regulations do not specify controls such as routeing or physical protection which
37 may be instituted for reasons other than radiological safety. Any such controls shall take into
38 account radiological and non-radiological hazards, and shall not detract from the standards of
39 safety which these Regulations are intended to provide.

40 109. For radioactive material having subsidiary risks, and for transport of radioactive material
41 with other dangerous goods, the relevant transport regulations for dangerous goods shall apply in
42 addition to these Regulations.

1 STRUCTURE

2 110. This publication is structured so that Section II defines the terms that are required for the
3 purposes of the Regulations; Section III provides general provisions; Section IV provides activity
4 limits and material restrictions used throughout these Regulations; Section V provides
5 requirements and controls for transport; Section VI provides requirements for radioactive
6 material and for packagings and packages; Section VII provides requirements for test procedures;
7 Section VIII provides requirements for approvals and administration.

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1 **Section II**

2 **DEFINITIONS**

3
4 The following definitions shall apply for the purposes of these Regulations:

5 *A₁ and A₂*

6 201. *A₁* shall mean the activity value of special form radioactive material which is listed in Table
7 1 or derived in Section IV and is used to determine the activity limits for the requirements of
8 these Regulations. *A₂* shall mean the activity value of radioactive material, other than special
9 form radioactive material, which is listed in Table 1 or derived in Section IV and is used to
10 determine the activity limits for the requirements of these Regulations.

11 *Aircraft*

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

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

17 *Approval*

18 204. *Multilateral approval* shall mean approval by the relevant *competent authority* of the
19 country of origin of the *design* or *shipment*, as applicable, and also, where the *consignment* is to
20 be transported *through or into* any other country, approval by the *competent authority* of that
21 country.

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

24 *Carrier*

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

29 *Competent authority*

30 207. *Competent authority* shall mean any body or authority designated or otherwise recognized
31 as such for any purpose in connection with these Regulations.

32 *Compliance assurance*

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

4 *Confinement system*

5 209. *Confinement system* shall mean the assembly of *fissile material* and *packaging* components
6 specified by the designer and agreed to by the *competent authority* as intended to preserve
7 criticality safety.

8 *Consignee*

9 210. *Consignee* shall mean any person, organization or government which is entitled to take
10 delivery of a *consignment*.

11 *Consignment*

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

14 *Consignor*

15 212. *Consignor* shall mean any person, organization or government which prepares a
16 *consignment* for transport.

17 *Containment system*

18 213. *Containment system* shall mean the assembly of components of the *packaging* specified by
19 the designer as intended to retain the radioactive material during transport.

20 *Contamination*

21 214. *Contamination* shall mean the presence of a radioactive substance on a surface in quantities
22 in excess of 0.4 Bq/cm² for beta and gamma emitters and *low toxicity alpha emitters*, or 0.04
23 Bq/cm² for all other alpha emitters.

24 215. *Non-fixed contamination* shall mean *contamination* that can be removed from a surface
25 during routine conditions of transport.

26 216. *Fixed contamination* shall mean *contamination* other than *non-fixed contamination*.

27 *Conveyance*

28 217. *Conveyance* shall mean

29 (a) for transport by road or rail: any vehicle,

30 (b) for transport by water: any vessel, or any hold, compartment, or *defined deck area* of a vessel,
31 and

32 (c) for transport by air: any *aircraft*.

1 *Criticality safety index*

2 218. *Criticality safety index (CSI)* assigned to a *package, overpack* or *freight container*
3 containing *fissile material* shall mean a number which is used to provide control over the
4 accumulation of *packages, overpacks* or *freight containers* containing *fissile material*.

5 *Defined deck area*

6 219. *Defined deck area* shall mean the area, of the weather deck of a vessel, or of a vehicle deck
7 of a roll-on/roll-off ship or a ferry, which is allocated for the stowage of radioactive material.

8 *Design*

9 220. *Design* shall mean the description of special form radioactive material, *low dispersible*
10 *radioactive material, package* or *packaging* which enables such an item to be fully identified.
11 The description may include specifications, engineering drawings, reports demonstrating
12 compliance with regulatory requirements, and other relevant documentation.

13 *Exclusive use*

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

17 *Fissile material*

18 222. Fissile nuclides shall mean uranium-233, uranium-235, plutonium-239 and plutonium-241.
19 *Fissile material* shall mean a material containing any of the fissile nuclides. Excluded from the
20 definition of *fissile material* are:

- 21 (a) natural uranium or depleted uranium which is unirradiated, and
22 (b) natural uranium or depleted uranium which has been irradiated in thermal reactors only.

23 *Freight container*

24 223. *Freight container* shall mean an article of transport equipment that is of permanent
25 character and accordingly strong enough to be suitable for repeated use, specially designed to
26 facilitate the transport of goods, by one or more modes of transport without intermediate
27 reloading; designed to be secured and/or readily handled, having fittings for these purposes, and
28 approved in accordance with the International Convention for Safe Containers (CSC), 1972, as
29 amended. The term "*freight container*" includes neither vehicle nor *packaging*. However a
30 *freight container* that is carried on a chassis is included. A *freight container* may be used as a
31 *packaging*.

32 A small *freight container* is that which has either any overall outer dimension less than 1.5 m, or
33 an internal volume of not more than 3 m³. Any other *freight container* is considered to be a large
34 *freight container*.

35 *Intermediate bulk container*

1 224. *Intermediate bulk container (IBC)* shall mean a portable *packaging* that:

2 (a) has a capacity of not more than 3 m³,

3 (b) is designed for mechanical handling, and

4 (c) is resistant to the stresses produced in handling and transport, as determined by tests.

5 *Low dispersible radioactive material*

6 225. *Low dispersible radioactive material* shall mean either a solid radioactive material or a solid
7 radioactive material in a sealed capsule, that has limited dispersibility and is not in powder form.

8 *Low specific activity material*

9 See para. 409.

10 *Low toxicity alpha emitters*

11 226. *Low toxicity alpha emitters* are: natural uranium; depleted uranium; natural thorium;
12 uranium-235 or uranium-238; thorium-232; thorium-228 and thorium-230 when contained in ores
13 or physical and chemical concentrates; or alpha emitters with a half-life of less than 10 days.

14 *Maximum normal operating pressure*

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

20 *Overpack*

21 228. *Overpack* shall mean an enclosure used by a single *consignor* to contain one or more
22 *packages* and to form one unit for convenience of handling and stowage during transport.
23 Examples of *overpacks* are a number of *packages* either:

24 (a) Placed or stacked on to a load board such as a pallet and secured by strapping, shrink
25 wrapping, stretch wrapping, or other suitable means; or

26

27 (b) Placed in a protective outer *packaging* such as a box or crate;

28

29 *Package*

30 229. *Package* shall mean the complete product of the packing operation, consisting of the
31 *packaging* and its contents prepared for transport. The types of *packages* covered by these
32 Regulations, which are subject to the activity limits and material restrictions of Section IV and
33 meet the corresponding requirements, are:

34 (a) *Excepted package*;

1 (b) *Industrial package Type 1 (Type IP-1);*

2 (c) *Industrial package Type 2 (Type IP-2);*

3 (d) *Industrial package Type 3 (Type IP-3);*

4 (e) *Type A package;*

5 (f) *Type B(U) package;*

6 (g) *Type B(M) package;*

7 (h) *Type C package.*

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

10 *Packaging*

11 230. *Packaging* shall mean one or more receptacles and any other components or materials
12 necessary for the receptacles to perform the containment and other safety functions.

13 *Quality assurance*

14 231. *Quality assurance* shall mean a systematic programme of controls and inspections applied
15 by any organization or body which is aimed at providing adequate confidence that the standard of
16 safety prescribed in these Regulations is achieved in practice.

17 *Radiation level*

18 232. *Radiation level* shall mean the corresponding dose rate expressed in millisieverts per hour.

19 *Radiation Protection Programme*

20 233. *Radiation Protection Programme* shall mean systematic arrangements which are aimed at
21 providing adequate consideration of radiation protection measures.

22 *Radioactive contents*

23 234. *Radioactive contents* shall mean the radioactive material together with any contaminated or
24 activated solids, liquids and gases within the *packaging*.

25 *Radioactive material*

26 See para. 401.

27 *Shipment*

28 235. *Shipment* shall mean the specific movement of a *consignment* from origin to destination.

29 *Special arrangement*

1 236. *Special arrangement* shall mean those provisions, approved by the *competent authority*,
2 under which *consignments* which do not satisfy all the applicable requirements of these
3 Regulations may be transported.

4 *Special form radioactive material*

5 237. *Special form radioactive material* shall mean either an indispersible solid radioactive
6 material or a sealed capsule containing radioactive material.

7 *Specific activity*

8 238. *Specific activity* of a radionuclide shall mean the activity per unit mass of that nuclide. The
9 specific activity of a material shall mean the activity per unit mass of the material in which the
10 radionuclides are essentially uniformly distributed.

11 *Surface contaminated object*

12 See para. 410.

13 *Tank*

14 239. *Tank* shall mean a portable tank, including a tank container, a road tank vehicle, a rail tank
15 wagon or a receptacle to contain solids, liquids, or gases, having a capacity of not less than 450
16 litres when used for the transport of gases.

17 *Through or into*

18 240. *Through or into* shall mean through or into the countries in which a *consignment* is
19 transported but specifically excludes countries “over” which a *consignment* is carried by air,
20 provided that there is no scheduled stop in that country.

21 *Transport index*

22 241. *Transport index* (TI) assigned to a *package*, *overpack* or *freight container*, or to unpackaged
23 LSA-I or SCO-I, shall mean a number which is used to provide control over radiation exposure.

24 *Unirradiated thorium*

25 242. *Unirradiated thorium* shall mean thorium containing not more than 10^{-7} g of uranium-233
26 per gram of thorium-232.

27 *Unirradiated uranium*

28 243. *Unirradiated uranium* shall mean uranium containing not more than 2×10^3 Bq of
29 plutonium per gram of uranium-235, not more than 9×10^6 Bq of fission products per gram of
30 uranium-235 and not more than 5×10^{-3} g of uranium-236 per gram of uranium-235.

31 *Uranium — natural, depleted, enriched*

32 244. *Natural uranium* shall mean uranium (which may be chemically separated) containing the
33 naturally occurring distribution of uranium isotopes (approximately 99.28% uranium-238 and

1 0.72% uranium-235 by mass). Depleted uranium shall mean uranium containing a lesser mass
2 percentage of uranium-235 than natural uranium. Enriched uranium shall mean uranium
3 containing a greater mass percentage of uranium-235 than 0.72%. In all cases, a very small mass
4 percentage of uranium-234 is present.

5 *Vehicle*

6 245. *Vehicle* shall mean a road vehicle (including an articulated vehicle, i.e. a tractor and semi-
7 trailer combination) railroad car or railway wagon. Each trailer shall be considered as a separate
8 vehicle.

9 *Vessel*

10 246. *Vessel* shall mean any seagoing vessel or inland waterway craft used for carrying cargo.

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1 **Section III**

2 **GENERAL PROVISIONS RADIATION PROTECTION**

3
4 **RADIATION PROTECTION**

5 301. Doses to persons shall be below the relevant dose limits. Protection and safety shall be
6 optimized in order that the magnitude of individual doses, the number of persons exposed, and
7 the likelihood of incurring exposure shall be kept as low as reasonably achievable, economic and
8 social factors being taken into account, within the restriction that the doses to individuals be
9 subject to dose constraints. A structured and systematic approach shall be adopted and shall
10 include consideration of the interfaces between transport and other activities.

11 302. A *Radiation Protection Programme* shall be established for the transport of radioactive
12 material. The nature and extent of the measures to be employed in the programme shall be related
13 to the magnitude and likelihood of radiation exposures. The programme shall incorporate the
14 requirements of paras 301, 303-305 and 311. Programme documents shall be available, on
15 request, for inspection by the relevant *competent authority*.

16 303. For occupational exposures arising from transport activities, where it is assessed that the
17 effective dose:

18 (a) is likely to be between 1 and 6 mSv in a year, a dose assessment programme via
19 workplace monitoring or individual monitoring shall be conducted;

20 (b) is likely to exceed 6 mSv in a year, individual monitoring shall be conducted.

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

23 **EMERGENCY RESPONSE**

24 304. In the event of accidents or incidents during the transport of radioactive material, emergency
25 provisions, as established by relevant national and/or international organizations, shall be
26 observed to protect persons, property and the environment. Appropriate guidelines for such
27 provisions are contained in Ref. [4].

28 305. Emergency procedures shall take into account the formation of other dangerous substances
29 that may result from the reaction between the contents of a *consignment* and the environment in
30 the event of an accident.

31 **QUALITY ASSURANCE**

32 306. Quality assurance programmes based on international, national or other standards acceptable
33 to the *competent authority* shall be established and implemented for the *design*, manufacture,
34 testing, documentation, use, maintenance and inspection of all special form radioactive material,
35 *low dispersible radioactive material* and *packages* and for transport and in-transit storage
36 operations to ensure compliance with the relevant provisions of these Regulations. Certification
37 that the *design* specification has been fully implemented shall be available to the *competent*

1 *authority*. The manufacturer, *consignor* or user shall be prepared to provide facilities for
2 *competent authority* inspection during manufacture and use and to demonstrate to any cognizant
3 *competent authority* that:

4 (a) the manufacturing methods and materials used are in accordance with the approved
5 *design* specifications; and

6 (b) all packagings are periodically inspected and, as necessary, repaired and maintained in
7 good condition so that they continue to comply with all relevant requirements and
8 specifications, even after repeated use.

9 Where *competent authority approval* is required, such *approval* shall take into account and be
10 contingent upon the adequacy of the *quality assurance programme*.

11 COMPLIANCE ASSURANCE

12 307. The *competent authority* is responsible for assuring compliance with these Regulations.
13 Means to discharge this responsibility include the establishment and execution of a programme
14 for monitoring the *design*, manufacture, testing, inspection and maintenance of *packaging*,
15 special form radioactive material and *low dispersible radioactive material*, and the preparation,
16 documentation, handling and stowage of *packages* by *consignors* and *carriers*, to provide
17 evidence that the provisions of these Regulations are being met in practice.

18 308. The relevant *competent authority* shall arrange for periodic assessments of the radiation
19 doses to persons due to the transport of radioactive material, to ensure that the system of
20 protection and safety complies with the Basic Safety Standards [2].

21 NON-COMPLIANCE

22 309. In the event of non-compliance with any limit in these Regulations applicable to radiation
23 level or *contamination*:

24 (a) the *consignor* shall be informed of the non-compliance by:

25 (i) the *carrier* if the non-compliance is identified during transport; or

26 (ii) the *consignee* if the non-compliance is identified at receipt;

27 (b) the *carrier, consignor* or *consignee*, as appropriate, shall:

28 (i) take immediate steps to mitigate the consequences of the noncompliance;

29 (ii) investigate the non-compliance and its causes, circumstances and consequences;

30 (iii) take appropriate action to remedy the causes and circumstances that led to the non-
31 compliance and to prevent a recurrence of circumstances similar to those that led to the
32 non-compliance; and

33 (iv) communicate to the relevant *competent authority(ies)* on the causes of the non-
34 compliance and on corrective or preventive actions taken or to be taken; and

1 (c) the communication of the non-compliance to the *consignor* and relevant *competent*
2 *authority(ies)*, respectively, shall be made as soon as practicable and it shall be
3 immediate whenever an emergency exposure situation has developed or is developing.

4 SPECIAL ARRANGEMENT

5 310. *Consignments* for which conformity with the other provisions of these Regulations is
6 impracticable shall not be transported except under special arrangement. Provided the *competent*
7 *authority* is satisfied that conformity with the other provisions of these Regulations is
8 impracticable and that the requisite standards of safety established by these Regulations have
9 been demonstrated through means alternative to the other provisions, the *competent authority*
10 may approve special arrangement transport operations for single or a planned series of multiple
11 *consignments*. The overall level of safety in transport shall be at least equivalent to that which
12 would be provided if all the applicable requirements had been met. For *consignments* of this type,
13 *multilateral approval* shall be required.

14 TRAINING

15 311. Workers shall receive appropriate training concerning radiation protection including the
16 precautions to be observed in order to restrict their occupational exposure and the exposure of
17 other persons who might be affected by their actions.

18 312. Persons engaged in the transport of radioactive material shall receive training in the contents
19 of these Regulations commensurate with their responsibilities.

20 313. Individuals such as those who classify radioactive material; pack radioactive material; mark
21 and label radioactive material; prepare transport documents for radioactive material; offer or
22 accept radioactive material for transport; carry or handle radioactive material in transport; mark
23 or placard or load or unload *packages* of radioactive material into or from transport vehicles,
24 bulk *packagings* or *freight containers*; or are otherwise directly involved in the transport of
25 radioactive material as determined by the *competent authority*; shall receive the following
26 training:

27 (a) General awareness/familiarization training:

28 (i) Each person shall receive training designed to provide familiarity with the general
29 provisions of these Regulations;

30 (ii) Such training shall include a description of the categories of radioactive material;
31 labelling, marking, placarding and *packaging* and segregation requirements; a description of the
32 purpose and content of the radioactive material transport document; and a description of
33 available emergency response documents;

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

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

1 (i) Methods and procedures for accident avoidance, such as proper use of *package*
2 handling equipment and appropriate methods of stowage of radioactive material;

3 (ii) Available emergency response information and how to use it;

4 (iii) General dangers presented by the various categories of radioactive material and how
5 to prevent exposure to those hazards, including if appropriate the use of personal protective
6 clothing and equipment; and

7 (iv) Immediate procedures to be followed in the event of an unintentional release of
8 radioactive material, including any emergency response procedures for which the person is
9 responsible and personal protection procedures to be followed.

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

12 315. The training required in para. 313 shall be provided or verified upon employment in a
13 position involving radioactive material transport and shall be periodically supplemented with
14 retraining as deemed appropriate by the *competent authority*.

DRAFT

1 **Section IV**

2 **ACTIVITY LIMITS AND MATERIAL RESTRICTIONS**

3
4 **RADIOACTIVE MATERIAL**

5
6 401. Radioactive material shall mean any material containing radionuclides where both the
7 activity concentration and the total activity in the *consignment* exceed the values specified in
8 paras. 403–408.

9
10 402. Radioactive material shall be assigned to one of the UN number specified in Table 8
11 below depending on the activity level of the radionuclides contained in a *package*, the fissile or
12 non-fissile properties of these radionuclides, the type of *package* to be presented for transport,
13 and the nature or form of the contents of the *package*, or special arrangements governing the
14 transport operation, in accordance with the provisions laid down in 409 to 431 below.

15
16 **TABLE 8. EXCERPTS FROM LIST OF UNITED NATIONS NUMBERS, PROPER SHIPPING**
17 **NAMES AND DESCRIPTIONS**

Assignment of UN numbers	Proper shipping name and description
<i>Excepted packages</i>	
UN 2908	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE - EMPTY PACKAGING
UN 2909	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE - ARTICLES MANUFACTURED FROM NATURAL URANIUM or DEPLETED URANIUM or NATURAL THORIUM
UN 2910	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE - LIMITED QUANTITY OF MATERIAL
UN 2911	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE - INSTRUMENTS or ARTICLES
Low specific activity radioactive material	
UN 2912	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-I), non-fissile or fissile-excepted
UN 3321	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), non fissile or fissile-excepted

UN 3322	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-III), non fissile or fissile-excepted
UN 3324	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), FISSILE
UN 3325	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY, (LSA-III), FISSILE
Surface contaminated objects	
UN 2913	RADIOACTIVE MATERIAL, SURFACE CONTAMINATED OBJECTS (SCO-I or SCO-II), non-fissile or fissile-excepted
UN 3326	RADIOACTIVE MATERIAL, SURFACE CONTAMINATED OBJECTS (SCO-I or SCO-II), FISSILE
Type A packages	
UN 2915	RADIOACTIVE MATERIAL, TYPE A PACKAGE, non-special form, non-fissile or fissile-excepted
UN 3327	RADIOACTIVE MATERIAL, TYPE A PACKAGE, FISSILE, non-special form
UN 3332	RADIOACTIVE MATERIAL, TYPE A PACKAGE, SPECIAL FORM, non fissile or fissile-excepted
UN 3333	RADIOACTIVE MATERIAL, TYPE A PACKAGE, SPECIAL FORM, FISSILE
Type B(U) package	
UN 2916	RADIOACTIVE MATERIAL, TYPE B(U) PACKAGE, non-fissile or fissile-excepted
UN 3328	RADIOACTIVE MATERIAL, TYPE B(U) PACKAGE, FISSILE
Type B(M) package	
UN 2917	RADIOACTIVE MATERIAL, TYPE B(M) PACKAGE, non-fissile or fissile-excepted
UN 3329	RADIOACTIVE MATERIAL, TYPE B(M) PACKAGE, FISSILE
Type C package	
UN 3323	RADIOACTIVE MATERIAL, TYPE C

	UN 3330	PACKAGE, non fissile or fissile-excepted RADIOACTIVE MATERIAL, TYPE C PACKAGE, FISSILE
Special arrangement		
	UN 2919	RADIOACTIVE MATERIAL, TRANSPORTED UNDER SPECIAL ARRANGEMENT, non-fissile or fissile- excepted
	UN 3331	RADIOACTIVE MATERIAL, TRANSPORTED UNDER SPECIAL ARRANGEMENT, FISSILE
Uranium hexafluoride		
	UN 2977	RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, FISSILE
	UN 2978	RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, non-fissile or fissile- excepted

1

2 BASIC RADIONUCLIDE VALUES

3

4 403. The following basic values for individual radionuclides are given in Table 1:

5

6 (a) A_1 and A_2 in TBq;

7 (b) activity concentration for exempt material in Bq/g; and

8 (c) activity limits for exempt *consignments* in Bq.

9

10

11 DETERMINATION OF BASIC RADIONUCLIDE VALUES

12

13 404. For individual radionuclides which are not listed in Table 1 the determination of the
14 basic radionuclide values referred to in para. 401 shall require *multilateral approval*. It is
15 permissible to use an A_2 value calculated using a dose coefficient for the appropriate lung
16 absorption type, as recommended by the International Commission on Radiological Protection, if
17 the chemical forms of each radionuclide under both normal and accident conditions of transport
18 are taken into consideration. Alternatively, the radionuclide values in Table 2 may be used
19 without obtaining *competent authority* approval.

20

21 405. In the calculations of A_1 and A_2 for a radionuclide not in Table 1, a single radioactive
22 decay chain in which the radionuclides are present in their naturally occurring proportions, and in

1 which no daughter nuclide has a half-life either longer than 10 days or longer than that of the
 2 parent nuclide, shall be considered as a single radionuclide; and the activity to be taken into
 3 account and the A_1 or A_2 value to be applied shall be those corresponding to the parent nuclide of
 4 that chain. In the case of radioactive decay chains in which any daughter nuclide has a half-life
 5 either longer than 10 days or greater than that of the parent nuclide, the parent and such daughter
 6 nuclides shall be considered as mixtures of different nuclides.

8 TABLE 1. BASIC RADIONUCLIDE VALUES

9	Radionuclide (atomic number)	A_1	A_2	Activity concentration for exempt material	Activity limit for an exempt consignment
10		(TBq)	(TBq)	(Bq/g)	(Bq)
14	Actinium (89)				
15	Ac-225 (a)	8×10^{-1}	6×10^{-3}	1×10^1	1×10^4
16	Ac-227 (a)	9×10^{-1}	9×10^{-5}	1×10^{-1}	1×10^3
17	Ac-228	6×10^{-1}	5×10^{-1}	1×10^1	1×10^6
18	Silver (47)				
19	Ag-105	2×10^0	2×10^0	1×10^2	1×10^6
20	Ag-108m (a)	7×10^{-1}	7×10^{-1}	1×10^1 (b)	1×10^6 (b)
21	Ag-110m (a)	4×10^{-1}	4×10^{-1}	1×10^1	1×10^6
22	Ag-111	2×10^0	6×10^{-1}	1×10^3	1×10^6
23	Aluminium (13)				
24	Al-26	1×10^{-1}	1×10^{-1}	1×10^1	1×10^5
25	Americium (95)				
26	Am-241	1×10^1	1×10^{-3}	1×10^0	1×10^4
27	Am-242m (a)	1×10^1	1×10^{-3}	1×10^0 (b)	1×10^4 (b)
28	Am-243 (a)	5×10^0	1×10^{-3}	1×10^0 (b)	1×10^3 (b)
29	Argon (18)				
30	Ar-37	4×10^1	4×10^1	1×10^6	1×10^8
31	Ar-39	4×10^1	2×10^1	1×10^7	1×10^4
32	Ar-41	3×10^{-1}	3×10^{-1}	1×10^2	1×10^9
33	Arsenic (33)				
34	As-72	3×10^{-1}	3×10^{-1}	1×10^1	1×10^5
35	As-73	4×10^1	4×10^1	1×10^3	1×10^7

1	As-74	1×10^0	9×10^{-1}	1×10^1	1×10^6
2	As-76	3×10^{-1}	3×10^{-1}	1×10^2	1×10^5
3	As-77	2×10^1	7×10^{-1}	1×10^3	1×10^6
4	Astatine (85)				
5	At-211 (a)	2×10^1	5×10^{-1}	1×10^3	1×10^7
6	Gold (79)				
7	Au-193	7×10^0	2×10^0	1×10^2	1×10^7
8	Au-194	1×10^0	1×10^0	1×10^1	1×10^6
9	Au-195	1×10^1	6×10^0	1×10^2	1×10^7
10	Au-198	1×10^0	6×10^{-1}	1×10^2	1×10^6
11	Au-199	1×10^1	6×10^{-1}	1×10^2	1×10^6
12	Barium (56)				
13	Ba-131 (a)	2×10^0	2×10^0	1×10^2	1×10^6
14	Ba-133	3×10^0	3×10^0	1×10^2	1×10^6
15	Ba-133m	2×10^1	6×10^{-1}	1×10^2	1×10^6
16	Ba-140 (a)	5×10^{-1}	3×10^{-1}	1×10^1 (b)	1×10^5 (b)
17	Beryllium (4)				
18	Be-7	2×10^1	2×10^1	1×10^3	1×10^7
19	Be-10	4×10^1	6×10^{-1}	1×10^4	1×10^6
20	Bismuth (83)				
21	Bi-205	7×10^{-1}	7×10^{-1}	1×10^1	1×10^6
22	Bi-206	3×10^{-1}	3×10^{-1}	1×10^1	1×10^5
23	Bi-207	7×10^{-1}	7×10^{-1}	1×10^1	1×10^6
24	Bi-210	1×10^0	6×10^{-1}	1×10^3	1×10^6
25	Bi-210m (a)	6×10^{-1}	2×10^{-2}	1×10^1	1×10^5
26	Bi-212 (a)	7×10^{-1}	6×10^{-1}	1×10^1 (b)	1×10^5 (b)
27	Berkelium (97)				
28	Bk-247	8×10^0	8×10^{-4}	1×10^0	1×10^4
29	Bk-249 (a)	4×10^1	3×10^{-1}	1×10^3	1×10^6
30	Bromine (35)				
31	Br-76	4×10^{-1}	4×10^{-1}	1×10^1	1×10^5
32	Br-77	3×10^0	3×10^0	1×10^2	1×10^6
33	Br-82	4×10^{-1}	4×10^{-1}	1×10^1	1×10^6
34	Carbon (6)				

1	C-11	1×10^0	6×10^{-1}	1×10^1	1×10^6
2	C-14	4×10^1	3×10^0	1×10^4	1×10^7
<hr/>					
3	Calcium (20)				
4	Ca-41	Unlimited	Unlimited	1×10^5	1×10^7
5	Ca-45	4×10^1	1×10^0	1×10^4	1×10^7
6	Ca-47 (a)	3×10^0	3×10^{-1}	1×10^1	1×10^6
7	Cadmium (48)				
8	Cd-109	3×10^1	2×10^0	1×10^4	1×10^6
9	Cd-113m	4×10^1	5×10^{-1}	1×10^3	1×10^6
10	Cd-115 (a)	3×10^0	4×10^{-1}	1×10^2	1×10^6
11	Cd-115m	5×10^{-1}	5×10^{-1}	1×10^3	1×10^6
12	Cerium (58)				
13	Ce-139	7×10^0	2×10^0	1×10^2	1×10^6
14	Ce-141	2×10^1	6×10^{-1}	1×10^2	1×10^7
15	Ce-143	9×10^{-1}	6×10^{-1}	1×10^2	1×10^6
16	Ce-144 (a)	2×10^{-1}	2×10^{-1}	1×10^2 (b)	1×10^5 (b)
17	Californium (98)				
18	Cf-248	4×10^1	6×10^{-3}	1×10^1	1×10^4
19	Cf-249	3×10^0	8×10^{-4}	1×10^0	1×10^3
20	Cf-250	2×10^1	2×10^{-3}	1×10^1	1×10^4
21	Cf-251	7×10^0	7×10^{-4}	1×10^0	1×10^3
22	Cf-252	1×10^{-1}	3×10^{-3}	1×10^1	1×10^4
23	Cf-253 (a)	4×10^1	4×10^{-2}	1×10^2	1×10^5
24	Cf-254	1×10^{-3}	1×10^{-3}	1×10^0	1×10^3
25	Chlorine (17)				
26	Cl-36	1×10^1	6×10^{-1}	1×10^4	1×10^6
27	Cl-38	2×10^{-1}	2×10^{-1}	1×10^1	1×10^5
28	Curium (96)				
29	Cm-240	4×10^1	2×10^{-2}	1×10^2	1×10^5
30	Cm-241	2×10^0	1×10^0	1×10^2	1×10^6
31	Cm-242	4×10^1	1×10^{-2}	1×10^2	1×10^5
<hr/>					
32	Cm-243	9×10^0	1×10^{-3}	1×10^0	1×10^4
33	Cm-244	2×10^1	2×10^{-3}	1×10^1	1×10^4

1	Cm-245	9×10^0	9×10^{-4}	1×10^0	1×10^3
2	Cm-246	9×10^0	9×10^{-4}	1×10^0	1×10^3
3	Cm-247 (a)	3×10^0	1×10^{-3}	1×10^0	1×10^4
4	Cm-248	2×10^{-2}	3×10^{-4}	1×10^0	1×10^3
5	Cobalt (27)				
6	Co-55	5×10^{-1}	5×10^{-1}	1×10^1	1×10^6
7	Co-56	3×10^{-1}	3×10^{-1}	1×10^1	1×10^5
8	Co-57	1×10^1	1×10^1	1×10^2	1×10^6
9	Co-58	1×10^0	1×10^0	1×10^1	1×10^6
10	Co-58m	4×10^1	4×10^1	1×10^4	1×10^7
11	Co-60	4×10^{-1}	4×10^{-1}	1×10^1	1×10^5
12	Chromium (24)				
13	Cr-51	3×10^1	3×10^1	1×10^3	1×10^7
14	Caesium (55)				
15	Cs-129	4×10^0	4×10^0	1×10^2	1×10^5
16	Cs-131	3×10^1	3×10^1	1×10^3	1×10^6
17	Cs-132	1×10^0	1×10^0	1×10^1	1×10^5
18	Cs-134	7×10^{-1}	7×10^{-1}	1×10^1	1×10^4
19	Cs-134m	4×10^1	6×10^{-1}	1×10^3	1×10^5
20	Cs-135	4×10^1	1×10^0	1×10^4	1×10^7
21	Cs-136	5×10^{-1}	5×10^{-1}	1×10^1	1×10^5
22	Cs-137 (a)	2×10^0	6×10^{-1}	1×10^1 (b)	1×10^4 (b)
23	Copper (29)				
24	Cu-64	6×10^0	1×10^0	1×10^2	1×10^6
25	Cu-67	1×10^1	7×10^{-1}	1×10^2	1×10^6
26	Dysprosium (66)				
27	Dy-159	2×10^1	2×10^1	1×10^3	1×10^7
<hr/>					
28	Dy-165	9×10^{-1}	6×10^{-1}	1×10^3	1×10^6
29	Dy-166 (a)	9×10^{-1}	3×10^{-1}	1×10^3	1×10^6
30	Erbium (68)				
31	Er-169	4×10^1	1×10^0	1×10^4	1×10^7
32	Er-171	8×10^{-1}	5×10^{-1}	1×10^2	1×10^6
33	Europium (63)				
34	Eu-147	2×10^0	2×10^0	1×10^2	1×10^6

1	Eu-148	5×10^{-1}	5×10^{-1}	1×10^1	1×10^6
2	Eu-149	2×10^1	2×10^1	1×10^2	1×10^7
3	Eu-150 (short lived)	2×10^0	7×10^{-1}	1×10^3	1×10^6
4	Eu-150 (long lived)	7×10^{-1}	7×10^{-1}	1×10^1	1×10^6
5	Eu-152	1×10^0	1×10^0	1×10^1	1×10^6
6	Eu-152m	8×10^{-1}	8×10^{-1}	1×10^2	1×10^6
7	Eu-154	9×10^{-1}	6×10^{-1}	1×10^1	1×10^6
8	Eu-155	2×10^1	3×10^0	1×10^2	1×10^7
9	Eu-156	7×10^{-1}	7×10^{-1}	1×10^1	1×10^6
10	Fluorine (9)				
11	F-18	1×10^0	6×10^{-1}	1×10^1	1×10^6
12	Iron (26)				
13	Fe-52 (a)	3×10^{-1}	3×10^{-1}	1×10^1	1×10^6
14	Fe-55	4×10^1	4×10^1	1×10^4	1×10^6
15	Fe-59	9×10^{-1}	9×10^{-1}	1×10^1	1×10^6
16	Fe-60 (a)	4×10^{-1}	2×10^{-1}	1×10^2	1×10^5
17	Gallium (31)				
18	Ga-67	7×10^0	3×10^0	1×10^2	1×10^6
19	Ga-68	5×10^{-1}	5×10^{-1}	1×10^1	1×10^5
20	Ga-72	4×10^{-1}	4×10^{-1}	1×10^1	1×10^5
21	Gadolinium (64)				
22	Gd-146 (a)	5×10^{-1}	5×10^{-1}	1×10^1	1×10^6
23	Gd-148	2×10^1	2×10^{-3}	1×10^1	1×10^4
24	Gd-153	1×10^1	9×10^0	1×10^2	1×10^7
25	Gd-159	3×10^0	6×10^{-1}	1×10^3	1×10^6
26	Germanium (32)				
27	Ge-68 (a)	5×10^{-1}	5×10^{-1}	1×10^1	1×10^5
28	Ge-71	4×10^1	4×10^1	1×10^4	1×10^8
29	Ge-77	3×10^{-1}	3×10^{-1}	1×10^1	1×10^5
30	Hafnium (72)				
31	Hf-172 (a)	6×10^{-1}	6×10^{-1}	1×10^1	1×10^6
32	Hf-175	3×10^0	3×10^0	1×10^2	1×10^6
33	Hf-181	2×10^0	5×10^{-1}	1×10^1	1×10^6
34	Hf-182	Unlimited	Unlimited	1×10^2	1×10^6

1	Mercury (80)				
2	Hg-194 (a)	1×10^0	1×10^0	1×10^1	1×10^6
3	Hg-195m (a)	3×10^0	7×10^{-1}	1×10^2	1×10^6
4	Hg-197	2×10^1	1×10^1	1×10^2	1×10^7
5	Hg-197m	1×10^1	4×10^{-1}	1×10^2	1×10^6
6	Hg-203	5×10^0	1×10^0	1×10^2	1×10^5
7	Holmium (67)				
8	Ho-166	4×10^{-1}	4×10^{-1}	1×10^3	1×10^5
9	Ho-166m	6×10^{-1}	5×10^{-1}	1×10^1	1×10^6
10	Iodine (53)				
11	I-123	6×10^0	3×10^0	1×10^2	1×10^7
12	I-124	1×10^0	1×10^0	1×10^1	1×10^6
13	I-125	2×10^1	3×10^0	1×10^3	1×10^6
14	I-126	2×10^0	1×10^0	1×10^2	1×10^6
15	I-129	Unlimited	Unlimited	1×10^2	1×10^5
16	I-131	3×10^0	7×10^{-1}	1×10^2	1×10^6
17	I-132	4×10^{-1}	4×10^{-1}	1×10^1	1×10^5
18	I-133	7×10^{-1}	6×10^{-1}	1×10^1	1×10^6
19	I-134	3×10^{-1}	3×10^{-1}	1×10^1	1×10^5
20	I-135 (a)	6×10^{-1}	6×10^{-1}	1×10^1	1×10^6
21	Indium (49)				
22	In-111	3×10^0	3×10^0	1×10^2	1×10^6
23	In-113m	4×10^0	2×10^0	1×10^2	1×10^6
24	In-114m (a)	1×10^1	5×10^{-1}	1×10^2	1×10^6
25	In-115m	7×10^0	1×10^0	1×10^2	1×10^6
26	Iridium (77)				
27	Ir-189 (a)	1×10^1	1×10^1	1×10^2	1×10^7
28	Ir-190	7×10^{-1}	7×10^{-1}	1×10^1	1×10^6
29	Ir-192	1×10^0 (c)	6×10^{-1}	1×10^1	1×10^4
30	Ir-194	3×10^{-1}	3×10^{-1}	1×10^2	1×10^5
31	Potassium (19)				
32	K-40	9×10^{-1}	9×10^{-1}	1×10^2	1×10^6
33	K-42	2×10^{-1}	2×10^{-1}	1×10^2	1×10^6
34	K-43	7×10^{-1}	6×10^{-1}	1×10^1	1×10^6

1	Krypton (36)				
2	Kr-79	4×10^0	2×10^0	1×10^3	1×10^5
3	Kr-81	4×10^1	4×10^1	1×10^4	1×10^7
4	Kr-85	1×10^1	1×10^1	1×10^5	1×10^4
5	Kr-85m	8×10^0	3×10^0	1×10^3	1×10^{10}
6	Kr-87	2×10^{-1}	2×10^{-1}	1×10^2	1×10^9
7	Lanthanum (57)				
8	La-137	3×10^1	6×10^0	1×10^3	1×10^7
9	La-140	4×10^{-1}	4×10^{-1}	1×10^1	1×10^5
10	Lutetium (71)				
11	Lu-172	6×10^{-1}	6×10^{-1}	1×10^1	1×10^6
12	Lu-173	8×10^0	8×10^0	1×10^2	1×10^7
13	Lu-174	9×10^0	9×10^0	1×10^2	1×10^7
14	Lu-174m	2×10^1	1×10^1	1×10^2	1×10^7
15	Lu-177	3×10^1	7×10^{-1}	1×10^3	1×10^7
16	Magnesium (12)				
17	Mg-28 (a)	3×10^{-1}	3×10^{-1}	1×10^1	1×10^5
18	Manganese (25)				
19	Mn-52	3×10^{-1}	3×10^{-1}	1×10^1	1×10^5
20	Mn-53	Unlimited	Unlimited	1×10^4	1×10^9
21	Mn-54	1×10^0	1×10^0	1×10^1	1×10^6
22	Mn-56	3×10^{-1}	3×10^{-1}	1×10^1	1×10^5
23	Molybdenum (42)				
24	Mo-93	4×10^1	2×10^1	1×10^3	1×10^8
25	Mo-99 (a)	1×10^0	6×10^{-1}	1×10^2	1×10^6
26	Nitrogen (7)				
27	N-13	9×10^{-1}	6×10^{-1}	1×10^2	1×10^9
28	Sodium (11)				
29	Na-22	5×10^{-1}	5×10^{-1}	1×10^1	1×10^6
30	Na-24	2×10^{-1}	2×10^{-1}	1×10^1	1×10^5
31	Niobium (41)				
32	Nb-93m	4×10^1	3×10^1	1×10^4	1×10^7
33	Nb-94	7×10^{-1}	7×10^{-1}	1×10^1	1×10^6
34	Nb-95	1×10^0	1×10^0	1×10^1	1×10^6

1	Nb-97	9×10^{-1}	6×10^{-1}	1×10^1	1×10^6
2	Neodymium (60)				
3	Nd-147	6×10^0	6×10^{-1}	1×10^2	1×10^6
4	Nd-149	6×10^{-1}	5×10^{-1}	1×10^2	1×10^6
5	Nickel (28)				
6	Ni-59	Unlimited	Unlimited	1×10^4	1×10^8
7	Ni-63	4×10^1	3×10^1	1×10^5	1×10^8
8	Ni-65	4×10^{-1}	4×10^{-1}	1×10^1	1×10^6
9	Neptunium (93)				
10	Np-235	4×10^1	4×10^1	1×10^3	1×10^7
11	Np-236 (short lived)	2×10^1	2×10^0	1×10^3	1×10^7
12	Np-236 (long lived)	9×10^0	2×10^{-2}	1×10^2	1×10^5
13	Np-237	2×10^1	2×10^{-3}	1×10^0 (b)	1×10^3 (b)
14	Np-239	7×10^0	4×10^{-1}	1×10^2	1×10^7
15	Osmium (76)				
16	Os-185	1×10^0	1×10^0	1×10^1	1×10^6
17	Os-191	1×10^1	2×10^0	1×10^2	1×10^7
18	Os-191m	4×10^1	3×10^1	1×10^3	1×10^7
19	Os-193	2×10^0	6×10^{-1}	1×10^2	1×10^6
20	Os-194 (a)	3×10^{-1}	3×10^{-1}	1×10^2	1×10^5
21	Phosphorus (15)				
22	P-32	5×10^{-1}	5×10^{-1}	1×10^3	1×10^5
23	P-33	4×10^1	1×10^0	1×10^5	1×10^8
24	Protactinium (91)				
25	Pa-230 (a)	2×10^0	7×10^{-2}	1×10^1	1×10^6
26	Pa-231	4×10^0	4×10^{-4}	1×10^0	1×10^3
27	Pa-233	5×10^0	7×10^{-1}	1×10^2	1×10^7
28	Lead (82)				
29	Pb-201	1×10^0	1×10^0	1×10^1	1×10^6
30	Pb-202	4×10^1	2×10^1	1×10^3	1×10^6
31	Pb-203	4×10^0	3×10^0	1×10^2	1×10^6
32	Pb-205	Unlimited	Unlimited	1×10^4	1×10^7
33	Pb-210 (a)	1×10^0	5×10^{-2}	1×10^1 (b)	1×10^4 (b)
34	Pb-212 (a)	7×10^{-1}	2×10^{-1}	1×10^1 (b)	1×10^5 (b)

1	Palladium (46)				
2	Pd-103 (a)	4×10^1	4×10^1	1×10^3	1×10^8
3	Pd-107	Unlimited	Unlimited	1×10^5	1×10^8
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4	Pd-109	2×10^0	5×10^{-1}	1×10^3	1×10^6
5	Promethium (61)				
6	Pm-143	3×10^0	3×10^0	1×10^2	1×10^6
7	Pm-144	7×10^{-1}	7×10^{-1}	1×10^1	1×10^6
8	Pm-145	3×10^1	1×10^1	1×10^3	1×10^7
9	Pm-147	4×10^1	2×10^0	1×10^4	1×10^7
10	Pm-148m (a)	8×10^{-1}	7×10^{-1}	1×10^1	1×10^6
11	Pm-149	2×10^0	6×10^{-1}	1×10^3	1×10^6
12	Pm-151	2×10^0	6×10^{-1}	1×10^2	1×10^6
13	Polonium (84)				
14	Po-210	4×10^1	2×10^{-2}	1×10^1	1×10^4
15	Praseodymium (59)				
16	Pr-142	4×10^{-1}	4×10^{-1}	1×10^2	1×10^5
17	Pr-143	3×10^0	6×10^{-1}	1×10^4	1×10^6
18	Platinum (78)				
19	Pt-188 (a)	1×10^0	8×10^{-1}	1×10^1	1×10^6
20	Pt-191	4×10^0	3×10^0	1×10^2	1×10^6
21	Pt-193	4×10^1	4×10^1	1×10^4	1×10^7
22	Pt-193m	4×10^1	5×10^{-1}	1×10^3	1×10^7
23	Pt-195m	1×10^1	5×10^{-1}	1×10^2	1×10^6
24	Pt-197	2×10^1	6×10^{-1}	1×10^3	1×10^6
25	Pt-197m	1×10^1	6×10^{-1}	1×10^2	1×10^6
26	Plutonium (94)				
27	Pu-236	3×10^1	3×10^{-3}	1×10^1	1×10^4
28	Pu-237	2×10^1	2×10^1	1×10^3	1×10^7
29	Pu-238	1×10^1	1×10^{-3}	1×10^0	1×10^4
30	Pu-239	1×10^1	1×10^{-3}	1×10^0	1×10^4
31	Pu-240	1×10^1	1×10^{-3}	1×10^0	1×10^3
32	Pu-241 (a)	4×10^1	6×10^{-2}	1×10^2	1×10^5
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33	Pu-242	1×10^1	1×10^{-3}	1×10^0	1×10^4

1	Pu-244 (a)	4×10^{-1}	1×10^{-3}	1×10^0	1×10^4
2	Radium (88)				
3	Ra-223 (a)	4×10^{-1}	7×10^{-3}	1×10^2 (b)	1×10^5 (b)
4	Ra-224 (a)	4×10^{-1}	2×10^{-2}	1×10^1 (b)	1×10^5 (b)
5	Ra-225 (a)	2×10^{-1}	4×10^{-3}	1×10^2	1×10^5
6	Ra-226 (a)	2×10^{-1}	3×10^{-3}	1×10^1 (b)	1×10^4 (b)
7	Ra-228 (a)	6×10^{-1}	2×10^{-2}	1×10^1 (b)	1×10^5 (b)
8	Rubidium (37)				
9	Rb-81	2×10^0	8×10^{-1}	1×10^1	1×10^6
10	Rb-83 (a)	2×10^0	2×10^0	1×10^2	1×10^6
11	Rb-84	1×10^0	1×10^0	1×10^1	1×10^6
12	Rb-86	5×10^{-1}	5×10^{-1}	1×10^2	1×10^5
13	Rb-87	Unlimited	Unlimited	1×10^4	1×10^7
14	Rb (nat)	Unlimited	Unlimited	1×10^4	1×10^7
15	Rhenium (75)				
16	Re-184	1×10^0	1×10^0	1×10^1	1×10^6
17	Re-184m	3×10^0	1×10^0	1×10^2	1×10^6
18	Re-186	2×10^0	6×10^{-1}	1×10^3	1×10^6
19	Re-187	Unlimited	Unlimited	1×10^6	1×10^9
20	Re-188	4×10^{-1}	4×10^{-1}	1×10^2	1×10^5
21	Re-189 (a)	3×10^0	6×10^{-1}	1×10^2	1×10^6
22	Re (nat)	Unlimited	Unlimited	1×10^6	1×10^9
23	Rhodium (45)				
24	Rh-99	2×10^0	2×10^0	1×10^1	1×10^6
25	Rh-101	4×10^0	3×10^0	1×10^2	1×10^7
26	Rh-102	5×10^{-1}	5×10^{-1}	1×10^1	1×10^6
27	Rh-102m	2×10^0	2×10^0	1×10^2	1×10^6
28	Rh-103m	4×10^1	4×10^1	1×10^4	1×10^8
29	Rh-105	1×10^1	8×10^{-1}	1×10^2	1×10^7
30	Radon (86)				
31	Rn-222 (a)	3×10^{-1}	4×10^{-3}	1×10^1 (b)	1×10^8 (b)
32	Ruthenium (44)				
33	Ru-97	5×10^0	5×10^0	1×10^2	1×10^7
34	Ru-103 (a)	2×10^0	2×10^0	1×10^2	1×10^6

1	Ru-105	1×10^0	6×10^{-1}	1×10^1	1×10^6
2	Ru-106 (a)	2×10^{-1}	2×10^{-1}	1×10^2 (b)	1×10^5 (b)
3	Sulphur (16)				
4	S-35	4×10^1	3×10^0	1×10^5	1×10^8
5	Antimony (51)				
6	Sb-122	4×10^{-1}	4×10^{-1}	1×10^2	1×10^4
7	Sb-124	6×10^{-1}	6×10^{-1}	1×10^1	1×10^6
8	Sb-125	2×10^0	1×10^0	1×10^2	1×10^6
9	Sb-126	4×10^{-1}	4×10^{-1}	1×10^1	1×10^5
10	Scandium (21)				
11	Sc-44	5×10^{-1}	5×10^{-1}	1×10^1	1×10^5
12	Sc-46	5×10^{-1}	5×10^{-1}	1×10^1	1×10^6
13	Sc-47	1×10^1	7×10^{-1}	1×10^2	1×10^6
14	Sc-48	3×10^{-1}	3×10^{-1}	1×10^1	1×10^5
15	Selenium (34)				
16	Se-75	3×10^0	3×10^0	1×10^2	1×10^6
17	Se-79	4×10^1	2×10^0	1×10^4	1×10^7
18	Silicon (14)				
19	Si-31	6×10^{-1}	6×10^{-1}	1×10^3	1×10^6
20	Si-32	4×10^1	5×10^{-1}	1×10^3	1×10^6
21	Samarium (62)				
22	Sm-145	1×10^1	1×10^1	1×10^2	1×10^7
23	Sm-147	Unlimited	Unlimited	1×10^1	1×10^4
24	Sm-151	4×10^1	1×10^1	1×10^4	1×10^8
25	Sm-153	9×10^0	6×10^{-1}	1×10^2	1×10^6
26	Tin (50)				
27	Sn-113 (a)	4×10^0	2×10^0	1×10^3	1×10^7
28	Sn-117m	7×10^0	4×10^{-1}	1×10^2	1×10^6
29	Sn-119m	4×10^1	3×10^1	1×10^3	1×10^7
30	Sn-121m (a)	4×10^1	9×10^{-1}	1×10^3	1×10^7
31	Sn-123	8×10^{-1}	6×10^{-1}	1×10^3	1×10^6
32	Sn-125	4×10^{-1}	4×10^{-1}	1×10^2	1×10^5
33	Sn-126 (a)	6×10^{-1}	4×10^{-1}	1×10^1	1×10^5
34	Strontium (38)				

1	Sr-82 (a)	2×10^{-1}	2×10^{-1}	1×10^1	1×10^5
2	Sr-85	2×10^0	2×10^0	1×10^2	1×10^6
3	Sr-85m	5×10^0	5×10^0	1×10^2	1×10^7
4	Sr-87m	3×10^0	3×10^0	1×10^2	1×10^6
5	Sr-89	6×10^{-1}	6×10^{-1}	1×10^3	1×10^6
6	Sr-90 (a)	3×10^{-1}	3×10^{-1}	1×10^2 (b)	1×10^4 (b)
7	Sr-91 (a)	3×10^{-1}	3×10^{-1}	1×10^1	1×10^5
8	Sr-92 (a)	1×10^0	3×10^{-1}	1×10^1	1×10^6
9	Tritium (1)				
10	T(H-3)	4×10^1	4×10^1	1×10^6	1×10^9
11	Tantalum (73)				
12	Ta-178 (long lived)	1×10^0	8×10^{-1}	1×10^1	1×10^6
13	Ta-179	3×10^1	3×10^1	1×10^3	1×10^7
14	Ta-182	9×10^{-1}	5×10^{-1}	1×10^1	1×10^4
15	Terbium (65)				
16	Tb-157	4×10^1	4×10^1	1×10^4	1×10^7
17	Tb-158	1×10^0	1×10^0	1×10^1	1×10^6
18	Tb-160	1×10^0	6×10^{-1}	1×10^1	1×10^6
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19	Technetium (43)				
20	Tc-95m (a)	2×10^0	2×10^0	1×10^1	1×10^6
21	Tc-96	4×10^{-1}	4×10^{-1}	1×10^1	1×10^6
22	Tc-96m (a)	4×10^{-1}	4×10^{-1}	1×10^3	1×10^7
23	Tc-97	Unlimited	Unlimited	1×10^3	1×10^8
24	Tc-97m	4×10^1	1×10^0	1×10^3	1×10^7
25	Tc-98	8×10^{-1}	7×10^{-1}	1×10^1	1×10^6
26	Tc-99	4×10^1	9×10^{-1}	1×10^4	1×10^7
27	Tc-99m	1×10^1	4×10^0	1×10^2	1×10^7
28	Tellurium (52)				
29	Te-121	2×10^0	2×10^0	1×10^1	1×10^6
30	Te-121m	5×10^0	3×10^0	1×10^2	1×10^6
31	Te-123m	8×10^0	1×10^0	1×10^2	1×10^7
32	Te-125m	2×10^1	9×10^{-1}	1×10^3	1×10^7
33	Te-127	2×10^1	7×10^{-1}	1×10^3	1×10^6
34	Te-127m (a)	2×10^1	5×10^{-1}	1×10^3	1×10^7

1	Te-129	7×10^{-1}	6×10^{-1}	1×10^2	1×10^6
2	Te-129m (a)	8×10^{-1}	4×10^{-1}	1×10^3	1×10^6
3	Te-131m (a)	7×10^{-1}	5×10^{-1}	1×10^1	1×10^6
4	Te-132 (a)	5×10^{-1}	4×10^{-1}	1×10^2	1×10^7
5	Thorium (90)				
6	Th-227	1×10^1	5×10^{-3}	1×10^1	1×10^4
7	Th-228 (a)	5×10^{-1}	1×10^{-3}	1×10^0 (b)	1×10^4 (b)
8	Th-229	5×10^0	5×10^{-4}	1×10^0 (b)	1×10^3 (b)
9	Th-230	1×10^1	1×10^{-3}	1×10^0	1×10^4
10	Th-231	4×10^1	2×10^{-2}	1×10^3	1×10^7
11	Th-232	Unlimited	Unlimited	1×10^1	1×10^4
12	Th-234 (a)	3×10^{-1}	3×10^{-1}	1×10^3 (b)	1×10^5 (b)
13	Th (nat)	Unlimited	Unlimited	1×10^0 (b)	1×10^3 (b)
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14	Titanium (22)				
15	Ti-44 (a)	5×10^{-1}	4×10^{-1}	1×10^1	1×10^5
16	Thallium (81)				
17	Tl-200	9×10^{-1}	9×10^{-1}	1×10^1	1×10^6
18	Tl-201	1×10^1	4×10^0	1×10^2	1×10^6
19	Tl-202	2×10^0	2×10^0	1×10^2	1×10^6
20	Tl-204	1×10^1	7×10^{-1}	1×10^4	1×10^4
21	Thulium (69)				
22	Tm-167	7×10^0	8×10^{-1}	1×10^2	1×10^6
23	Tm-170	3×10^0	6×10^{-1}	1×10^3	1×10^6
24	Tm-171	4×10^1	4×10^1	1×10^4	1×10^8
25	Uranium (92)				
26	U-230 (fast lung absorption)	4×10^1	1×10^{-1}	1×10^1 (b)	1×10^5 (b)
27	(a)(d)				
28	U-230 (medium lung	4×10^1	4×10^{-3}	1×10^1	1×10^4
29	absorption)(a)(e)				
30	U-230 (slow lung absorption)	3×10^1	3×10^{-3}	1×10^1	1×10^4
31	(a)(f)				
32	U-232 (fast lung absorption)(d)	4×10^1	1×10^{-2}	1×10^0 (b)	1×10^3 (b)
33	U-232 (medium lung	4×10^1	7×10^{-3}	1×10^1	1×10^4
34	absorption)(e)				

1	U-232 (slow lung absorption)(f)	1×10^1	1×10^{-3}	1×10^1	1×10^4
2	U-233 (fast lung absorption)(d)	4×10^1	9×10^{-2}	1×10^1	1×10^4
3	U-233 (medium lung	4×10^1	2×10^{-2}	1×10^2	1×10^5
4	absorption)(e)				
5	U-233 (slow lung absorption)(f)	4×10^1	6×10^{-3}	1×10^1	1×10^5
6	U-234 (fast lung absorption)(d)	4×10^1	9×10^{-2}	1×10^1	1×10^4
7	U-234 (medium lung	4×10^1	2×10^{-2}	1×10^2	1×10^5
8	absorption)(e)				
9	U-234 (slow lung	4×10^1	6×10^{-3}	1×10^1	1×10^5
10	absorption)(f)				
11	U-235 (all lung absorption	Unlimited	Unlimited	1×10^1 (b)	1×10^4 (b)
12	types)(a),(d),(e),(f)				
13	U-236 (fast lung absorption)(d)	Unlimited	Unlimited	1×10^1	1×10^4
14	U-236 (medium lung	4×10^1	2×10^{-2}	1×10^2	1×10^5
15	absorption)(e)				
16	U-236 (slow lung	4×10^1	6×10^{-3}	1×10^1	1×10^4
17	absorption)(f)				
18	U-238 (all lung absorption	Unlimited	Unlimited	1×10^1 (b)	1×10^4 (b)
19	types)(d),(e),(f)				
20	U (nat)	Unlimited	Unlimited	1×10^0 (b)	1×10^3 (b)
21	U (enriched to 20% or	Unlimited	Unlimited	1×10^0	1×10^3
22	less)(g)				
23	U (dep)	Unlimited	Unlimited	1×10^0	1×10^3
24	Vanadium (23)				
25	V-48	4×10^{-1}	4×10^{-1}	1×10^1	1×10^5
26	V-49	4×10^1	4×10^1	1×10^4	1×10^7
27	Tungsten (74)				
28	W-178 (a)	9×10^0	5×10^0	1×10^1	1×10^6
29	W-181	3×10^1	3×10^1	1×10^3	1×10^7
30	W-185	4×10^1	8×10^{-1}	1×10^4	1×10^7
31	W-187	2×10^0	6×10^{-1}	1×10^2	1×10^6
32	W-188 (a)	4×10^{-1}	3×10^{-1}	1×10^2	1×10^5
33	Xenon (54)				
34	Xe-122 (a)	4×10^{-1}	4×10^{-1}	1×10^2	1×10^9

1	Xe-123	2×10^0	7×10^{-1}	1×10^2	1×10^9
2	Xe-127	4×10^0	2×10^0	1×10^3	1×10^5
3	Xe-131m	4×10^1	4×10^1	1×10^4	1×10^4
<hr/>					
4	Xe-133	2×10^1	1×10^1	1×10^3	1×10^4
5	Xe-135	3×10^0	2×10^0	1×10^3	1×10^{10}
6	Yttrium (39)				
7	Y-87 (a)	1×10^0	1×10^0	1×10^1	1×10^6
8	Y-88	4×10^{-1}	4×10^{-1}	1×10^1	1×10^6
9	Y-90	3×10^{-1}	3×10^{-1}	1×10^3	1×10^5
10	Y-91	6×10^{-1}	6×10^{-1}	1×10^3	1×10^6
11	Y-91m	2×10^0	2×10^0	1×10^2	1×10^6
12	Y-92	2×10^{-1}	2×10^{-1}	1×10^2	1×10^5
13	Y-93	3×10^{-1}	3×10^{-1}	1×10^2	1×10^5
14	Ytterbium (70)				
15	Yb-169	4×10^0	1×10^0	1×10^2	1×10^7
16	Yb-175	3×10^1	9×10^{-1}	1×10^3	1×10^7
17	Zinc (30)				
18	Zn-65	2×10^0	2×10^0	1×10^1	1×10^6
19	Zn-69	3×10^0	6×10^{-1}	1×10^4	1×10^6
20	Zn-69m (a)	3×10^0	6×10^{-1}	1×10^2	1×10^6
21	Zirconium (40)				
22	Zr-88	3×10^0	3×10^0	1×10^2	1×10^6
23	Zr-93	Unlimited	Unlimited	1×10^3 (b)	1×10^7 (b)
24	Zr-95 (a)	2×10^0	8×10^{-1}	1×10^1	1×10^6
25	Zr-97 (a)	4×10^{-1}	4×10^{-1}	1×10^1 (b)	1×10^5 (b)

26

27

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

30	Mg-28	Al-28
31	Ar-42	K-42
32	Ca-47	Sc-47
33	Ti-44	Sc-44
34	Fe-52	Mn-52m

1	Fe-60	Co-60m
2	Zn-69m	Zn-69
3	Ge-68	Ga-68
4	Rb-83	Kr-83m
5	Sr-82	Rb-82
6	Sr-90	Y-90
7	Sr-91	Y-91m
8	Sr-92	Y-92
9	Y-87	Sr-87m
10	Zr-95	Nb-95m
11	Zr-97	Nb-97m, Nb-97
12	Mo-99	Tc-99m
13	Tc-95m	Tc-95
14	Tc-96m	Tc-96
15	Ru-103	Rh-103m
16	Ru-106	Rh-106
17	Pd-103	Rh-103m
18	Ag-108m	Ag-108
19	Ag-110m	Ag-110
20	Cd-115	In-115m
21	In-114m	In-114
22	Sn-113	In-113m
23	Sn-121m	Sn-121
24	Sn-126	Sb-126m
25	Te-118	Sb-118
26	Te-127m	Te-127
27	Te-129m	Te-129
28	Te-131m	Te-131
29	Te-132	I-132
30	I-135	Xe-135m
31	Xe-122	I-122
32	Cs-137	Ba-137m
33	Ba-131	Cs-131
34	Ba-140	La-140

1	Ce-144	Pr-144m, Pr-144
2	Pm-148m	Pm-148
3	Gd-146	Eu-146
4	Dy-166	Ho-166
5	Hf-172	Lu-172
6	W-178	Ta-178
7	W-188	Re-188
8	Re-189	Os-189m
9	Os-194	Ir-194
10	Ir-189	Os-189m
11	Pt-188	Ir-188
12	Hg-194	Au-194
13	Hg-195m	Hg-195
14	Pb-210	Bi-210
15	Pb-212	Bi-212, Tl-208, Po-212
16	Bi-210m	Tl-206
17	Bi-212	Tl-208, Po-212
18	At-211	Po-211
19	Rn-222	Po-218, Pb-214, At-218, Bi-214, Po-214
20	Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Po-211, Tl-207
21	Ra-224	Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
22	Ra-225	Ac-225, Fr-221, At-217, Bi-213, Tl-209, Po-213, Pb-209
23	Ra-226	Rn-222, Po-218, Pb-214, At-218, Bi-214, Po-214
24	Ra-228	Ac-228
25	Ac-225	Fr-221, At-217, Bi-213, Tl-209, Po-213, Pb-209
26	Ac-227	Fr-223
27	Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
28	Th-234	Pa-234m, Pa-234
29	Pa-230	Ac-226, Th-226, Fr-222, Ra-222, Rn-218, Po-214
30	U-230	Th-226, Ra-222, Rn-218, Po-214
31	U-235	Th-231
32	Pu-241	U-237
33	Pu-244	U-240, Np-240m
34	Am-242m	Am-242, Np-238

1	Am-243	Np-239
2	Cm-247	Pu-243
3	Bk-249	Am-245
4	Cf-253	Cm-249
5	(b) Parent nuclides and their progeny included in secular equilibrium are listed in the	
6	following:	
7	Sr-90	Y-90
8	Zr-93	Nb-93m
9	Zr-97	Nb-97
10	Ru-106	Rh-106
11	Ag-108m	Ag-108
12	Cs-137	Ba-137m
13	Ce-144	Pr-144
14	Ba-140	La-140
15	Bi-212	Tl-208 (0.36), Po-212 (0.64)
16	Pb-210	Bi-210, Po-210
17	Pb-212	Bi-212, Tl-208 (0.36), Po-212 (0.64)
18	Rn-222	Po-218, Pb-214, Bi-214, Po-214
19	Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Tl-207
20	Ra-224	Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
21	Ra-226	Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210
22	Ra-228	Ac-228
23	Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
24	Th-229	Ra-225, Ac-225, Fr-221, At-217, Bi-213, Po-213, Pb-209
25	Th-nat	Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208
26		(0.36), Po-212 (0.64)
27	Th-234	Pa-234m
28	U-230	Th-226, Ra-222, Rn-218, Po-214
29	U-232	Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
30	U-235	Th-231
31	U-238	Th-234, Pa-234m
32	U-nat	Th-234, Pa-234m, U-234, Th-230, Ra-226, Rn-222, Po-218, Pb-214, Bi-214, Po-
33		214, Pb-210, Bi-210, Po-210
34	Np-237	Pa-233
35	Am-242m	Am-242

1 Am-243 Np-239

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

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

6 (e) These values apply only to compounds of uranium that take the chemical form of UO₃, UF₄,
7 UCl₄ and hexavalent compounds in both normal and accident conditions of transport.

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

10 (g) These values apply to *unirradiated uranium* only.

11

12 406. For mixtures of radionuclides, the determination of the basic radionuclide values referred
13 to in para. 401 may be determined as follows:

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

14 where,

15 f(i) is the fraction of activity or activity concentration of radionuclide i in the mixture;

16 X(i) is the appropriate value of A₁ or A₂, or the activity concentration for exempt material or
17 the activity limit for an exempt *consignment* as appropriate for the radionuclide i; and

18 X_m is the derived value of A₁ or A₂, or the activity concentration for exempt material or the
19 activity limit for an exempt *consignment* in the case of a mixture.

20

21 407. When the identity of each radionuclide is known but the individual activities of some of
22 the radionuclides are not known, the radionuclides may be grouped and the lowest radionuclide
23 value, as appropriate, for the radionuclides in each group may be used in applying the formulas in
24 paras 406 and 426. Groups may be based on the total alpha activity and the total beta/gamma
25 activity when these are known, using the lowest radionuclide values for the alpha emitters or
26 beta/gamma emitters, respectively.

27

28 TABLE 2. BASIC RADIONUCLIDE VALUES FOR UNKNOWN RADIO-NUCLIDES OR
29 MIXTURES

30

	A ₁	A ₂	Activity concentration for exempt material	Activity limit for an exempt consignment
31				
32 <i>Radioactive contents</i>				
33				
34				

	(TBq)	(TBq)	(Bq/g)	(Bq)
Only beta or gamma emitting nuclides are known to be present	0.1	0.02	1×10^1	1×10^4
Alpha emitting nuclides but no neutron emitters are known to be present	0.2	9×10^{-5}	1×10^{-1}	1×10^3
Neutron emitting nuclides are known to be present or no relevant data are available	0.001	9×10^{-5}	1×10^{-1}	1×10^3

408. For individual radionuclides or for mixtures of radionuclides for which relevant data are not available, the values shown in Table 2 shall be used.

DETERMINATION OF OTHER MATERIAL CHARACTERISTICS

Low specific activity (LSA) material

409. LSA material shall be in one of three groups:

(a) LSA-I

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

(ii) Natural uranium, depleted uranium, natural thorium or their compounds or mixtures, that are unirradiated and in solid or liquid form;

(iii) Radioactive material for which the A_2 value is unlimited, excluding *fissile material* not excepted under para. 413; or

(iv) Other radioactive material in which the activity is distributed throughout and the estimated average specific activity does not exceed 30 times the values for activity concentration specified in paras 403–408, excluding *fissile material* not excepted under para. 413.

(b) LSA-II

(i) Water with tritium concentration up to 0.8 TBq/L; or

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

3
4 (c) LSA-III

5 Solids (e.g. consolidated wastes, activated materials), excluding powders, meeting the
6 requirements of para 601, in which:

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

10 (ii) The radioactive material is relatively insoluble, or it is intrinsically contained in a relatively
11 insoluble matrix, so that, even under loss of *packaging*, the loss of radioactive material per
12 *package* by leaching when placed in water for seven days would not exceed $0.1A_2$; and

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

15
16 Surface contaminated object (SCO)

17
18 410. SCO shall be in one of two groups:

19
20 (a) SCO-I: A solid object on which:

21 (i) the non-fixed *contamination* on the accessible surface averaged over 300 cm^2 (or the area of
22 the surface if less than 300 cm^2) does not exceed 4 Bq/cm^2 for beta and gamma emitters and
23 *low toxicity alpha emitters*, or 0.4 Bq/cm^2 for all other alpha emitters; and

24 (ii) the fixed *contamination* on the accessible surface averaged over 300 cm^2 (or the area of the
25 surface if less than 300 cm^2) does not exceed $4 \times 10^4 \text{ Bq/cm}^2$ for beta and gamma emitters
26 and *low toxicity alpha emitters*, or $4 \times 10^3 \text{ Bq/cm}^2$ for all other alpha emitters; and

27 (iii) the non-fixed *contamination* plus the fixed *contamination* on the inaccessible surface
28 averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed $4 \times$
29 10^4 Bq/cm^2 for beta and gamma emitters and *low toxicity alpha emitters*, or $4 \times 10^3 \text{ Bq/cm}^2$
30 for all other alpha emitters.

31
32 (b) SCO-II: A solid object on which either the fixed or non-fixed *contamination* on the surface
33 exceeds the applicable limits specified for SCO-I in (a) above and on which:

34 (i) the non-fixed *contamination* on the accessible surface averaged over 300 cm^2 (or the area of
35 the surface if less than 300 cm^2) does not exceed 400 Bq/cm^2 for beta and gamma emitters and
36 *low toxicity alpha emitters*, or 40 Bq/cm^2 for all other alpha emitters; and

37 (ii) the fixed *contamination* on the accessible surface, averaged over 300 cm^2 (or the area of the
38 surface if less than 300 cm^2) does not exceed $8 \times 10^5 \text{ Bq/cm}^2$ for beta and gamma emitters and
39 *low toxicity alpha emitters*, or $8 \times 10^4 \text{ Bq/cm}^2$ for all other alpha emitters; and

1 (iii) the non-fixed *contamination* plus the fixed *contamination* on the inaccessible surface
2 averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 8 ×
3 10⁵ Bq/cm² for beta and gamma emitters and *low toxicity alpha emitters*, or 8 × 10⁴ Bq/cm²
4 for all other alpha emitters.

5
6 *Special form radioactive material*

7
8 411. Special form radioactive material shall have at least one dimension not less than 5 mm.
9 When a sealed capsule constitutes part of the special form radioactive material, the capsule shall
10 be so manufactured that it can be opened only by **destroying** it. The *design* for special form
11 radioactive material shall meet the requirement of **para 603** and requires *unilateral approval*.

12
13 *Low dispersible radioactive material*

14
15 412. The *design* for *low dispersible radioactive material* shall require *multilateral approval*.
16 *Low dispersible radioactive material* shall be such that the total amount of this radioactive
17 material in a *package* shall meet the requirements of para 605.

18
19 *Fissile material*

20
21 413. *Packages* containing fissile radionuclides shall be classified under the relevant entry of
22 Table 8 for *fissile material* unless one of the following conditions is met:

23
24 (a) A mass limit per *consignment* provided that the smallest external dimension of each *package*
25 is not less than 10 cm, such that:

$$\frac{\text{mass of uranium-235(g)}}{X} + \frac{\text{mass of other fissile nuclides(g)}}{Y} \leq 1$$

26 where X and Y are the mass limits defined in Table 12, provided that either:

27 (i) each individual *package* contains not more than 15 g of *fissile nuclides*; for unpackaged
28 material, this quantity limitation shall apply to the *consignment* being carried in or on the
29 *conveyance*; or

30 (ii) the *fissile material* is a homogeneous hydrogenous solution or mixture where the ratio of
31 fissile nuclides to hydrogen is less than 5% by mass; or

32 (iii) there are not more than 5 g of fissile nuclides in any 10 litre volume of material

33 Beryllium shall not be present in quantities exceeding 1% of the applicable *consignment* mass
34 limits provided in Table 8 except where the concentration of beryllium in the material does not
35 exceed 1 gram beryllium in any 1000 grams.

1 Deuterium shall also not be present in quantities exceeding 1% of the applicable *consignment*
2 mass limits provided in Table 8 except where deuterium occurs up to natural concentration in
3 hydrogen.

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

8 (c) Liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2% by mass,
9 with a total plutonium and uranium-233 content not exceeding 0.002% of the mass of uranium,
10 and with a minimum nitrogen to uranium atomic ratio (N/U) of 2.

11 (d) Plutonium containing no more than 20% of *fissile nuclides* by mass up to a maximum of 1kg
12 of plutonium per *consignment*. *Shipments* under this exception shall be under *exclusive use*.

13
14 Classification of *packages* or unpackaged material

15
16 414. The quantity of radioactive material in a *package* shall not exceed the relevant limits for
17 the *package* type as specified below.

18
19 Classification as *excepted package*

20
21 415. *Packagings* may be classified as *excepted packages* if:

- 22
23 (a) they are empty *packagings* having contained radioactive material;
24 (b) they contain instruments or articles in limited quantities;
25 (c) they contain articles manufactured of natural uranium, depleted uranium or natural thorium;
26 or
27 (d) they contain radioactive material in limited quantities.

28
29 416. A *package* containing radioactive material may be classified as an *excepted package* only
30 if the radiation level at any point on its external surface does not exceed 5 $\mu\text{Sv/h}$.

31
32 417. For *radioactive material* other than articles manufactured of *natural uranium, depleted*
33 *uranium* or natural thorium, an *excepted package* shall not contain activities greater than the
34 following:

- 35
36 (a) where the *radioactive material* is enclosed in or is included as a component part of an
37 instrument or other manufactured article, such as a clock or electronic apparatus, the limits
38 specified in columns 2 and 3 of Table 3 for each individual item and each *package*,
39 respectively; and

1 (b) where the *radioactive material* is not so enclosed in or is not included as a component of an
2 instrument or other manufactured article, the *package* limits specified in column 4 of Table
3 3.

4
5 418. Radioactive material which is enclosed in or is included as a component part of an
6 instrument or other manufactured article, may be classified under UN 2911, RADIOACTIVE
7 MATERIAL, EXCEPTED PACKAGE – INSTRUMENTS or ARTICLES, only if:

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

10 (b) Each instrument or article bears the marking “RADIOACTIVE” except:

11 i) radioluminescent time-pieces or devices, or

12 ii) consumer products that either have received regulatory *approval* according to para.
13 107(d) or do not individually exceed the activity limit for an exempt *consignment* in
14 Table 1 (column 5), provided such products are transported in a *package* that bears the
15 marking “RADIOACTIVE” on an internal surface in such a manner that warning of the
16 presence of radioactive material is visible on opening the *package*; and

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

20 (d) The limits specified in column 2 of Table 3 are met for each instrument or manufactured
21 article and the limits specified in column 3 of Table 3 are met for each individual item and
22 each *package*, respectively.

23
24 419. Radioactive material with an activity not exceeding the limit specified in column 4 of
25 Table 3, may be classified under UN 2910, RADIOACTIVE MATERIAL, EXCEPTED
26 PACKAGE – LIMITED QUANTITY OF MATERIAL, provided that:

27 (a) the *package* retains its *radioactive contents* under routine conditions of transport; and

28 (b) the *package* bears the marking “RADIOACTIVE” on an internal surface in such a manner
29 that a warning of the presence of *radioactive material* is visible on opening the *package*.

30 420. Articles manufactured of natural uranium, depleted uranium or natural thorium and articles
31 in which the sole radioactive material is unirradiated natural uranium, unirradiated depleted
32 uranium or unirradiated natural thorium may be classified under UN 2909, RADIOACTIVE
33 MATERIAL, EXCEPTED PACKAGE - ARTICLES MANUFACTURED FROM NATURAL
34 URANIUM or DEPLETED URANIUM or NATURAL THORIUM, only if the outer surface of
35 the uranium or thorium is enclosed in an inactive sheath made of metal or some other substantial
36 material.

37
38 421. Empty *packaging* which had previously contained radioactive material with an activity
39 not exceeding the limit specified in column 4 of Table 3 may be classified under UN 2908,
40 RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – EMPTY PACKAGING, only if:

41 (a) It is in a well maintained condition and securely closed;

1 (b) The outer surface of any uranium or thorium in its structure is covered with an inactive
2 sheath made of metal or some other substantial material;

3 (c) The level of internal non-fixed *contamination* does not exceed one hundred times the
4 levels specified in para. 508; and

5 (d) Any labels which may have been displayed on it in conformity with para. 541 are no
6 longer visible.

7

8 Classification as Low specific activity (LSA) material

9

10 422. Radioactive material may only be classified as LSA material if the conditions of 409 and
11 521-524 are met.

12

13 Classification as Surface contaminated object (SCO)

14

15 423. Radioactive material may be classified as SCO if the conditions of 410 and 521-524 are
16 met.

17

18 Classification as Type A *package*

19

20 424. *Packages* containing radioactive material may be classified as Type A *packages* provided
21 that the following conditions are met:

22

23 425. *Type A packages* shall not contain activities greater than the following:

24 (a) for special form radioactive material — A_1 ; or

25 (b) for all other radioactive material — A_2 .

26

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

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

29

30 where

31 B(i) is the activity of radionuclide i as special form radioactive material and

1 $A_1(i)$ is the A_1 value for radionuclide i ; and
2 $C(j)$ is the activity of radionuclide j as other than special form radioactive material and $A_2(j)$ is
3 the A_2 value for radionuclide j .

4

5 Classification of Uranium Hexafluoride

6

7 427. Uranium hexafluoride shall only be assigned to UN Nos 2977, RADIOACTIVE
8 MATERIAL, URANIUM HEXAFLUORIDE, FISSILE, or 2978, RADIOACTIVE MATERIAL,
9 URANIUM HEXAFLUORIDE, non-fissile or fissile-excepted.

10

11 428. A *package* may only be classified as a Uranium Hexafluoride package if it does not
12 contain:

- 13 (a) A mass of uranium hexafluoride different from that authorized for the *package design*;
- 14 (b) A mass of uranium hexafluoride greater than a value that would lead to an ullage smaller
15 than 5 % at the maximum temperature of the *package* as specified for the plant systems where
16 the *package* shall be used; or
- 17 (c) uranium hexafluoride other than in solid form or at an internal pressure above
18 atmospheric pressure when presented for transport.

19

20 Classification as Type B(U), Type B(M) or Type C packages

21

22 429. Packages not otherwise classified [in the previous paragraphs of this section] shall be
23 classified in accordance with the *competent authority* approval certificate for the package issued
24 by the country of origin of *design*.

25

26 430. A package may only be classified as a Type B(U) if it does not contain:

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

31

32 as specified in the certificate of approval.

33

34 431. A package may only be classified as a Type B(M) if it does not contain:

- 35 (a) Activities greater than those authorized for the *package design*;
- 36 (b) Radionuclides different from those authorized for the *package design*; or

1 (c) Contents in a form, or a physical or chemical state different from those authorized for the
2 package *design*;

3 as specified in the certificate of approval.

4

5 432. A package may only be classified as a Type C if it does not contain:

6 (a) Activities greater than those authorized for the package *design*;

7 (b) Radionuclides different from those authorized for the package *design*; or

8 (c) Contents in a form, or a physical or chemical state different from those authorized for the
9 package *design*;

10 as specified in the certificate of approval.

11

12 433. Radioactive material in forms ~~other than~~ as specified in para. 418, with an activity not
13 exceeding the limit specified in column 4 of Table 3, may be ~~transported~~ in an *excepted*
14 *package* provided that:

15

16 (a) the package retains its radioactive contents under routine conditions of ~~transport~~; and

17 (b) the package bears the marking “RADIOACTIVE” on an internal surface in such a
18 manner that a warning of the presence of radioactive material is visible on opening the package.

19

20 **Additional requirements and controls for transport of empty packagings**

21

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

26

27 435. For transport by post, the total activity in each *excepted package* shall not exceed one
28 tenth of the relevant limit specified in Table 3.

29

30 TABLE 3. ACTIVITY LIMITS FOR EXCEPTED PACKAGES

31

Physical state of contents	Instrument or article		Materials
	Item limits ^a	Package limits ^a	Package limits ^a

34

35 Solids:

36 *special form* $10^{-2} A_1$ A_1 $10^{-3} A_1$

1	other forms	$10^{-2}A_2$	A_2	$10^{-3}A_2$
2	Liquids	$10^{-3}A_2$	$10^{-1}A_2$	$10^{-4}A_2$
3	Gases			
4	tritium	$2 \times 10^{-2}A_2$	$2 \times 10^{-1}A_2$	$2 \times 10^{-2}A_2$
5	<i>special form</i>	$10^{-3}A_1$	$10^{-2}A_1$	$10^{-3}A_1$
6	other forms	$10^{-3}A_2$	$10^{-2}A_2$	$10^{-3}A_2$

7

8 ^a For mixtures of radionuclides, see paras 406.

9

10 **Type IP-1, Type IP-2 and Type IP-3**

11

12 436. The *radioactive contents* in a single *package* of *LSA material* or in a single *package* of
 13 *SCO* shall be so restricted that the *radiation level* specified in para. 521 shall not be exceeded,
 14 and the activity in a single *package* shall also be so restricted that the activity limits for a
 15 *conveyance* specified in para. 525 shall not be exceeded.

16

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

19

20 *Special arrangements*

21

22 438. Radioactive material shall be classified as a special arrangement when it is intended to be
 23 carried in accordance with 310.

1 **Section V**

2 **REQUIREMENTS AND CONTROLS FOR TRANSPORT**

3
4 **REQUIREMENTS BEFORE THE FIRST SHIPMENT**

5 501. Before a *packaging* is first used to transport radioactive material, the following
6 requirements shall be fulfilled:

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

10 (b) For each Type B(U), Type B(M) and Type C package and for each package containing *fissile*
11 *material*, it shall be ensured that the effectiveness of its shielding and containment and, where
12 necessary, the heat transfer characteristics and the effectiveness of the *confinement system*, are
13 within the limits applicable to or specified for the approved *design*.

14 (c) For packages containing *fissile material*, where, in order to comply with the requirements of
15 para. 671, neutron poisons are specifically included as components of the package, checks shall
16 be performed to confirm the presence and distribution of those neutron poisons.

17 **REQUIREMENTS BEFORE EACH SHIPMENT**

18 502. Before each *shipment* of any package, the following requirements shall be fulfilled:

19 (a) For any package it shall be ensured that all the requirements specified in the relevant
20 provisions of these Regulations have been satisfied.

21 (b) It shall be ensured that lifting attachments which do not meet the requirements of para. 607
22 have been removed or otherwise rendered incapable of being used for lifting the package, in
23 accordance with para. 608.

24 (c) For each package requiring *competent authority approval*, it shall be ensured that all the
25 requirements specified in the approval certificates have been satisfied.

26 (d) Each Type B(U), Type B(M) and Type C package shall be held until equilibrium conditions
27 have been approached closely enough to demonstrate compliance with the requirements for
28 temperature and pressure unless an exemption from these requirements has received *unilateral*
29 *approval*.

30 (e) For each Type B(U), Type B(M) and Type C package, it shall be ensured by inspection and/or
31 appropriate tests that all closures, valve and other openings of the *containment system* through
32 which the radioactive contents might escape are properly closed and, where appropriate, sealed in
33 the manner for which the demonstrations of compliance with the requirements of paras 657 and
34 669 were made.

1 (f) For each special form radioactive material, it shall be ensured that all the requirements
2 specified in the approval certificate and the relevant provisions of these Regulations have been
3 satisfied.

4 (g) For packages containing *fissile material* the measurement specified in para. 673(b) and the
5 tests to demonstrate closure of each package as specified in para. 676 shall be performed where
6 applicable.

7 (h) For each *low dispersible radioactive material*, it shall be ensured that all the requirements
8 specified in the approval certificate and the relevant provisions of these Regulations have been
9 satisfied.

10 TRANSPORT OF OTHER GOODS

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

14 504. *Packagings*, including IBCs, and tanks used for the transport of radioactive material shall
15 not be used for the storage or transport of other goods unless decontaminated below the level of
16 0.4 Bq/cm² for beta and gamma emitters and *low toxicity alpha emitters* and 0.04 Bq/cm² for all
17 other alpha emitters.

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

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

25 OTHER DANGEROUS PROPERTIES OF CONTENTS

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

33 REQUIREMENTS AND CONTROLS FOR CONTAMINATION AND FOR LEAKING 34 PACKAGES

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

37 (a) 4 Bq/cm² for beta and gamma emitters and *low toxicity alpha emitters*, and

1 (b) 0.4 Bq/cm² for all other alpha emitters.

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

3 509. Except as provided in para. 514, the level of *non-fixed contamination* on the external and
4 internal surfaces of *overpacks, freight containers, tanks, intermediate bulk containers* and
5 *conveyances* shall not exceed the limits specified in para. 508.

6 510. If it is evident that a package is damaged or leaking, or if it is suspected that the package
7 may have leaked or been damaged, access to the package shall be restricted and a qualified
8 person shall, as soon as possible, assess the extent of *contamination* and the resultant radiation
9 level of the package. The scope of the assessment shall include the package, the *conveyance*, the
10 adjacent loading and unloading areas, and, if necessary, all other material which has been carried
11 in the *conveyance*. When necessary, additional steps for the protection of persons, property and
12 the environment, in accordance with provisions established by the relevant *competent authority*,
13 shall be taken to overcome and minimize the consequences of such leakage or damage.

14 511. Packages which are damaged or leaking radioactive contents in excess of allowable limits
15 for normal conditions of transport may be removed to an acceptable interim location under
16 supervision, but shall not be forwarded until repaired or reconditioned and decontaminated.

17 512. A *conveyance* and equipment used regularly for the transport of radioactive material shall be
18 periodically checked to determine the level of *contamination*. The frequency of such checks shall
19 be related to the likelihood of *contamination* and the extent to which radioactive material is
20 transported.

21 513. Except as provided in para. 514, any *conveyance*, or equipment or part thereof which has
22 become contaminated above the limits specified in para. 508 in the course of the transport of
23 radioactive material, or which shows a radiation level in excess of 5 µSv/h at the surface, shall be
24 decontaminated as soon as possible by a qualified person and shall not be re-used unless the *non-*
25 *fixed contamination* does not exceed the limits specified in para. 508 and the radiation level
26 resulting from the *fixed contamination* on surfaces after decontamination is less than 5 µSv/h at
27 the surface.

28 514. A *freight container, tank, intermediate bulk container* or *conveyance* dedicated to the
29 transport of unpackaged radioactive material under *exclusive use* shall be excepted from the
30 requirements of paras 509 and 513 solely with regard to its internal surfaces and only for as long
31 as it remains under that specific *exclusive use*.

32 REQUIREMENTS AND CONTROLS FOR TRANSPORT OF EXCEPTED PACKAGES

33 515. *Excepted packages* shall be subject only to the following provisions in Sections V and VI:

34 (a) The requirements specified in paras 502(a), (b) and (f), 504, 507, 508, 509, 510, 511, 512, 513,
35 516, 529–532, first sentence in 545, 545(a), 553, 554, 560, 563, 580, 581 and, as applicable, 418-
36 421;

37 (b) The requirements for *excepted packages* specified in para. 620;

1 (c) If the *excepted package* contains *fissile material*, one of the fissile exceptions provided by
2 para. 413 shall apply and the requirement of para. 634 shall be met; and

3 (d) The requirements in paras 578 and 579 if transported by post.

4 516. The radiation level at any point on the external surface of an *excepted package* shall not
5 exceed 5 $\mu\text{Sv/h}$.

6

7 REQUIREMENTS AND CONTROLS FOR TRANSPORT OF LSA MATERIAL AND SCO IN
8 INDUSTRIAL PACKAGES OR UNPACKAGED

9 517. The quantity of LSA material or SCO in a single Type IP-1, Type IP-2, Type IP-3, or object
10 or collection of objects, whichever is appropriate, shall be so restricted that the external radiation
11 level at 3 m from the unshielded material or object or collection of objects does not exceed 10
12 mSv/h.

13 518. For LSA material and SCO which is or contains *fissile material* the applicable requirements
14 of paras 567, 568 and 671 shall be met.

15 519. LSA material and SCO in groups LSA-I and SCO-I may be transported unpackaged under
16 the following conditions:

17 (a) All unpackaged material other than ores containing only naturally occurring radionuclides
18 shall be transported in such a manner that under routine conditions of transport there will be no
19 escape of the radioactive contents from the *conveyance* nor will there be any loss of shielding;

20 (b) Each *conveyance* shall be under *exclusive use*, except when only transporting SCO-I on which
21 the *contamination* on the accessible and the inaccessible surfaces is not greater than ten times the
22 applicable level specified in para. 214; and

23 (c) For SCO-I where it is suspected that *non-fixed contamination* exists on inaccessible surfaces
24 in excess of the values specified in para. 410(a)(i), measures shall be taken to ensure that the
25 radioactive material is not released into the *conveyance*.

26

27 TABLE 4. INDUSTRIAL PACKAGE REQUIREMENTS FOR LSA MATERIAL AND SCO

28

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

39

2
3 ^a Under the conditions specified in para. 519, *LSA-I material* and *SCO-I* may be transported
4 unpackaged.
5

6 520. LSA material and SCO, except as otherwise specified in para. 518, shall be packaged in
7 accordance with Table 4.

8 521. The total activity in a single hold or compartment of an inland watercraft, or in another
9 conveyance, for carriage of LSA material or SCO in Type IP-1, Type IP-2, Type IP-3 or
10 unpackaged, shall not exceed the limits shown in Table 5.

11 DETERMINATION OF TRANSPORT INDEX

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

14 (a) Determine the maximum radiation level in units of millisieverts per hour (mSv/h) at a
15 distance of 1 m from the external surfaces of the package, *overpack*, *freight container* or
16 unpackaged LSA-I and SCO-I. The value determined shall be multiplied by 100 and the
17 resulting number is the transport index. For uranium and thorium ores and their concentrates,
18 the maximum radiation level at any point 1 m from the external surface of the load may be
19 taken as:

20 (i) 0.4 mSv/h for ores and physical concentrates of uranium and thorium;

21 (ii) 0.3 mSv/h for chemical concentrates of thorium;

22 (iii) 0.02 mSv/h for chemical concentrates of uranium, other than uranium hexafluoride.

23 (b) For tanks, *freight containers* and unpackaged LSA-I and SCO-I, the value determined in step
24 (a) above shall be multiplied by the appropriate factor from Table 6.

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

27 TABLE 5. CONVEYANCE ACTIVITY LIMITS FOR LSA MATERIAL AND SCO IN
28 INDUSTRIAL PACKAGES OR UNPACKAGED

Nature of material	Activity limit for conveyances other than by inland waterway	Activity limit for a hold or compartment of an inland water craft
<i>LSA-I</i>	No limit	No limit
<i>LSA-II</i> and <i>LSA-III</i> non-combustible solids	No limit	100 A ₂
<i>LSA-II</i> and <i>LSA-III</i> combustible solids, and all liquids and gases	100 A ₂	10 A ₂

1	SCO	100 A ₂	10 A ₂
2			
3			

4 523. The transport index for each *overpack*, *freight container* or *conveyance* shall be determined
5 as either the sum of the TIs of all the packages contained, or by direct measurement of radiation
6 level, except in the case of non-rigid *overpacks*, for which the transport index shall be determined
7 only as the sum of the TIs of all the packages.

8 TABLE 6. MULTIPLICATION FACTORS FOR TANKS, FREIGHT CONTAINERS, AND
9 UNPACKAGED LSA-I AND SCO-I

11	Size of load ^a	Multiplication factor
13	size of load ≤ 1 m ²	1
14	1 m ² < size of load ≤ 5 m ²	2
15	5 m ² < size of load ≤ 20 m ²	3
16	20 m ² < size of load	10

17
18 ^a Largest cross-sectional area of the load being measured.
19

20 DETERMINATION OF CRITICALITY SAFETY INDEX

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

24 LIMITS ON TRANSPORT INDEX, CRITICALITY SAFETY INDEX AND RADIATION
25 LEVELS FOR PACKAGES AND OVERPACKS

26 525. Except for *consignments* under *exclusive use*, the transport index of any package or
27 *overpack* shall not exceed 10, nor shall the *criticality safety index* of any package or *overpack*
28 exceed 50.

29 526. Except for packages or *overpacks* transported under *exclusive use* by rail or by road under
30 the conditions specified in para. 571(a), or under *exclusive use* and special arrangement by vessel
31 or by air under the conditions specified in paras 572 or 576 respectively, the maximum radiation
32 level at any point on the external surface of a package or *overpack* shall not exceed 2 mSv/h.

33 527. The maximum radiation level at any point on the external surface of a package or *overpack*
34 under *exclusive use* shall not exceed 10 mSv/h.

35 CATEGORIES

36 528. Packages and *overpacks* shall be assigned to either category I-WHITE, II-YELLOW or III-
37 YELLOW in accordance with the conditions specified in Table 7 and with the following
38 requirements:

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

6 (b) The transport index shall be determined following the procedures specified in paras 522 and
 7 523.

8 (c) If the surface radiation level is greater than 2 mSv/h, the package or *overpack* shall be
 9 transported under *exclusive use* and under the provisions of paras 571(a), 572 or 576, as
 10 appropriate.

11 (d) A package transported under a special arrangement shall be assigned to category III-
 12 YELLOW except under the provisions of para. 534.

13 (e) An *overpack* which contains packages transported under special arrangement shall be
 14 assigned to category III-YELLOW except under the provisions of para. 534.

15
 16 TABLE 7. CATEGORIES OF PACKAGES AND OVERPACKS
 17

<i>Transport index</i>	Conditions	Maximum radiation level at any point on external surface	Category
0 ^a		Not more than 0.005 mSv/h	I-WHITE
More than 0 but not more than 1 ^a		More than 0.005 mSv/h but not more than 0.5 mSv/h	II-YELLOW
More than 1 but not more than 10		More than 0.5 mSv/h but not more than 2 mSv/h	III-YELLOW
More than 10		More than 2 mSv/h but not more than 10 mSv/h	III-YELLOW ^b

29
 30 ^a If the measured *TI* is not greater than 0.05, the value quoted may be zero in accordance with
 31 para. 526(c).

32 ^b Shall also be transported under *exclusive use*.
 33

34 **MARKING, LABELLING AND PLACARDING**

35 529. For each package or *overpack* the UN number and proper shipping name shall be
 36 determined (see Table 8). In all cases of international transport of packages requiring *competent*
 37 *authority design* or *shipment* approval, for which different approval types apply in the different
 38 countries concerned by the *shipment*, the UN number, proper shipping name, categorization,
 39 labelling and marking shall be in accordance with the certificate of the country of origin of
 40 *design*.

41 **Marking**

1 530. Each package shall be legibly and durably marked on the outside of the *packaging* with an
2 identification of either the *consignor* or *consignee*, or both.

3 531. Each package and *overpack* shall be legibly and durably marked on the outside with the UN
4 marking as specified in Table 9. Additionally each *overpack* shall be legibly and durably marked
5 with the word “OVERPACK”.

DRAFT

1 TABLE 9. UN MARKING FOR PACKAGES AND OVERPACKS

Item	UN marking*
<i>Package</i> (other than an <i>excepted package</i>)	United Nations number, preceded by the letters “UN”, and the proper shipping name.
<i>Excepted package</i> (other than those in <i>consignments</i> accepted for international movement by post)	United Nations number, preceded by the letters “UN”
<i>Overpack</i> (other than an <i>overpack</i> containing only <i>excepted packages</i>)	United Nations number, preceded by the letters “UN” for each applicable United Nations number in the <i>overpack</i> , followed by the proper shipping name in the case of a <i>non-excepted package</i>
<i>Overpack</i> containing only <i>excepted packages</i> (other than <i>consignments</i> accepted for international movement by post)	United Nations number, preceded by the letters “UN”. If more than one UN number is carried within the <i>overpack</i> , then each applicable United Nations number preceded by the letters “UN”.
<i>Consignment</i> accepted for international movement by post	The requirement of para. 579.

2 *(see Table 8 for listing of United Nations number and proper shipping name)

3

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

6 533. Each package which conforms to:

7 (a) An IP-1, an IP-2 or an IP-3 *design* shall be legibly and durably marked on the outside of the
8 *packaging* with “TYPE IP-1”, “TYPE IP-2” or “TYPE IP-3” as appropriate;

9 (b) A Type A *package design* shall be legibly and durably marked on the outside of the
10 *packaging* with “TYPE A”;

11 (c) An IP-2, an IP-3 or a Type A *package design* shall be legibly and durably marked on the
12 outside of the *packaging* with the international vehicle registration code (VRI Code) of the
13 country of origin of *design* and either the name of the manufacturer or other identification of the
14 *packaging* specified by the *competent authority* of the country of origin of *design*.

15 534. Each package which conforms to a *design* approved under paras 805–814 or 816–817 shall
16 be legibly and durably marked on the outside of the *packaging* with:

17 (a) The identification mark allocated to that *design* by the *competent authority*;

18 (b) A serial number to uniquely identify each *packaging* which conforms to that *design*;

1 (c) In the case of a Type B(U) or Type B(M) package *design*, with “TYPE B(U)” or “TYPE
2 B(M)”;

3 (d) In the case of a Type C package *design*, with “TYPE C”.

4 535. Each package which conforms to a Type B(U), Type B(M) or Type C package *design* shall
5 have the outside of the outermost receptacle which is resistant to the effects of fire and water
6 plainly marked by embossing, stamping or other means resistant to the effects of fire and water
7 with the trefoil symbol shown in Fig. 1.

8 536. Where LSA-I or SCO-I material is contained in receptacles or wrapping materials and is
9 transported under *exclusive use* as permitted by para. 523, the outer surface of these receptacles
10 or wrapping materials may bear the marking ‘RADIOACTIVE LSA-I’ or ‘RADIOACTIVE SCO-
11 I’ as appropriate.

12
13 Existing Fig. 1 to be placed here
14

15
16 *FIG. 1. Basic trefoil symbol with proportions based on a central circle of radius X. The -
17 minimum allowable size of X shall be 4 mm.*
18

19 Labelling

20 537. Each package, *overpack* and *freight container* shall bear the labels which conform to the
21 models in Fig. 2, Fig. 3 or Fig. 4, except as allowed under the alternative provisions of para. 546
22 for large *freight containers* and tanks, according to the appropriate category. In addition, each
23 package, *overpack* and *freight container* containing *fissile material*, other than *fissile material*
24 *excepted* under the provisions of para. 413, shall bear labels which conform to the model in Fig.
25 5. Any labels which do not relate to the contents shall be removed or covered. For radioactive
26 material having other dangerous properties see para. 507.

27 538. The labels conforming to the models in Fig. 2, Fig. 3 and Fig. 4 shall be affixed to two
28 opposite sides of the outside of a package or *overpack* or on the outside of all four sides of a
29 *freight container* or tank. The labels conforming to the model in Fig. 5, where applicable, shall
30 be affixed adjacent to the labels conforming to the models in Fig. 2, Fig. 3 and Fig. 4. The labels
31 shall not cover the markings specified in paras 535–540.

32
33 Existing Fig. 2 to be placed here
34

35 *FIG. 2. Category I-WHITE label. The background colour of the label shall be white, the colour
36 of the trefoil and the printing shall be black, and the colour of the category bar shall be red.*
37
38

39 Labelling for radioactive contents

1 539. Each label conforming to the models in Fig. 2, Fig. 3 and Fig. 4 shall be completed with the
2 following information:

3 (a) Contents:

4 (i) Except for LSA-I material, the name(s) of the radionuclide(s) as taken from Table 1, using the
5 symbols prescribed therein. For mixtures of radionuclides, the most restrictive nuclides must be
6 listed to the extent the space on the line permits. The group of LSA or SCO shall be shown
7 following the name(s) of the radionuclide(s). The terms “LSA-II”, “LSA-III”, “SCO-I” and
8 “SCO-II” shall be used for this purpose.

9
10 Existing Fig. 3 to be placed here
11
12

13 *FIG. 3. Category II-YELLOW label. The background colour of the upper half of the label shall*
14 *be yellow and the lower half white, the colour of the trefoil and the printing shall be black, and*
15 *the colour of the category bars shall be red.*
16

17 (ii) For LSA-I material, the term “LSA-I” is all that is necessary; the name of the radionuclide is
18 not necessary.

19 (b) Activity: The maximum activity of the radioactive contents during transport expressed in
20 units of becquerels (Bq) with the appropriate SI prefix symbol (see Annex II). For *fissile*
21 *material*, the mass of *fissile material* in units of grams (g), or multiples thereof, may be used in
22 place of activity.

23 Existing Fig. 4 to be placed here
24
25

26 *FIG. 4. Category III-YELLOW label. The background colour of the upper half of the label shall*
27 *be yellow and the lower half white, the colour of the trefoil and the printing shall be black, and*
28 *the colour of the category bars shall be red.*
29

30 (c) For *overpacks* and *freight containers* the “contents” and “activity” entries on the label shall
31 bear the information required in paras 544543(a) and 543(b), respectively, totalled together for
32 the entire contents of the *overpack* or *freight container* except that on labels for *overpacks* or
33 *freight containers* containing mixed loads of packages containing different radionuclides, such
34 entries may read “See Transport Documents”.

35 (d) Transport index: The number determined in accordance with paras 422 and 523. (No
36 transport index entry is required for category I-WHITE.)

37 **Labelling for criticality safety**

38 540. Each label conforming to the model in Fig. 5 shall be completed with the *criticality safety*
39 *index* (CSI) as stated in the certificate of approval for special arrangement or the certificate of
40 approval for the package *design* issued by the *competent authority*.

Existing Fig. 5 to be placed here

1
2
3
4 *FIG. 5. Criticality safety index label. The background colour of the label shall be white, the*
5 *colour of the printing shall be black.*

6
7 541. For *overpacks* and *freight containers*, the *criticality safety index* (CSI) on the label shall
8 bear the information required in para. 540 totalled together for the fissile contents of the
9 *overpack* or *freight container*.

10 Placarding

11 542. Large *freight containers* carrying packages other than *excepted packages*, and tanks, shall
12 bear four placards which conform to the model given in Fig. 6. The placards shall be affixed in a
13 vertical orientation to each side wall and each end wall of the large *freight container* or tank. Any
14 placards which do not relate to the contents shall be removed. Instead of using both labels and
15 placards, it is permitted as an alternative to use enlarged labels only, where appropriate, as shown
16 in Fig. 2, Fig. 3, Fig. 4 and Fig. 5, with dimensions of the minimum size shown in Fig. 6.

17 543. Where the *consignment* in the *freight container* or tank is unpackaged LSA-I or SCO-I or
18 where a *consignment* in a *freight container* is required to be shipped under *exclusive use* and is
19 packaged *radioactive material* with a single United Nations number, the appropriate United
20 Nations number for the *consignment* (see Table 8) shall also be displayed, in black digits not less
21 than 65 mm high, either:

22 (a) in the lower half of the placard shown in Fig. 6 and against the white background, or

23 (b) on the placard shown in Fig. 7.

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

26 CONSIGNOR'S RESPONSIBILITIES

27 544. Except as otherwise provided in these Regulations, no person may offer radioactive material
28 for transport unless it is properly marked, labelled, placarded, described and certified on a
29 transport document, and otherwise in a condition for transport as required by these Regulations.

30 Particulars of consignment

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

34 (a) The United Nations number assigned to the material as specified in accordance with the
35 provisions of para. 402, preceded by the letters "UN";

36 (b) The proper shipping name, as specified in accordance with the provisions of para. 534;

37 (c) The United Nations Class number "7";

Existing Fig. 6 to be placed here

1
2
3
4
5 FIG. 6. Placard. Except as permitted by para. 569 minimum dimensions shall be as shown;
6 when different dimensions are used the relative proportions must be maintained. The number '7'
7 shall not be less than 25 mm high. The background colour of the upper half of the placard shall
8 be yellow and of the lower half white, the colour of the trefoil and the printing shall be black.
9 The use of the word "RADIOACTIVE" in the bottom half is optional to allow the alternative use
10 of this placard to display the appropriate United Nations number for the consignment.
11

12 (d) The name or symbol of each radionuclide or, for mixtures of radionuclides, an appropriate
13 general description or a list of the most restrictive nuclides;

14 (e) A description of the physical and chemical form of the material, or a notation that the material
15 is special form radioactive material or *low dispersible radioactive material*. A generic chemical
16 description is acceptable for chemical form;

17 (f) The maximum activity of the radioactive contents during transport expressed in units of
18 becquerels (Bq) with the appropriate SI prefix symbol (see Annex II). For *fissile material*, the
19 mass of *fissile material* in units of grams (g), or appropriate multiples thereof, may be used in
20 place of activity;

21 (g) The category of the package, i.e. I-WHITE, II-YELLOW, III-YELLOW;

22 (h) The transport index (categories II-YELLOW and III-YELLOW only);

23 (i) For *consignments* including *fissile material* other than *consignments* excepted under para.
24 413, the *criticality safety index*;

25 (j) The identification mark for each *competent authority approval* certificate (special form
26 radioactive material, *low dispersible radioactive material*, special arrangement, package *design*
27 or *shipment*) applicable to the *consignment*;

28 (k) For *consignments* of more than one package, the information contained in paras 550(a)–(j)
29 shall be given for each package. For packages in an *overpack*, *freight container* or *conveyance*, a
30 detailed statement of the contents of each package within the *overpack*, *freight container* or
31 *conveyance* and, where appropriate, of each *overpack*, *freight container* or *conveyance* shall be
32 included. If packages are to be removed from the *overpack*, *freight container* or *conveyance* at a
33 point of intermediate unloading, appropriate transport documents shall be made available;

34 (l) Where a *consignment* is required to be shipped under *exclusive use*, the statement
35 "EXCLUSIVE USE SHIPMENT"; and

36 (m) For LSA-II, LSA-III, SCO-I and SCO-II, the total activity of the *consignment* as a multiple of
37 A_2 .

38
39 Existing Fig 7 to be placed here

1
2 *FIG. 7. Placard for separate display of United Nations number. The background colour of the*
3 *placard shall be orange and the border and United Nations number shall be black. The symbol*
4 *“*****” denotes the space in which the appropriate United Nations number for radioactive*
5 *material, as specified in Table 8, shall be displayed.*
6

7 **Consignor’s declaration**

8 546. The *consignor* shall include in the transport documents a declaration in the following terms
9 or in terms having an equivalent meaning: “I hereby declare that the contents of this *consignment*
10 are fully and accurately described above by the proper shipping name and are classified, packed,
11 marked and labelled/placarded, and are in all respects in proper condition for transport according
12 to the applicable international and national governmental regulations.”

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

16 548. The declaration shall be signed and dated by the *consignor*. Facsimile signatures are
17 acceptable where applicable laws and regulations recognize the legal validity of facsimile
18 signatures.

19 549. If the dangerous goods documentation is presented to the *carrier* by means of electronic
20 data processing (EDP) or electronic data interchange (EDI) transmission techniques, the
21 signature(s) may be replaced by the name(s) (in capitals) of the person authorized to sign.
22

23 550. When radioactive material, other than when carried in tanks, is packed or loaded into any
24 *freight container* or vehicle which will be transported by sea, those responsible for packing of the
25 container or vehicle shall provide a “container/vehicle packing certificate” specifying the
26 container/vehicle identification number(s) and certifying that the operation has been carried out
27 in accordance with the following conditions:

- 28 (a) The container/vehicle was clean, dry and apparently fit to receive the goods;
- 29 (b) Packages, which need to be segregated in accordance with applicable segregation
30 requirements, have not been packed together onto or in the container/vehicle;
- 31 (c) All packages have been externally inspected for damage, and only sound packages have
32 been loaded;
- 33 (d) All goods have been properly loaded and, where necessary, adequately braced with
34 securing material to suit the mode(s) of transport for the intended journey;
- 35 (e) Goods loaded in bulk have been evenly distributed within the container/vehicle;
- 36 (f) For *consignments* including goods of Class 1 other than Division 1.4, the container/vehicle
37 is structurally serviceable in accordance with 7.1.3.2.1 of the UN Model Regulations;
- 38 (g) The container/vehicle and packages are properly marked, labelled and placarded, as
39 appropriate;
- 40 (h) When solid carbon dioxide (CO₂-dry ice) is used for cooling purposes, the

1 container/vehicle is externally marked or labelled in a conspicuous place, such as, at the
2 door end, with the words: “DANGEROUS CO₂ (DRY ICE) INSIDE. VENTILATE
3 THOROUGHLY BEFORE ENTERING”; and

- 4 (i) A transport document, as indicated in 546, has been received for each dangerous goods
5 *consignment* loaded in the container/vehicle.

6 551. The information required in the transport document and the container/vehicle packing
7 certificate may be incorporated into a single document, if not, these documents shall be attached
8 one to the other. If the information is incorporated into a single document, the document shall
9 include a signed declaration such as “It is declared that the packing of the goods into the
10 container/vehicle has been carried out in accordance with the applicable provisions”. This
11 declaration shall be dated and the person signing this declaration shall be identified on the
12 document.

13 552. The declaration shall be made on the same transport document which contains the
14 particulars of *consignment* listed in para. 550.

15 **Removal or covering of labels**

16 553. When an empty *packaging* is transported as an *excepted package* under the provisions of
17 para. 421, the previously displayed labels shall not be visible.

18 **Information for carriers**

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

23 (a) Supplementary requirements for loading, stowage, carriage, handling and unloading of the
24 package, *overpack* or *freight container* including any special stowage provisions for the safe
25 dissipation of heat (see para. 564), or a statement that no such requirements are necessary;

26 (b) Restrictions on the mode of transport or *conveyance* and any necessary routing instructions;

27 (c) Emergency arrangements appropriate to the *consignment*.

28 555. The applicable *competent authority* certificates need not necessarily accompany the
29 *consignment*. The *consignor* shall make them available to the *carrier(s)* before loading and
30 unloading.

31 **Notification of competent authorities**

32 556. Before the first *shipment* of any package requiring *competent authority* approval, the
33 *consignor* shall ensure that copies of each applicable *competent authority* certificate applying to
34 that package *design* have been submitted to the *competent authority* of each country through or
35 into which the *consignment* is to be transported. The *consignor* is not required to await an
36 acknowledgement from the *competent authority*, nor is the *competent authority* required to make
37 such acknowledgement of receipt of the certificate.

1 557. For each *shipment* listed in (a), (b), (c) or (d) below, the *consignor* shall notify the
2 *competent authority* of each country through or into which the *consignment* is to be transported.
3 This notification shall be in the hands of each *competent authority* prior to the commencement of
4 the *shipment*, and preferably at least 7 days in advance.

5 (a) Type C packages containing radioactive material with an activity greater than $3000A_1$ or
6 $3000A_2$, as appropriate, or 1000 TBq, whichever is the lower;

7 (b) Type B(U) packages containing radioactive material with an activity greater than $3000A_1$ or
8 $3000A_2$, as appropriate, or 1000 TBq, whichever is the lower;

9 (c) Type B(M) packages;

10 (d) Shipments under special arrangement.

11 558. The *consignment* notification shall include:

12 (a) Sufficient information to enable the identification of the package or packages including all
13 applicable certificate numbers and identification marks;

14 (b) Information on the date of *shipment*, the expected date of arrival and proposed routing;

15 (c) The names of the radioactive materials or nuclides;

16 (d) Descriptions of the physical and chemical forms of the radioactive material, or whether it is
17 special form radioactive material or *low dispersible radioactive material*; and

18 (e) The maximum activity of the radioactive contents during transport expressed in units of
19 becquerels (Bq) with the appropriate SI prefix symbol (see Annex II). For *fissile material*, the
20 mass of *fissile material* (or mass of each fissile nuclide for mixture when appropriate) in units of
21 grams (g), or multiples thereof, may be used in place of activity.

22 559. The *consignor* is not required to send a separate notification if the required information has
23 been included in the application for *shipment* approval; see para. 822.

24 **Possession of certificates and instructions**

25 560. The *consignor* shall have in his or her possession a copy of each certificate required under
26 Section VIII of these Regulations and a copy of the instructions with regard to the proper closing
27 of the package and other preparations for *shipment* before making any *shipment* under the terms
28 of the certificates.

29 **TRANSPORT AND STORAGE IN TRANSIT**

30 **Segregation during transport and storage in transit**

31 561. Packages, *overpacks* and *freight containers* containing radioactive material and unpackaged
32 radioactive material shall be segregated during transport and during storage in transit:

33 (a) from workers in regularly occupied working areas by distances calculated using a dose
34 criterion of 5 mSv in a year and conservative model parameters;

1 (b) from members of the critical group of the public, in areas where the public has regular access,
2 by distances calculated using a dose criterion of 1 mSv in a year and conservative model
3 parameters;

4 (c) from undeveloped photographic film by distances calculated using a radiation exposure
5 criterion for undeveloped photographic film due to the transport of radioactive material of 0.1
6 mSv per *consignment* of such film; and

7 (d) from other dangerous goods in accordance with para. 506.

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

11 **Stowage during transport and storage in transit**

12 563. *Consignments* shall be securely stowed.

13 564. Provided that its average surface heat flux does not exceed 15 W/m² and that the
14 immediately surrounding cargo is not in sacks or bags, a package or *overpack* may be carried or
15 stored among packaged general cargo without any special stowage provisions except as may be
16 specifically required by the *competent authority* in an applicable approval certificate.

17 565. Loading of *freight containers* and accumulation of packages, *overpacks* and *freight*
18 *containers* shall be controlled as follows:

19 (a) Except under the condition of *exclusive use*, and for *consignments* of LSA-I material, the total
20 number of packages, *overpacks* and *freight containers* aboard a single *conveyance* shall be so
21 limited that the total sum of the transport indexes aboard the *conveyance* does not exceed the
22 values shown in Table 9.

23 (b) The radiation level under routine conditions of transport shall not exceed 2 mSv/h at any
24 point on, and 0.1 mSv/h at 2 m from, the external surface of the *conveyance*, except for
25 *consignments* transported under *exclusive use* by road or rail, for which the radiation limits
26 around the vehicle are set forth in paras 571(b) and (c).

27 (c) The total sum of the *criticality safety indexes* in a *freight container* and aboard a *conveyance*
28 shall not exceed the values shown in Table 10.

29 TABLE 10. TI LIMITS FOR FREIGHT CONTAINERS AND CONVEYANCES NOT UNDER
30 EXCLUSIVE USE

31	Type of <i>freight container</i> 32 or <i>conveyance</i>	Limit on total sum of <i>transport indexes</i> in a 33 <i>freight container</i> or aboard a <i>conveyance</i>
34		
35	<i>Freight container</i> — Small	50
36	<i>Freight container</i> — Large	50
37	<i>Vehicle</i>	50
38	<i>Aircraft</i>	
39	<i>Passenger</i>	50

1	<i>Cargo</i>	200
2	Inland water-way craft	50
3	Seagoing vessel ^a	
4	(1) Hold, compartment or <i>defined deck area</i> :	
5	<i>Packages, overpacks, small freight containers</i>	50
6	Large freight containers	200
7	(2) Total vessel:	
8	<i>Packages, overpacks, small freight containers</i>	200
9	Large freight containers	No limit

10
11 ^a *Packages* or *overpacks* carried in or on a *vehicle* which are in accordance with the provisions
12 of para. 571 may be transported by *vessels* provided that they are not removed from the *vehicle*
13 at any time while on board the *vessel*.
14

15 566. Any package or *overpack* having a transport index greater than 10, or any *consignment*
16 having a *criticality safety index* greater than 50, shall be transported only under *exclusive use*.

17 **Segregation of packages containing fissile material during transport and storage in transit**

18 567. Any group of packages, *overpacks* and *freight containers* containing *fissile material* stored
19 in transit in any one storage area shall be so limited that the total sum of the *criticality safety*
20 *indexes* in the group does not exceed 50. Each group shall be stored so as to maintain a spacing
21 of at least 6 m from other such groups.

22 TABLE 11. CSI LIMITS FOR FREIGHT CONTAINERS AND CONVEYANCES
23 CONTAINING FISSILE MATERIAL
24

25 Type of <i>freight container</i> 26 or <i>conveyance</i>	27 Limit on total sum of <i>criticality safety indexes</i> in a <i>freight container</i> or aboard a <i>conveyance</i>	
	Not under <i>exclusive use</i>	Under <i>exclusive use</i>
28		
29 <i>Freight container</i> — Small	50	n.a.
30 <i>Freight container</i> — Large	50	100
31 <i>Vehicle</i>	50	100
32 <i>Aircraft</i>		
33 <i>Passenger</i>	50	n.a.
34 <i>Cargo</i>	50	100
35 Inland water-way craft	50	100
36 Seagoing vessel ^a		
37 (1) Hold, compartment or <i>defined deck area</i> :		
38 <i>Packages, overpacks, small freight</i>		
39 <i>containers</i>	50	100
40 Large freight containers	50	100
41 (2) Total vessel:		
42 <i>Packages, overpacks, small freight</i>		
43 <i>containers</i>	200 ^b	200 ^c
44 Large freight containers	No limit ^b	No limit ^c

45

1 568. Where the total sum of the *criticality safety indexes* on board a *conveyance* or in a *freight*
2 *container* exceeds 50, as permitted in Table 11, storage shall be such as to maintain a spacing of
3 at least 6 m from other groups of packages, *overpacks* or *freight containers* containing *fissile*
4 *material* or other *conveyances* carrying radioactive material.

5 **Additional requirements relating to transport by rail and by road**

6 569. Rail and road vehicles carrying packages, *overpacks* or *freight containers* labelled with any
7 of the labels shown in Fig. 2, Fig. 3, Fig. 4 or Fig. 5, or carrying *consignments* under *exclusive*
8 *use*, shall display the placard shown in Fig. 6 on each of:

- 9 (a) The two external lateral walls in the case of a rail vehicle;
- 10 (b) The two external lateral walls and the external rear wall in the case of a road vehicle.

11 In the case of a vehicle without sides, the placards may be affixed directly on the cargo carrying
12 unit provided that they are readily visible; in the case of physically large tanks or *freight*
13 *containers*, the placards on the tanks or *freight containers* shall suffice. In the case of vehicles
14 which have insufficient area to allow the fixing of larger placards, the dimensions of the placard
15 as described in Fig. 6 may be reduced to 100 mm. Any placards which do not relate to the
16 contents shall be removed.

17 570. Where the *consignment* in or on the vehicle is unpackaged LSA-I material or SCO-I or
18 where an *exclusive use consignment* is packaged radioactive material with a single United
19 Nations number, the appropriate United Nations number (see Table 8) shall also be displayed, in
20 black digits not less than 65 mm high, either:

- 21 (a) In the lower half of the placard shown in Fig. 6, against the white background; or
- 22 (b) On the placard shown in Fig. 7.

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

27 571. For *consignments* under *exclusive use*, the radiation level shall not exceed:

28 (a) 10 mSv/h at any point on the external surface of any package or *overpack*, and may only
29 exceed 2 mSv/h provided that:

- 30 (i) the vehicle is equipped with an enclosure which, during routine conditions of transport,
31 prevents the access of unauthorized persons to the interior of the enclosure; and
- 32 (ii) provisions are made to secure the package or *overpack* so that its position within the vehicle
33 enclosure remains fixed during routine conditions of transport; and
- 34 (iii) there is no loading or unloading during the *shipment*;

35 (b) 2 mSv/h at any point on the outer surfaces of the vehicle, including the upper and lower
36 surfaces, or, in the case of an open vehicle, at any point on the vertical planes projected from the

1 outer edges of the vehicle, on the upper surface of the load, and on the lower external surface of
2 the vehicle; and

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

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

9 **Additional requirements relating to transport by vessels**

10 573. Packages or *overpacks* having a surface radiation level greater than 2 mSv/h, unless being
11 carried in or on a vehicle under *exclusive use* in accordance with Table 9, footnote (a), shall not
12 be transported by vessel except under special arrangement.

13 574. The transport of *consignments* by means of a special use vessel which, by virtue of its
14 *design*, or by reason of its being chartered, is dedicated to the purpose of carrying radioactive
15 material, shall be excepted from the requirements specified in para. 565 provided that the
16 following conditions are met:

17 (a) A Radiation Protection Programme for the *shipment* shall be approved by the *competent*
18 *authority* of the flag state of the vessel and, when requested, by the *competent authority* at each
19 port of call;

20 (b) Stowage arrangements shall be predetermined for the whole voyage including any
21 *consignments* to be loaded at ports of call en route; and

22 (c) The loading, carriage and unloading of the *consignments* shall be supervised by persons
23 qualified in the transport of radioactive material.

24 **Additional requirements relating to transport by air**

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

27 576. Vented Type B(M) packages, packages which require external cooling by an ancillary
28 cooling system, packages subject to operational controls during transport and packages
29 containing liquid pyrophoric materials shall not be transported by air.

30 577. Packages or *overpacks* having a surface radiation level greater than 2 mSv/h shall not be
31 transported by air except by special arrangement.

32 **Additional requirements relating to transport by post**

33 578. A *consignment* that conforms with the requirements of para. 515, and in which the activity
34 of the radioactive contents does not exceed one tenth of the limits prescribed in Table 3, may be
35 accepted for domestic movement by national postal authorities, subject to such additional
36 requirements as those authorities may prescribe.

1 579. A *consignment* that conforms with the requirements of para. 515, and in which the activity
2 of the radioactive contents does not exceed one tenth of the limits prescribed in Table 3, may be
3 accepted for international movement by post, subject in particular to the following additional
4 requirements as prescribed by the Acts of the Universal Postal Union:

5 (a) it shall be deposited with the postal service only by *consignors* authorized by the national
6 authority;

7 (b) it shall be dispatched by the quickest route, normally by air;

8 (c) it shall be plainly and durably marked on the outside with the words “RADIOACTIVE
9 MATERIAL — QUANTITIES PERMITTED FOR MOVEMENT BY POST”; these words shall
10 be crossed out if the *packaging* is returned empty;

11 (d) it shall carry on the outside the name and address of the *consignor* with the request that the
12 *consignment* be returned in the case of non-delivery; and

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

15 CUSTOMS OPERATIONS

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

20 UNDELIVERABLE CONSIGNMENTS

21 581. Where a *consignment* is undeliverable, the *consignment* shall be placed in a safe location
22 and the appropriate *competent authority* shall be informed as soon as possible and a request made
23 for instructions on further action.

1 **Section VI**

2 **REQUIREMENTS FOR RADIOACTIVE MATERIALS**
3 **AND FOR PACKAGINGS AND PACKAGES**

4 REQUIREMENTS FOR RADIOACTIVE MATERIALS

5 **Requirements for LSA-III material**

6 601. LSA-III material shall be a solid of such a nature that if the entire contents of a package
7 were subjected to the test specified in para. 703 the activity in the water would not exceed $0.1A_2$.

8 **Requirements for special form radioactive material**

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

10 603. Special form radioactive material shall be of such a nature or shall be so designed that if it is
11 subjected to the tests specified in paras 704–711, it shall meet the following requirements:

12 (a) It would not break or shatter under the impact, percussion and bending tests in paras 705, 706,
13 707 and 709(a) as applicable;

14 (b) It would not melt or disperse in the heat test in para. 708 or para. 709(b) as applicable; and

15 (c) The activity in the water from the leaching tests specified in paras 710 and 711 would not
16 exceed 2 kBq; or alternatively for sealed sources, the leakage rate for the volumetric leakage
17 assessment test specified in the International Organization for Standardization document ISO
18 9978: “Radiation Protection — Sealed Radioactive Sources — Leakage Test Methods” [8],
19 would not exceed the applicable acceptance threshold acceptable to the *competent authority*.

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

22 **Requirements for low dispersible radioactive material**

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

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

27 (b) If subjected to the tests specified in paras 736 and 737, the airborne release in gaseous and
28 particulate forms of up to 100 μm aerodynamic equivalent diameter would not exceed $100A_2$. A
29 separate specimen may be used for each test; and

30 (c) If subjected to the test specified in para. 703 the activity in the water would not exceed $100A_2$.
31 In the application of this test, the damaging effects of the tests specified in (b) above shall be
32 taken into account.

33 GENERAL REQUIREMENTS FOR ALL PACKAGINGS AND PACKAGES

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

4 607. The *design* shall be such that any lifting attachments on the package will not fail when used
5 in the intended manner and that, if failure of the attachments should occur, the ability of the
6 package to meet other requirements of these Regulations would not be impaired. The *design* shall
7 take account of appropriate safety factors to cover snatch lifting.

8 608. Attachments and any other features on the outer surface of the package which could be used
9 to lift it shall be designed either to support its mass in accordance with the requirements of para.
10 607 or shall be removable or otherwise rendered incapable of being used during transport.

11 609. As far as practicable, the *packaging* shall be so designed and finished that the external
12 surfaces are free from protruding features and can be easily decontaminated.

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

15 611. Any features added to the package at the time of transport which are not part of the package
16 shall not reduce its safety.

17 612. The package shall be capable of withstanding the effects of any acceleration, vibration or
18 vibration resonance which may arise under routine conditions of transport without any
19 deterioration in the effectiveness of the closing devices on the various receptacles or in the
20 integrity of the package as a whole. In particular, nuts, bolts and other securing devices shall be
21 so designed as to prevent them from becoming loose or being released unintentionally, even after
22 repeated use.

23 613. The materials of the *packaging* and any components or structures shall be physically and
24 chemically compatible with each other and with the radioactive contents. Account shall be taken
25 of their behaviour under irradiation.

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

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

30 616. For radioactive material having other dangerous properties the package *design* shall take
31 into account those properties; see paras 109 and 507.

32
33 **ADDITIONAL REQUIREMENTS FOR PACKAGES TRANSPORTED BY AIR**

34 617. For packages to be transported by air, the temperature of the accessible surfaces shall not
35 exceed 50°C at an ambient temperature of 38°C with no account taken for insulation.

36

1 618. Packages to be transported by air shall be so designed that, if they were exposed to ambient
2 temperatures ranging from -40°C to $+55^{\circ}\text{C}$, the integrity of containment would not be impaired.

3 619. Packages containing radioactive material to be transported by air shall be capable of
4 withstanding, without leakage, an internal pressure which produces a pressure differential of not
5 less than *maximum normal operating pressure* plus 95 kPa.

6 REQUIREMENTS FOR EXCEPTED PACKAGES

7 620. An *excepted package* shall be designed to meet the requirements specified in paras 606–616
8 and, in addition, the requirements of paras 617–619 if carried by air.

9 REQUIREMENTS FOR INDUSTRIAL PACKAGES

10 **Requirements for Type IP-1**

11 621. A Type IP-1 package shall be designed to meet the requirements specified in paras 606–616
12 and 634, and, in addition, the requirements of paras 617–619 if carried by air.

13 **Requirements for Type IP-2**

14 622. A package to be qualified as a Type IP-2 shall be designed to meet the requirements for
15 Type IP-1 as specified in para. 621 and, in addition, if it were subjected to the tests specified in
16 paras 722 and 723, it would prevent:

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

20 **Requirements for Type IP-3**

21 623. A package to be qualified as a Type IP-3 shall be designed to meet the requirements for
22 Type IP-1 as specified in para. 621 and, in addition, the requirements specified in paras 634–647.

23 **Alternative requirements for Type IP-2 and Type IP-3**

24 624. Packages may be used as Type IP-2 provided that:

- 25 (a) They satisfy the requirements for Type IP-1 specified in para. 621;
- 26 (b) They are designed to satisfy the requirements prescribed for UN Packing Group I or II in
27 Chapter 6.1 of the United Nations Recommendations on the Transport of Dangerous Goods,
28 Model Regulations [7]; and
- 29 (c) When subjected to the tests required for UN Packing Group I or II, they would prevent: (i)
30 loss or dispersal of the radioactive contents; and (ii) more than a 20% increase in the
31 maximum radiation level at the external surface of the package.

32 625. Portable tanks may also be used as Type IP-2 or Type IP-3, provided that:

- 33 (a) They satisfy the requirements for Type IP-1 specified in para. 621;

- 1 (b) They are designed to satisfy the requirements prescribed in Chapter 6.7 of the United Nations
2 Recommendations on the Transport of Dangerous Goods, Model Regulations [7], or other
3 requirements at least equivalent to those standards, and are capable of withstanding a test
4 pressure of 265 kPa; and
- 5 (c) They are designed so that any additional shielding which is provided shall be capable of
6 withstanding the static and dynamic stresses resulting from handling and routine conditions
7 of transport and of preventing more than a 20% increase in the maximum radiation level at
8 the external surface of the tank containers.

9 626. Tanks, other than portable tanks , may also be used as Type IP-2 or Type IP-3 for
10 transporting LSA-I and LSA-II liquids and gases as prescribed in Table 4, provided that:

- 11 (a) They satisfy the requirements for *Type IP-1* specified in para. 621;
- 12 (b) They are designed to satisfy the requirements prescribed in regional or national regulations
13 for the transport of dangerous goods and are capable of withstanding a test pressure of 265
14 kPa; and
- 15 (c) They are designed so that any additional shielding which is provided shall be capable of
16 withstanding the static and dynamic stresses resulting from handling and routine
17 conditions of transport and of preventing an increase of more than 20% in the maximum
18 radiation level at any external surface of the tanks.

19
20 627. *Freight containers* with the characteristics of a permanent enclosure may also be used as
21 Type IP-2 or Type IP-3, provided that:

- 22 (a) The radioactive contents are restricted to solid materials;
- 23 (b) They satisfy the requirements for Type IP-1 specified in para. 621; and
- 24 (c) They are designed to conform to the International Organization for Standardization document
25 ISO 1496/1: “Series 1 *Freight Containers* — Specifications and Testing — Part 1: General
26 Cargo Containers” [9] excluding dimensions and ratings. They shall be designed such that if
27 subjected to the tests prescribed in that document and to the accelerations occurring during
28 routine conditions of transport they would prevent: (i) loss or dispersal of the radioactive
29 contents; and (ii) more than a 20% increase in the maximum radiation level at the external
30 surface of the *freight containers*.

31 628. Metal *intermediate bulk containers* may also be used as Type IP-2 or Type IP-3, provided
32 that:

- 33 (a) They satisfy the requirements for Type IP-1 specified in para. 621; and
- 34 (b) They are designed to satisfy the requirements prescribed for UN Packing Group I or II in
35 Chapter 6.5 of the United Nations Recommendations on the Transport of Dangerous Goods,
36 Model Regulations [7], and if they were subjected to the tests prescribed in that document,
37 but with the drop test conducted in the most damaging orientation, they would prevent:
- 38 (i) loss or dispersal of the radioactive contents; and

1 (ii) more than a 20% increase in the maximum radiation level at the external surface of
2 the *intermediate bulk container*.

3 REQUIREMENTS FOR PACKAGES CONTAINING URANIUM HEXAFLUORIDE

4 629. Packages designed to contain uranium hexafluoride shall meet the requirements prescribed
5 elsewhere in these Regulations which pertain to the radioactive and fissile properties of the
6 material. Except as allowed in para. 632, uranium hexafluoride in quantities of 0.1 kg or more
7 shall also be packaged and transported in accordance with the provisions of the International
8 Organization for Standardization document ISO 7195: “Packaging of Uranium Hexafluoride
9 (UF6) for Transport” [10], and the requirements of paras 630–631.

10 630. Each package designed to contain 0.1 kg or more of uranium hexafluoride shall be designed
11 so that it would meet the following requirements:

12 (a) Withstand without leakage and without unacceptable stress, as specified in the International
13 Organization for Standardization document ISO 7195 [10], the structural test as specified in para.
14 718;

15 (b) Withstand without loss or dispersal of the uranium hexafluoride the free drop test specified in
16 para. 722; and

17 (c) Withstand without rupture of the *containment system* the thermal test specified in para. 728.

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

20 632. Subject to the approval of the *competent authority*, packages designed to contain 0.1 kg or
21 more of uranium hexafluoride may be transported if:

22 (a) The packages are designed to international or national standards other than ISO 7195 [10],
23 provided an equivalent level of safety is maintained;

24 (b) The packages are designed to withstand without leakage and without unacceptable stress a
25 test pressure of less than 2.76 MPa as specified in para. 718; or

26 (c) For packages designed to contain 9000 kg or more of uranium hexafluoride, the packages do
27 not meet the requirement of para. 630(c).

28 In all other respects the requirements specified in paras 629–631 shall be satisfied.

29 REQUIREMENTS FOR TYPE A PACKAGES

30 633. Type A packages shall be designed to meet the requirements specified in paras 606–616
31 and, in addition, the requirements of paras 617–619 if carried by air, and of paras 634–649.

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

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

- 1 636. Any tie-down attachments on the package shall be so designed that, under normal and
2 accident conditions of transport, the forces in those attachments shall not impair the ability of the
3 package to meet the requirements of these Regulations.
- 4 637. The *design* of the package shall take into account temperatures ranging from -40°C to
5 $+70^{\circ}\text{C}$ for the components of the *packaging*. Attention shall be given to freezing temperatures for
6 liquids and to the potential degradation of *packaging* materials within the given temperature
7 range.
- 8 638. The *design* and manufacturing techniques shall be in accordance with national or
9 international standards, or other requirements, acceptable to the *competent authority*.
- 10 639. The *design* shall include a *containment system* securely closed by a positive fastening device
11 which cannot be opened unintentionally or by a pressure which may arise within the package.
- 12 640. Special form radioactive material may be considered as a component of the *containment*
13 *system*.
- 14 641. If the *containment system* forms a separate unit of the package, it shall be capable of being
15 securely closed by a positive fastening device which is independent of any other part of the
16 *packaging*.
- 17 642. The *design* of any component of the *containment system* shall take into account, where
18 applicable, the radiolytic decomposition of liquids and other vulnerable materials and the
19 generation of gas by chemical reaction and radiolysis.
- 20 643. The *containment system* shall retain its radioactive contents under a reduction of ambient
21 pressure to 60 kPa.
- 22 644. All valves, other than pressure relief valves, shall be provided with an enclosure to retain
23 any leakage from the valve.
- 24 645. A radiation shield which encloses a component of the package specified as a part of the
25 *containment system* shall be so designed as to prevent the unintentional release of that component
26 from the shield. Where the radiation shield and such component within it form a separate unit,
27 the radiation shield shall be capable of being securely closed by a positive fastening device which
28 is independent of any other *packaging* structure.
- 29 646. A package shall be so designed that, if it were subjected to the tests specified in paras 719–
30 724, it would prevent:
- 31 (a) Loss or dispersal of the radioactive contents; and
- 32 (b) More than a 20% increase in the maximum radiation level at the external surface of the
33 package.
- 34 647. The *design* of a package intended for liquid radioactive material shall make provision for
35 ullage to accommodate variations in the temperature of the contents, dynamic effects and filling
36 dynamics.
- 37 648. A Type A package designed to contain liquid radioactive material shall, in addition:

1 (a) Be adequate to meet the conditions specified in para. 646(a) if the package is subjected to the
2 tests specified in para. 725; and

3 (b) Either

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

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

11 649. A package designed for gases shall prevent loss or dispersal of the radioactive contents if
12 the package were subjected to the tests specified in para. 725. A Type A package designed for
13 tritium gas or for noble gases shall be excepted from this requirement.

14 REQUIREMENTS FOR TYPE B(U) PACKAGES

15 650. Type B(U) packages shall be designed to meet the requirements specified in paras 606–616,
16 the requirements of paras 617–619 if carried by air, and of paras 634–647, except as specified in
17 para. 646(a), and, in addition, the requirements specified in paras 651–664.

18 651. A package shall be so designed that, under the ambient conditions specified in paras 654
19 and 655, heat generated within the package by the radioactive contents shall not, under normal
20 conditions of transport, as demonstrated by the tests in paras 719–724, adversely affect the
21 package in such a way that it would fail to meet the applicable requirements for containment and
22 shielding if left unattended for a period of one week. Particular attention shall be paid to the
23 effects of heat, which may:

24 (a) Alter the arrangement, the geometrical form or the physical state of the radioactive contents
25 or, if the radioactive material is enclosed in a can or receptacle (for example, clad fuel elements),
26 cause the can, receptacle or radioactive material to deform or melt; or

27 (b) Lessen the efficiency of the *packaging* through differential thermal expansion, or cracking or
28 melting of the radiation shielding material; or

29 (c) In combination with moisture, accelerate corrosion.

30 652. A package shall be so designed that, under the ambient condition specified in para. 654 and
31 in the absence of insolation, the temperature of the accessible surfaces of a package shall not
32 exceed 50°C, unless the package is transported under *exclusive use*.

33 653. Except as required in para. 617 for a package transported by air, the maximum temperature
34 of any surface readily accessible during transport of a package under *exclusive use* shall not
35 exceed 85°C in the absence of insolation under the ambient conditions specified in para. 654.
36 Account may be taken of barriers or screens intended to give protection to persons without the
37 need for the barriers or screens being subject to any test.

1 654. The ambient temperature shall be assumed to be 38°C.

2 655. The solar insolation conditions shall be assumed to be as specified in Table 11.

3 656. A package which includes thermal protection for the purpose of satisfying the requirements
4 of the thermal test specified in para. 728 shall be so designed that such protection will remain
5 effective if the package is subjected to the tests specified in paras 719–724 and 727(a) and (b) or
6 727(b) and (c), as appropriate. Any such protection on the exterior of the package shall not be
7 rendered ineffective by ripping, cutting, skidding, abrasion or rough handling.

8 TABLE 12. INSOLATION DATA

9

10 Case	11 Form and location of surface	12 Insolation for 12 hours per day (W/m ²)
13 1	14 Flat surfaces transported horizontally — downward facing	0
15 2	15 Flat surfaces transported horizontally — upward facing	800
16 3	16 Surfaces transported vertically	200 ^a
17 4	17 Other downward facing (not horizontal) surfaces	200a
18 5	18 All other surfaces	400 ^a

19
20 ^a Alternatively, a sine function may be used, with an absorption coefficient adopted and the
21 effects of possible reflection from neighbouring objects neglected.
22

23 657. A package shall be so designed that, if it were subjected to:

24 (a) The tests specified in paras 719–724, it would restrict the loss of radioactive contents to not
25 more than 10–6A₂ per hour; and

26 (b) The tests specified in paras 726, 727(b), 728 and 729 and the tests in paras:

27 (i) 727(c), when the package has a mass not greater than 500 kg, an overall density not greater
28 than 1000 kg/m³ based on the external dimensions, and radioactive contents greater than 1000A₂
29 not as special form radioactive material, or

30 (ii) 727(a), for all other packages,

31 it would meet the following requirements:

32 (i) retain sufficient shielding to ensure that the radiation level at 1 m from the surface of the
33 package would not exceed 10 mSv/h with the maximum radioactive contents which the package
34 is designed to contain; and

35 (ii) restrict the accumulated loss of radioactive contents in a period of one week to not more than
36 10A₂ for krypton-85 and not more than A₂ for all other radionuclides. Where mixtures of different
37 radionuclides are present, the provisions of paras 404–406 shall apply except that for krypton-85
38 an effective A₂(i) value equal to 10A₂ may be used. For case (a) above, the assessment shall take
39 into account the external *contamination* limits of para. 508.

1 658. A package for radioactive contents with activity greater than $105A_2$ shall be so designed
2 that, if it were subjected to the enhanced water immersion test specified in para. 730, there would
3 be no rupture of the *containment system*.

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

6 660. A package shall not include a pressure relief system from the *containment system* which
7 would allow the release of radioactive material to the environment under the conditions of the
8 tests specified in paras 719–724 and 726–729.

9 661. A package shall be so designed that if it were at the *maximum normal operating pressure*
10 and it were subjected to the tests specified in paras 719–724 and 726–729, the level of strains in
11 the *containment system* would not attain values which would adversely affect the package in such
12 a way that it would fail to meet the applicable requirements.

13 662. A package shall not have a *maximum normal operating pressure* in excess of a gauge
14 pressure of 700 kPa.

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

19 664. A package shall be designed for an ambient temperature range from -40°C to $+38^{\circ}\text{C}$.
20

21 REQUIREMENTS FOR TYPE B(M) PACKAGES

22 665. Type B(M) packages shall meet the requirements for Type B(U) packages specified in para.
23 650, except that for packages to be transported solely within a specified country or solely
24 between specified countries, conditions other than those given in paras 637, 653–655 and 658–
25 664 above may be assumed with the approval of the competent authorities of these countries.
26 Notwithstanding, the requirements for Type B(U) packages specified in paras 653 and 658–664
27 shall be met as far as practicable.

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

30 REQUIREMENTS FOR TYPE C PACKAGES

31 667. Type C packages shall be designed to meet the requirements specified in paras 606–619,
32 and of paras 634–647, except as specified in para. 646(a), and of the requirements specified in
33 paras 651–655, 659–664, and, in addition, of paras 668–670.

34 668. A package shall be capable of meeting the assessment criteria prescribed for tests in paras
35 657(b) and 661 after burial in an environment defined by a thermal conductivity of $0.33 \text{ W}/(\text{m}\cdot\text{K})$
36 and a temperature of 38°C in the steady state. Initial conditions for the assessment shall assume
37 that any thermal insulation of the package remains intact, the package is at the *maximum normal*
38 *operating pressure* and the ambient temperature is 38°C .

1 669. A package shall be so designed that, if it were at the *maximum normal operating pressure*
2 and subjected to:

3 (a) the tests specified in paras 719–724, it would restrict the loss of radioactive contents to not
4 more than $10-6A_2$ per hour; and

5 (b) the test sequences in para. 734, it would meet the following requirements:

6 (i) retain sufficient shielding to ensure that the radiation level at 1 m from the surface of the
7 package would not exceed 10 mSv/h with the maximum radioactive contents which the
8 package is designed to contain; and

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

11 Where mixtures of different radionuclides are present, the provisions of paras 404–406 shall
12 apply, except that for krypton-85 an effective $A_2(i)$ value equal to $10A_2$ may be used. For case (a)
13 above, the assessment shall take into account the external *contamination* limits of para. 508.

14 670. A package shall be so designed that there will be no rupture of the *containment system*
15 following performance of the enhanced water immersion test specified in para. 730.

16 REQUIREMENTS FOR PACKAGES CONTAINING FISSILE MATERIAL

17 671. *Fissile material* shall be transported so as to:

18 (a) maintain subcriticality during normal and accident conditions of transport; in particular, the
19 following contingencies shall be considered:

20 (i) water leaking into or out of packages;

21 (ii) the loss of efficiency of built-in neutron absorbers or moderators;

22 (iii) rearrangement of the contents either within the package or as a result of loss from the
23 package;

24 (iv) reduction of spaces within or between packages;

25 (v) packages becoming immersed in water or buried in snow; and

26 (vi) temperature changes; and SECTION VI 94

27 (b) meet the requirements:

28 (i) of para 634 for packages containing *fissile material*;

29 (ii) prescribed elsewhere in these Regulations which pertain to the radioactive properties of
30 the material; and

31 (iii) specified in paras 635 and 672–681, unless excepted by para. 413.

1 **Exceptions from the requirements for packages containing fissile material**

2 672. Where the chemical or physical form, isotopic composition, mass or concentration,
3 moderation ratio or density, or geometric configuration is not known, the assessments of paras
4 676–681 shall be performed assuming that each parameter that is not known has the value which
5 gives the maximum neutron multiplication consistent with the known conditions and parameters
6 in these assessments.

7 673. For irradiated nuclear fuel the assessments of paras 676–681 shall be based on an isotopic
8 composition demonstrated to provide:

- 9 (a) the maximum neutron multiplication during the irradiation history, or
10 (b) a conservative estimate of the neutron multiplication for the package assessments. After
11 irradiation but prior to *shipment*, a measurement shall be performed to confirm the conservatism
12 of the isotopic composition.

13 **Geometry and temperature requirements**

14 674. The package, after being subjected to the tests specified in paras 719–724, shall:

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

17 TABLE 13. CONSIGNMENT MASS LIMITS FOR EXCEPTIONS FROM THE
18 REQUIREMENTS FOR PACKAGES CONTAINING FISSILE MATERIAL

<i>Fissile material</i>	<i>Fissile material</i> mass (g) mixed with substances having an average hydrogen density less than or equal to water	<i>Fissile material</i> mass (g) mixed with substances having an average hydrogen density greater than water
Uranium-235 (X)	400	290
Other <i>fissile material</i> (Y)	250	180

27
28 675. The package shall be designed for an ambient temperature range of -40°C to +38°C unless
29 the *competent authority* specifies otherwise in the certificate of approval for the *package design*.

30 **Assessment of an individual package in isolation**

31 676. For a package in isolation, it shall be assumed that water can leak into or out of all void
32 spaces of the package, including those within the *containment system*. However, if the *design*
33 incorporates special features to prevent such leakage of water into or out of certain void spaces,
34 even as a result of error, absence of leakage may be assumed in respect of those void spaces.
35 Special features shall include the following:

- 36 (a) Multiple high standard water barriers, each of which would remain watertight if the package
37 were subject to the tests prescribed in para. 681(b), a high degree of quality control in the

1 manufacture, maintenance and repair of *packagings*, and tests to demonstrate the closure of each
2 package before each *shipment*; or

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

5 (i) packages where, following the tests prescribed in para. 682(b), there is no physical contact
6 between the valve and any other component of the *packaging* other than at its original point of
7 attachment and where, in addition, following the test prescribed in para. 728 the valves remain
8 leaktight; and

9 (ii) a high degree of quality control in the manufacture, maintenance and repair of *packagings*,
10 coupled with tests to demonstrate closure of each package before each *shipment*.

11 677. It shall be assumed that the *confinement system* shall be closely reflected by at least 20 cm
12 of water or such greater reflection as may additionally be provided by the surrounding material of
13 the *packaging*. However, when it can be demonstrated that the *confinement system* remains
14 within the *packaging* following the tests prescribed in para. 682(b), close reflection of the
15 package by at least 20 cm of water may be assumed in para. 678(c).

16 678. The package shall be subcritical under the conditions of paras 676 and 677 with the *package*
17 conditions that result in the maximum neutron multiplication consistent with:

18 (a) routine conditions of transport (incident free);

19 (b) the tests specified in para. 681(b);

20 (c) the tests specified in para. 682(b).

21 679. For packages to be transported by air:

22 (a) the package shall be subcritical under conditions consistent with the Type C package tests
23 specified in para. 734 assuming reflection by at least 20 cm of water but no water in-leakage; and

24 (b) in the assessment of para. 678 allowance shall not be made for special features of para. 676
25 unless, following the Type C package tests specified in para. 734 and, subsequently, the water in-
26 leakage test of para. 733, leakage of water into or out of the void spaces is prevented.

27 **Assessment of package arrays under normal conditions of transport**

28 680. The *criticality safety index* (CSI) for packages containing *fissile material* shall be obtained
29 by dividing the number 50 by the smaller of the two values of N derived in paras 681 and 682
30 (i.e. $CSI = 50/N$). The value of the *criticality safety index* may be zero; provided that an
31 unlimited number of packages is subcritical (i.e. N is effectively equal to infinity in both cases).

32 681. A number “N” shall be derived, such that five times “N” packages shall be subcritical for
33 the arrangement and *package* conditions that provide the maximum neutron multiplication
34 consistent with the following:

35 (a) There shall not be anything between the packages, and the package arrangement shall be
36 reflected on all sides by at least 20 cm of water; and

1 (b) The state of the packages shall be their assessed or demonstrated condition if they had been
2 subjected to the tests specified in paras 719-724.

3 **Assessment of package arrays under accident conditions of transport**

4 682. A number “N” shall be derived, such that two times “N” packages shall be subcritical for
5 the arrangement and package conditions that provide the maximum neutron multiplication
6 consistent with the following:

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

9 (b) The tests specified in paras 719–724 followed by whichever of the following is the more
10 limiting:

11 (i) the tests specified in para. 727(b), and either para. 727(c) for packages having a mass not
12 greater than 500 kg and an overall density not greater than 1000 kg/m^3 based on the external
13 dimensions, or para. 727(a) for all other packages; followed by the test specified in para. 728 and
14 completed by the tests specified in paras 731–733; or

15 (ii) the test specified in para. 729; and

16 (c) Where any part of the *fissile material* escapes from the *containment system* following the tests
17 specified in para. 682(b), it shall be assumed that *fissile material* escapes from each package in
18 the array, and all of the *fissile material* shall be arranged in the configuration and moderation that
19 results in the maximum neutron multiplication with close reflection by at least 20 cm of water.

1 **Section VII**

2 **TEST PROCEDURES**

3
4 **DEMONSTRATION OF COMPLIANCE**

5 701. Demonstration of compliance with the performance standards required in Section VI shall
6 be accomplished by any of the methods listed below or by a combination thereof.

7 (a) Performance of tests with specimens representing LSA-III material, or special form
8 radioactive material, or *low dispersible radioactive material* or with prototypes or samples of the
9 *packaging*, where the contents of the specimen or the *packaging* for the tests shall simulate as
10 closely as practicable the expected range of radioactive contents and the specimen or *packaging*
11 to be tested shall be prepared as presented for transport.

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

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

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

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

23 **LEACHING TEST FOR LSA-III MATERIAL AND LOW DISPERSIBLE RADIOACTIVE**
24 **MATERIAL**

25 703. A solid material sample representing the entire contents of the package shall be immersed
26 for 7 days in water at ambient temperature. The volume of water to be used in the test shall be
27 sufficient to ensure that at the end of the 7 day test period the free volume of the unabsorbed and
28 unreacted water remaining shall be at least 10% of the volume of the solid test sample itself. The
29 water shall have an initial pH of 6–8 and a maximum conductivity of 1 mS/m at 20°C. The total
30 activity of the free volume of water shall be measured following the 7 day immersion of the test
31 sample.

32 **TESTS FOR SPECIAL FORM RADIOACTIVE MATERIAL**

33 **General**

34 704. Specimens that comprise or simulate special form radioactive material shall be subjected to
35 the impact test, the percussion test, the bending test and the heat test specified in paras 705–708.
36 A different specimen may be used for each of the tests. Following each test, a leaching
37 assessment or volumetric leakage test shall be performed on the specimen by a method no less

1 sensitive than the methods given in para. 710 for indispersible solid material or in para. 711 for
2 encapsulated material.

3 **Test methods**

4 705. Impact test: The specimen shall drop onto the target from a height of 9 m. The target shall
5 be as defined in para. 717.

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

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

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

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

25 (a) The tests prescribed in paras 705 and 706 provided the mass of the special form radioactive
26 material

27 (i) is less than 200 g and they are alternatively subjected to the Class 4 impact test prescribed in
28 the International Organization for Standardization document ISO 2919: "Sealed Radioactive
29 Sources — Classification" [11], or

30 (ii) is less than 500 g and they are alternatively subjected to the Class 5 impact test prescribed in
31 the International Organization for Standardization document ISO 2919: "Sealed Radioactive
32 Sources — Classification" [11], and

33 (b) The test prescribed in para. 708 provided they are alternatively subjected to the Class 6
34 temperature test specified in the International Organization for Standardization document ISO
35 2919: "Sealed Radioactive Sources — Classification" [11].

36 **Leaching and volumetric leakage assessment methods**

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

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

6 (b) The water with specimen shall then be heated to a temperature of $(50 \pm 5)^\circ\text{C}$ and maintained
7 at this temperature for 4 hours.

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

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

11 (e) The specimen shall then be immersed in water of the same specification as in (a) above and
12 the water with the specimen heated to $(50 \pm 5)^\circ\text{C}$ and maintained at this temperature for 4 hours.

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

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

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

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

19 (ii) The water and specimen shall be heated to a temperature of $(50 \pm 5)^\circ\text{C}$ and maintained at this
20 temperature for 4 hours.

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

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

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

25 (b) The alternative volumetric leakage assessment shall comprise any of the tests prescribed in
26 the International Organization for Standardization document ISO 9978: “Radiation Protection —
27 Sealed Radioactive Sources — Leakage Test Methods” [8] which are acceptable to the *competent*
28 *authority*.

29

30 TESTS FOR LOW DISPERSIBLE RADIOACTIVE MATERIAL

31 712. A specimen that comprises or simulates *low dispersible radioactive material* shall be
32 subjected to the enhanced thermal test specified in para. 736 and the impact test specified in para.
33 737. A different specimen may be used for each of the tests. Following each test, the specimen
34 shall be subjected to the leach test specified in para. 703. After each test it shall be determined if
35 the applicable requirements of para. 605 have been met.

1 TESTS FOR PACKAGES

2 **Preparation of a specimen for testing**

3 713. All specimens shall be inspected before testing in order to identify and record faults or
4 damage including the following:

- 5 (a) divergence from the *design*;
- 6 (b) defects in manufacture;
- 7 (c) corrosion or other deterioration; and
- 8 (d) distortion of features.

9 714. The *containment system* of the package shall be clearly specified.

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

12 **Testing the integrity of the containment system and shielding and assessing criticality**
13 **safety**

14 716. After each of the applicable tests specified in paras 718–737:

- 15 (a) Faults and damage shall be identified and recorded;
- 16 (b) It shall be determined whether the integrity of the *containment system* and shielding has been
17 retained to the extent required in Section VI for the package under test; and
- 18 (c) For packages containing *fissile material*, it shall be determined whether the assumptions and
19 conditions used in the assessments required by paras 671–681 for one or more packages are
20 valid.

21 **Target for drop tests**

22 717. The target for the drop test specified in paras 705, 722, 725(a), 727 and 735 shall be a flat,
23 horizontal surface of such a character that any increase in its resistance to displacement or
24 deformation upon impact by the specimen would not significantly increase damage to the
25 specimen.

26 **Test for packagings designed to contain uranium hexafluoride**

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

32 **Tests for demonstrating ability to withstand normal conditions of transport**

33 719. The tests are: the water spray test, the free drop test, the stacking test and the penetration
34 test. Specimens of the package shall be subjected to the free drop test, the stacking test and the

1 penetration test, preceded in each case by the water spray test. One specimen may be used for all
2 the tests, provided that the requirements of para. 720 are fulfilled.

3 720. The time interval between the conclusion of the water spray test and the succeeding test
4 shall be such that the water has soaked in to the maximum extent, without appreciable drying of
5 the exterior of the specimen. In the absence of any evidence to the contrary, this interval shall be
6 taken to be two hours if the water spray is applied from four directions simultaneously. No time
7 interval shall elapse, however, if the water spray is applied from each of the four directions
8 consecutively.

9 721. Water spray test: The specimen shall be subjected to a water spray test that simulates
10 exposure to rainfall of approximately 5 cm per hour for at least one hour.

11 722. Free drop test: The specimen shall drop onto the target so as to suffer maximum damage in
12 respect of the safety features to be tested.

13 (a) The height of drop measured from the lowest point of the specimen to the upper surface of the
14 target shall be not less than the distance specified in Table 14 for the applicable mass. The target
15 shall be as defined in para. 717.

16 (b) For rectangular fibreboard or wood packages not exceeding a mass of 50 kg, a separate
17 specimen shall be subjected to a free drop onto each corner from a height of 0.3 m.

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

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

23 (a) The equivalent of the total weight of 5 identical packages; and

24 (b) The equivalent of 13 kPa multiplied by the vertically projected area of the package. The load
25 shall be applied uniformly to two opposite sides of the specimen, one of which shall be the base
26 on which the package would typically rest.

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

29 (a) A bar of 3.2 cm in diameter with a hemispherical end and a mass of 6 kg shall be dropped and
30 directed to fall, with its longitudinal axis vertical, onto the centre of the weakest part of the
31 specimen, so that, if it penetrates sufficiently far, it will hit the *containment system*. The bar shall
32 not be significantly deformed by the test performance.

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

35 **Additional tests for Type A packages designed for liquids and gases**

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

4 (a) Free drop test: The specimen shall drop onto the target so as to suffer the maximum damage
5 in respect of containment. The height of the drop measured from the lowest part of the specimen
6 to the upper surface of the target shall be 9 m. The target shall be as defined in para. 717.

7 (b) Penetration test: The specimen shall be subjected to the test specified in para. 724 except that
8 the height of drop shall be increased to 1.7 m from the 1 m specified in para. 724(b).

9

10 TABLE 14. FREE DROP DISTANCE FOR TESTING PACKAGES TO NORMAL
11 CONDITIONS OF TRANSPORT

13 <i>Package mass (kg)</i>	Free drop distance (m)
14	
15 <i>Package mass</i> < 5 000	1.2
16 5 000 ≤ <i>Package mass</i> < 10 000	0.9
17 10 000 ≤ <i>Package mass</i> < 15 000	0.6
18 15 000 ≤ <i>Package mass</i>	0.3

19

20 **Tests for demonstrating ability to withstand accident conditions of transport**

21 726. The specimen shall be subjected to the cumulative effects of the tests specified in para. 727
22 and para. 728, in that order. Following these tests, either this specimen or a separate specimen
23 shall be subjected to the effect(s) of the water immersion test(s) as specified in para. 729 and, if
24 applicable, para. 730.

25 727. Mechanical test: The mechanical test consists of three different drop tests. Each specimen
26 shall be subjected to the applicable drops as specified in para. 657 or para. 681. The order in
27 which the specimen is subjected to the drops shall be such that, on completion of the mechanical
28 test, the specimen shall have suffered such damage as will lead to maximum damage in the
29 thermal test which follows:

30 (a) For drop I, the specimen shall drop onto the target so as to suffer maximum damage, and the
31 height of the drop measured from the lowest point of the specimen to the upper surface of the
32 target shall be 9 m. The target shall be as defined in para. 717.

33 (b) For drop II, the specimen shall drop so as to suffer maximum damage onto a bar rigidly
34 mounted perpendicularly on the target. The height of the drop measured from the intended point
35 of impact of the specimen to the upper surface of the bar shall be 1 m. The bar shall be of solid
36 mild steel of circular section, (15.0 ± 0.5) cm in diameter and 20 cm long unless a longer bar
37 would cause greater damage, in which case a bar of sufficient length to cause maximum damage
38 shall be used. The upper end of the bar shall be flat and horizontal with its edge rounded off to a
39 radius of not more than 6 mm. The target on which the bar is mounted shall be as described in
40 para. 717.

1 (c) For drop III, the specimen shall be subjected to a dynamic crush test by positioning the
2 specimen on the target so as to suffer maximum damage by the drop of a 500 kg mass from 9 m
3 onto the specimen. The mass shall consist of a solid mild steel plate 1 m by 1 m and shall fall in a
4 horizontal attitude. The height of the drop shall be measured from the underside of the plate to
5 the highest point of the specimen. The target on which the specimen rests shall be as defined in
6 para. 717.

7 728. Thermal test: The specimen shall be in thermal equilibrium under conditions of an ambient
8 temperature of 38°C, subject to the solar insolation conditions specified in Table 12 and subject
9 to the *design* maximum rate of internal heat generation within the package from the radioactive
10 contents. Alternatively, any of these parameters are allowed to have different values prior to and
11 during the test, provided due account is taken of them in the subsequent assessment of package
12 response. The thermal test shall then consist of:

13 (a) Exposure of a specimen for a period of 30 minutes to a thermal environment which provides a
14 heat flux at least equivalent to that of a hydrocarbon fuel/air fire in sufficiently quiescent ambient
15 conditions to give a minimum average flame emissivity coefficient of 0.9 and an average
16 temperature of at least 800°C, fully engulfing the specimen, with a surface absorptivity
17 coefficient of 0.8 or that value which the package may be demonstrated to possess if exposed to
18 the fire specified, followed by

19 (b) Exposure of the specimen to an ambient temperature of 38°C, subject to the solar insolation
20 conditions specified in Table 12 and subject to the *design* maximum rate of internal heat
21 generation within the package by the radioactive contents for a sufficient period to ensure that
22 temperatures in the specimen are everywhere decreasing and/or are approaching initial steady
23 state conditions. Alternatively, any of these parameters are allowed to have different values
24 following cessation of heating, provided due account is taken of them in the subsequent
25 assessment of package response. During and following the test the specimen shall not be
26 artificially cooled and any combustion of materials of the specimen shall be permitted to proceed
27 naturally.

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

32 **Enhanced water immersion test for Type B(U) and Type B(M) packages containing more**
33 **than 10⁵A₂ and Type C packages**

34 730. Enhanced water immersion test: The specimen shall be immersed under a head of water of
35 at least 200 m for a period of not less than one hour. For demonstration purposes, an external
36 gauge pressure of at least 2 MPa shall be considered to meet these conditions. Water leakage test
37 for packages containing *fissile material*

38 731. Packages for which water in-leakage or out-leakage to the extent which results in greatest
39 reactivity has been assumed for purposes of assessment under paras 676–681 shall be excepted
40 from the test.

1 732. Before the specimen is subjected to the water leakage test specified below, it shall be
2 subjected to the tests in para. 727(b), and either para. 727(a) or (c) as required by para. 681, and
3 the test specified in para. 728.

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

6 **Tests for Type C packages**

7 734. Specimens shall be subjected to the effects of each of the following test sequences in the
8 orders specified:

- 9 (a) the tests specified in paras 727(a), 727(c), 735 and 736; and
- 10 (b) the test specified in para. 737.

11 Separate specimens are allowed to be used for each of the sequences (a) and (b).

12 735. Puncture/tearing test: The specimen shall be subjected to the damaging effects of a solid
13 probe made of mild steel. The orientation of the probe to the surface of the specimen shall be
14 such as to cause maximum damage at the conclusion of the test sequence specified in para.
15 734(a):

16 (a) The specimen, representing a package having a mass of less than 250 kg, shall be placed on a
17 target and subjected to a probe having a mass of 250 kg falling from a height of 3 m above the
18 intended impact point. For this test the probe shall be a 20 cm diameter cylindrical bar with the
19 striking end forming a frustum of a right circular cone with the following dimensions: 30 cm
20 height and 2.5 cm diameter at the top with its edge rounded off to a radius of not more than 6
21 mm. The target on which the specimen is placed shall be as specified in para. 717.

22 (b) For packages having a mass of 250 kg or more, the base of the probe shall be placed on a
23 target and the specimen dropped onto the probe. The height of the drop, measured from the point
24 of impact with the specimen to the upper surface of the probe, shall be 3 m. For this test the
25 probe shall have the same properties and dimensions as specified in (a) above, except that the
26 length and mass of the probe shall be such as to incur maximum damage to the specimen. The
27 target on which the base of the probe is placed shall be as specified in para. 717.

28 736. Enhanced thermal test: The conditions for this test shall be as specified in para. 728, except
29 that the exposure to the thermal environment shall be for a period of 60 minutes.

30 737. Impact test: The specimen shall be subject to an impact on a target at a velocity of not less
31 than 90 m/s, at such an orientation as to suffer maximum damage. The target shall be as defined
32 in para. 717, except that the target surface may be at any orientation as long as the surface is
33 normal to the specimen path.

1 **Section VIII**

2 **APPROVAL AND ADMINISTRATIVE REQUIREMENTS**

3 GENERAL

4 801. For package *designs* where it is not required that a *competent authority* issue an approval
5 certificate the *consignor* shall, on request, make available for inspection by the relevant
6 *competent authority*, documentary evidence of the compliance of the package *design* with all the
7 applicable requirements.

8 802. *Competent authority* approval shall be required for the following:

9 (a) *designs* for

10 (i) special form radioactive material (see paras 803, 804 and 818);

11 (ii) *low dispersible radioactive material* (see paras 803 and 804);

12 (iii) packages containing 0.1 kg or more of uranium hexafluoride (see para. 805);

13 (iv) all packages containing *fissile material* unless excepted by para. 413 (see paras 812–814, 816
14 and 817);

15 (v) Type B(U) packages and Type B(M) packages (see paras 806–811, 816 and 817);

16 (vi) Type C packages (see paras 806–808);

17 (b) special arrangements (see paras 824–826);

18 (c) certain *shipments* (see paras 820–823);

19 (d) radiation protection programme for special use vessels (see para. 574(a)); and (e) calculation
20 of radionuclide values that are not listed in Table 1 (see para. 402).

21 APPROVAL OF SPECIAL FORM RADIOACTIVE MATERIAL AND LOW DISPERSIBLE
22 RADIOACTIVE MATERIAL

23 803. The *design* for special form radioactive material shall require *unilateral approval*. The
24 *design* for *low dispersible radioactive material* shall require *multilateral approval*. In both cases,
25 an application for approval shall include:

26 (a) a detailed description of the radioactive material or, if a capsule, the contents; particular
27 reference shall be made to both physical and chemical states;

28 (b) a detailed statement of the *design* of any capsule to be used;

29 (c) a statement of the tests which have been done and their results, or evidence based on
30 calculative methods to show that the radioactive material is capable of meeting the performance

1 standards, or other evidence that the special form radioactive material or *low dispersible*
2 *radioactive material* meets the applicable requirements of these Regulations;

3 (d) a specification of the applicable quality assurance programme as required in para. 306; and

4 (e) any proposed pre-shipment actions for use in the *consignment* of special form radioactive
5 material or *low dispersible radioactive material*.

6 804. The *competent authority* shall establish an approval certificate stating that the approved
7 *design* meets the requirements for special form radioactive material or *low dispersible*
8 *radioactive material* and shall attribute to that *design* an identification mark.

9 APPROVAL OF PACKAGE DESIGNS

10 Approval of package designs to contain uranium hexafluoride

11 805. The approval of *designs* for packages containing 0.1 kg or more of uranium hexafluoride
12 requires that:

13 (a) Each *design* that meets the requirements of para. 632 shall require *multilateral approval*.

14 (b) Each *design* that meets the requirements of paras 629–631 shall require *unilateral approval*
15 by the *competent authority* of the country of origin of the *design*, unless *multilateral approval* is
16 otherwise required by these regulations.

17 (c) The application for approval shall include all information necessary to satisfy the *competent*
18 *authority* that the *design* meets the requirements of para. 629, and a specification of the
19 applicable quality assurance programme as required in para. 306;

20 (d) The *competent authority* shall establish an approval certificate stating that the approved
21 *design* meets the requirements of para. 629 and shall attribute to that *design* an identification
22 mark.

23 Approval of Type B(U) and Type C package designs

24 806. Each Type B(U) and Type C package *design* shall require *unilateral approval*, except that:

25 (a) a package *design* for *fissile material*, which is also subject to paras 812-814, shall require
26 *multilateral approval*; and

27 (b) a Type B(U) package *design* for *low dispersible radioactive material* shall require
28 *multilateral approval*.

29 807. An application for approval shall include:

30 (a) a detailed description of the proposed radioactive contents with reference to their physical
31 and chemical states and the nature of the radiation emitted;

32 (b) a detailed statement of the *design*, including complete engineering drawings and schedules of
33 materials and methods of manufacture;

1 (c) a statement of the tests which have been done and their results, or evidence based on
2 calculative methods or other evidence that the *design* is adequate to meet the applicable
3 requirements;

4 (d) the proposed operating and maintenance instructions for the use of the *packaging*;

5 (e) if the package is designed to have a *maximum normal operating pressure* in excess of 100
6 kPa gauge, a specification of the materials of manufacture of the *containment system*, the samples
7 to be taken, and the tests to be made;

8 (f) where the proposed radioactive contents are irradiated fuel, the applicant shall state and
9 justify any assumption in the safety analysis relating to the characteristics of the fuel and
10 describe any pre-shipment measurement required by para. 673(b);

11 (g) any special stowage provisions necessary to ensure the safe dissipation of heat from the
12 package considering the various modes of transport to be used and type of *conveyance* or *freight*
13 *container*;

14 (h) a reproducible illustration, not larger than 21 cm by 30 cm, showing the make-up of the
15 package; and

16 (i) a specification of the applicable quality assurance programme as required in para. 306. 808.

17 808. The *competent authority* shall establish an approval certificate stating that the approved
18 *design* meets the requirements for Type B(U) or Type C packages and shall attribute to that
19 *design* an identification mark.

20 **Approval of Type B(M) package designs**

21 809. Each Type B(M) package *design*, including those for *fissile material* which are also subject
22 to paras 812–814 and those for *low dispersible radioactive material*, shall require *multilateral*
23 *approval*.

24 810. An application for approval of a Type B(M) package *design* shall include, in addition to the
25 information required in para. 807 for Type B(U) packages:

26 (a) a list of the requirements specified in paras 637, 653–655 and 658–664 with which the
27 package does not conform;

28 (b) any proposed supplementary operational controls to be applied during transport not regularly
29 provided for in these Regulations, but which are necessary to ensure the safety of the package or
30 to compensate for the deficiencies listed in (a) above;

31 (c) a statement relative to any restrictions on the mode of transport and to any special loading,
32 carriage, unloading or handling procedures; and

33 (d) the range of ambient conditions (temperature, solar radiation) which are expected to be
34 encountered during transport and which have been taken into account in the *design*.

1 811. The *competent authority* shall establish an approval certificate stating that the approved
2 *design* meets the applicable requirements for Type B(M) packages and shall attribute to that
3 *design* an identification mark.

4 **Approval of package designs to contain fissile material**

5 812. Each package *design* for *fissile material* which is not excepted according to para. 413 from
6 the requirements that apply specifically to packages containing *fissile material* shall require
7 *multilateral approval*.

8 813. An application for approval shall include all information necessary to satisfy the *competent*
9 *authority* that the *design* meets the requirements of para. 671, and a specification of the
10 applicable quality assurance programme as required in para. 306.

11 814. The *competent authority* shall establish an approval certificate stating that the approved
12 *design* meets the requirements of para. 671 and shall attribute to that *design* an identification
13 mark.

14 **TRANSITIONAL ARRANGEMENTS**

15 **Packages not requiring competent authority approval of design under the 1985 and 1985** 16 **(As Amended 1990) Editions of these Regulations**

17 815. *Excepted packages*, Type IP-1, Type IP-2, Type IP-3 and Type A packages that did not
18 require approval of *design* by the *competent authority* and which meet the requirements of the
19 1985 or 1985 (As Amended 1990) Editions of these Regulations may continue to be used subject
20 to the mandatory programme of quality assurance in accordance with the requirements of para.
21 306 and the activity limits and material restrictions of Section IV. Any *packaging* modified,
22 unless to improve safety, or manufactured after 31 December 2003, shall meet this Edition of the
23 Regulations in full. Packages prepared for transport not later than 31 December 2003 under the
24 1985 or 1985 (As Amended 1990) Editions of these Regulations may continue in transport.
25 Packages prepared for transport after this date shall meet this Edition of the Regulations in full.

26 **Packages approved under the 1973, 1973 (As Amended), 1985 and 1985 (As Amended 1990)** 27 **Editions of these Regulations**

28 816. *Packagings* manufactured to a package *design* approved by the *competent authority* under
29 the provisions of the 1973 or 1973 (As Amended) Editions of these Regulations may continue to
30 be used, subject to: *multilateral approval* of package *design*, the mandatory programme of
31 quality assurance in accordance with the applicable requirements of para. 306; the activity limits
32 and material restrictions of Section IV; and, for a package containing *fissile material* and
33 transported by air, the requirement of para. 679. No new manufacture of such *packaging* shall be
34 permitted to commence. Changes in the *design* of the *packaging* or in the nature or quantity of
35 the authorized radioactive contents which, as determined by the *competent authority*, would
36 significantly affect safety shall require that this Edition of the Regulations be met in full. A serial
37 number according to the provision of para. 539 shall be assigned to and marked on the outside of
38 each *packaging*.

1 817. *Packagings* manufactured to a package *design* approved by the *competent authority* under
2 the provisions of the 1985 or 1985 (As Amended 1990) Editions of these Regulations may
3 continue to be used, subject to: *multilateral approval* of package *design*, the mandatory
4 programme of quality assurance in accordance with the requirements of para. 306; the activity
5 limits and material restrictions of Section IV; and, for a package containing *fissile material* and
6 transported by air, the requirement of para. 679. Changes in the *design* of the *packaging* or in the
7 nature or quantity of the authorized radioactive contents which, as determined by the *competent*
8 *authority*, would significantly affect safety shall require that this Edition of the Regulations be
9 met in full. All *packagings* for which manufacture begins after 31 December 2006 shall meet this
10 Edition of the Regulations in full.

11 **Special form radioactive material approved under the 1973, 1973 (As Amended), 1985 and**
12 **1985 (As Amended 1990) Editions of these Regulations**

13 818. Special form radioactive material manufactured to a *design* which had received *unilateral*
14 *approval* by the *competent authority* under the 1973, 1973 (As Amended), 1985 or 1985 (As
15 Amended 1990) Editions of these Regulations may continue to be used when in compliance with
16 the mandatory programme of quality assurance in accordance with the applicable requirements of
17 para. 306. All special form radioactive material manufactured after 31 December 2003 shall meet
18 this Edition of the Regulations in full.

19 NOTIFICATION AND REGISTRATION OF SERIAL NUMBERS

20 819. The *competent authority* shall be informed of the serial number of each *packaging*
21 manufactured to a *design* approved under paras 806, 809, 812, 816 and 817.

22 APPROVAL OF SHIPMENTS

23 820. *Multilateral approval* shall be required for:

24 (a) The *shipment* of Type B(M) packages not conforming with the requirements of para. 637 or
25 designed to allow controlled intermittent venting;

26 (b) The *shipment* of Type B(M) packages containing radioactive material with an activity greater
27 than $3000A_1$ or $3000A_2$, as appropriate, or 1000 TBq, whichever is the lower;

28 (c) The *shipment* of packages containing *fissile materials* if the sum of the *criticality safety*
29 *indexes* of the packages in a single *freight container* or in a single *conveyance* exceeds 50.
30 Excluded from this requirement shall be shipments by seagoing vessels, if the sum of the
31 *criticality safety indexes* does not exceed 50 for any hold, compartment or *defined deck area* and
32 the distance of 6 m between groups of packages or *overpacks* as required in Table 11 is met; and

33 (d) Radiation protection programmes for shipments by special use vessels according to para.
34 574(a).

35 821. A *competent authority* may authorize transport into or through its country without *shipment*
36 approval, by a specific provision in its *design* approval (see para. 827).

37 822. An application for *shipment* approval shall include:

- 1 (a) the period of time, related to the *shipment*, for which the approval is sought;
- 2 (b) the actual radioactive contents, the expected modes of transport, the type of *conveyance*
3 and the probable or proposed route; and
- 4 (c) the details of how the precautions and administrative or operational controls, referred to
5 in the package *design* approval certificates issued under paras 808, 811 and 814, are to be
6 put into effect.

7 823. Upon approval of the *shipment*, the *competent authority* shall issue an approval certificate.

8 APPROVAL OF SHIPMENTS UNDER SPECIAL ARRANGEMENT

9 824. Each *consignment* transported under special arrangement shall require *multilateral*
10 *approval*.

11 825. An application for approval of shipments under special arrangement shall include all the
12 information necessary to satisfy the *competent authority* that the overall level of safety in
13 transport is at least equivalent to that which would be provided if all the applicable requirements
14 of these Regulations had been met. The application shall also include:

- 15 (a) A statement of the respects in which, and of the reasons why, the shipment cannot be
16 made in full accordance with the applicable requirements; and
- 17 (b) A statement of any special precautions or special administrative or operational controls
18 which are to be employed during transport to compensate for the failure to meet the
19 applicable requirements.

20 826. Upon approval of shipments under special arrangement, the *competent authority* shall issue
21 an approval certificate.

22 COMPETENT AUTHORITY APPROVAL CERTIFICATES

23 827. Five types of approval certificates may be issued: for special form radioactive material, *low*
24 *dispersible radioactive material*, special arrangement, *shipment* and package *design*. The
25 package *design* and *shipment* approval certificates may be combined into a single certificate.

26 **Competent authority identification marks**

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

29 VRI/Number/Type Code

- 30 (a) Except as provided in para. 829(b), VRI represents the international vehicle registration
31 identification code of the country issuing the certificate.
- 32 (b) The number shall be assigned by the *competent authority*, and shall be unique and specific
33 with regard to the particular *design* or *shipment*. The *shipment* approval identification mark
34 shall be clearly related to the *design* approval identification mark.

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

- 3 AF Type A package *design* for *fissile material*
- 4 B(U) Type B(U) package *design* [B(U)F if for *fissile material*]
- 5 B(M) Type B(M) package *design* [B(M)F if for *fissile material*]
- 6 C Type C package *design* [CF if for *fissile material*]
- 7 IF Industrial package *design* for *fissile material*
- 8 S Special form radioactive material
- 9 LD *Low dispersible radioactive material*
- 10 T *Shipment*
- 11 X Special arrangement.

12 In the case of package *designs* for non-fissile or fissile excepted uranium hexafluoride, where
13 none of the above codes apply, the following type codes shall be used;

- 14 H(U) *Unilateral approval*
- 15 H(M) *Multilateral approval.*

16 (d) For package *design* and special form radioactive material approval certificates, other than
17 those issued under the provisions of paras 816-818, and for *low dispersible radioactive*
18 *material* approval certificates, the symbols “-96” shall be added to the type code.

19 829. These type codes shall be applied as follows:

- 20 (a) Each certificate and each package shall bear the appropriate identification mark,
21 comprising the symbols prescribed in paras 828(a), (b), (c) and (d) above, except that, for
22 packages, only the applicable *design* type codes including, if applicable, the symbols ‘-
23 96’ shall appear following the second stroke, that is, the ‘T’ or ‘X’ shall not appear in the
24 identification marking on the package. Where the *design* approval and *shipment* approval
25 are combined, the applicable type codes do not need to be repeated. For example:

26 A/132/B(M)F-96: A Type B(M) package *design* approved for *fissile material*, requiring
27 *multilateral approval*, for which the *competent authority* of Austria has
28 assigned the *design* number 132 (to be marked both on the package and on the
29 package *design* approval certificate);

30 A/132/B(M)F-96T: The *shipment* approval issued for a package bearing the identification mark
31 elaborated above (to be marked on the certificate only);

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

4 A/139/IF-96: An Industrial package *design* for *fissile material* approved by the *competent*
5 *authority* of Austria, to which package *design* number 139 has been assigned
6 (to be marked both on the package and on the package *design* approval
7 certificate); and

8 A/145/H(U)-96: A package *design* for fissile excepted uranium hexafluoride approved by the
9 *competent authority* of Austria, to which package *design* number 145 has
10 been assigned (to be marked both on the package and on the package *design*
11 approval certificate).

12 (b) Where *multilateral approval* is effected by validation according to para. 834, only the
13 identification mark issued by the country of origin of the *design* or *shipment* shall be
14 used. Where *multilateral approval* is effected by issue of certificates by successive
15 countries, each certificate shall bear the appropriate identification mark, and the package
16 whose *design* was so approved shall bear all appropriate identification marks.

17 For example:

18 A/132/B(M)F-96

19 CH/28/B(M)F-96

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

23 (c) The revision of a certificate shall be indicated by a parenthetical expression following the
24 identification mark on the certificate. For example, A/132/B(M)F-96(Rev.2) would indicate
25 revision 2 of the Austrian package *design* approval certificate; or A/132/B(M)F-96(Rev.0)
26 would indicate the original issuance of the Austrian package *design* approval certificate. For
27 original issuances, the parenthetical entry is optional and other words such as 'original
28 issuance' may also be used in place of 'Rev.0'. Certificate revision numbers may only be
29 issued by the country issuing the original approval certificate.

30 (d) Additional symbols (as may be necessitated by national requirements) may be added in
31 brackets to the end of the identification mark; for example, A/132/B(M)F-96(SP503).

32 (e) It is not necessary to alter the identification mark on the *packaging* each time that a revision
33 to the *design* certificate is made. Such re-marking shall be required only in those cases
34 where the revision to the package *design* certificate involves a change in the letter type
35 codes for the package *design* following the second stroke.

36 CONTENTS OF APPROVAL CERTIFICATES

37 **Special form radioactive material and low dispersible radioactive material approval** 38 **certificates**

1 830. Each approval certificate issued by a *competent authority* for special form radioactive
2 material or *low dispersible radioactive material* shall include the following information:

3 (a) Type of certificate.

4 (b) The *competent authority* identification mark.

5 (c) The issue date and an expiry date.

6 (d) List of applicable national and international regulations, including the edition of the IAEA
7 Regulations for the Safe Transport of Radioactive Material under which the special form
8 radioactive material or *low dispersible radioactive material* is approved.

9 (e) The identification of the special form radioactive material or *low dispersible radioactive*
10 *material*.

11 (f) A description of the special form radioactive material or *low dispersible radioactive material*.

12 (g) *Design* specifications for the special form radioactive material or *low dispersible radioactive*
13 *material*, which may include references to drawings.

14 (h) A specification of the radioactive contents which includes the activities involved and which
15 may include the physical and chemical forms.

16 (i) A specification of the applicable quality assurance programme as required in para. 306.

17 (j) Reference to information provided by the applicant relating to specific actions to be taken
18 prior to *shipment*.

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

20 (l) Signature and identification of the certifying official.

21 **Special arrangement approval certificates**

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

24 (a) Type of certificate.

25 (b) The *competent authority* identification mark.

26 (c) The issue date and an expiry date.

27 (d) Mode(s) of transport.

28 (e) Any restrictions on the modes of transport, type of *conveyance*, *freight container*, and any
29 necessary routing instructions.

- 1 (f) List of applicable national and international regulations, including the edition of the IAEA
2 Regulations for the Safe Transport of Radioactive Material under which the special arrangement
3 is approved.
- 4 (g) The following statement: “This certificate does not relieve the *consignor* from compliance
5 with any requirement of the government of any country through or into which the package will be
6 transported.”
- 7 (h) References to certificates for alternative radioactive contents, other *competent authority*
8 validation, or additional technical data or information, as deemed appropriate by the *competent*
9 *authority*.
- 10 (i) Description of the *packaging* by a reference to the drawings or a specification of the *design*. If
11 deemed appropriate by the *competent authority*, a reproducible illustration not larger than 21 cm
12 by 30 cm, showing the make-up of the package, should also be provided, accompanied by a brief
13 description of the *packaging*, including materials of manufacture, gross mass, general outside
14 dimensions and appearance.
- 15 (j) A specification of the authorized radioactive contents, including any restrictions on the
16 radioactive contents which might not be obvious from the nature of the *packaging*. This shall
17 include the physical and chemical forms, the activities involved (including those of the various
18 isotopes, if appropriate), amounts in grams (for *fissile material* or for each *fissile nuclide* when
19 appropriate), and whether special form radioactive material or *low dispersible radioactive*
20 *material*, if applicable.
- 21 (k) Additionally, for packages containing *fissile material*:
- 22 (i) a detailed description of the authorized radioactive contents;
- 23 (ii) the value of the *criticality safety index*;
- 24 (iii) reference to the documentation that demonstrates the criticality safety of the contents;
- 25 (iv) any special features on the basis of which the absence of water from certain void spaces has
26 been assumed in the criticality assessment;
- 27 (v) any allowance (based on para. 673(b)) for a change in neutron multiplication assumed in the
28 criticality assessment as a result of actual irradiation experience; and
- 29 (vi) the ambient temperature range for which the special arrangement has been approved.
- 30 (l) A detailed listing of any supplementary operational controls required for preparation, loading,
31 carriage, unloading and handling of the *consignment*, including any special stowage provisions
32 for the safe dissipation of heat.
- 33 (m) If deemed appropriate by the *competent authority*, reasons for the special arrangement.
- 34 (n) Description of the compensatory measures to be applied as a result of the *shipment* being
35 under special arrangement.

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

3 (p) A statement regarding the ambient conditions assumed for purposes of *design* if these are not
4 in accordance with those specified in paras 654, 655 and 664, as applicable.

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

6 (r) A specification of the applicable quality assurance programme as required in para. 306.

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

9 (t) Signature and identification of the certifying official.

10 **Shipment approval certificates**

11 832. Each approval certificate for a *shipment* issued by a *competent authority* shall include the
12 following information:

13 (a) Type of certificate.

14 (b) The *competent authority* identification mark(s).

15 (c) The issue date and an expiry date.

16 (d) List of applicable national and international regulations, including the edition of the IAEA
17 Regulations for the Safe Transport of Radioactive Material under which the *shipment* is
18 approved.

19 (e) Any restrictions on the modes of transport, type of *conveyance*, *freight container*, and any
20 necessary routing instructions.

21 (f) The following statement: "This certificate does not relieve the *consignor* from compliance
22 with any requirement of the government of any country through or into which the package will be
23 transported."

24 (g) A detailed listing of any supplementary operational controls required for preparation, loading,
25 carriage, unloading and handling of the *consignment*, including any special stowage provisions
26 for the safe dissipation of heat or maintenance of criticality safety.

27 (h) Reference to information provided by the applicant relating to specific actions to be taken
28 prior to *shipment*.

29 (i) Reference to the applicable *design* approval certificate(s).

30 (j) A specification of the actual radioactive contents, including any restrictions on the radioactive
31 contents which might not be obvious from the nature of the *packaging*. This shall include the
32 physical and chemical forms, the total activities involved (including those of the various isotopes,
33 if appropriate), amounts in grams (for *fissile material* or for each *fissile nuclide* when

1 appropriate), and whether special form radioactive material or *low dispersible radioactive*
2 *material*, if applicable.

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

4 (l) A specification of the applicable quality assurance programme as required in para. 306.

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

6 (n) Signature and identification of the certifying official.

7 **Package design approval certificates**

8 833. Each approval certificate of the *design* of a package issued by a *competent authority* shall
9 include the following information:

10 (a) Type of certificate.

11 (b) The *competent authority* identification mark.

12 (c) The issue date and an expiry date.

13 (d) Any restriction on the modes of transport, if appropriate.

14 (e) List of applicable national and international regulations, including the edition of the IAEA
15 Regulations for the Safe Transport of Radioactive Material under which the *design* is approved.

16 (f) The following statement: "This certificate does not relieve the *consignor* from compliance
17 with any requirement of the government of any country through or into which the package will be
18 transported."

19 (g) References to certificates for alternative radioactive contents, other *competent authority*
20 validation, or additional technical data or information, as deemed appropriate by the *competent*
21 *authority*.

22 (h) A statement authorizing *shipment* where *shipment* approval is required under para. 820, if
23 deemed appropriate.

24 (i) Identification of the *packaging*.

25 (j) Description of the *packaging* by a reference to the drawings or specification of the *design*. If
26 deemed appropriate by the *competent authority*, a reproducible illustration not larger than 21 cm
27 by 30 cm, showing the make-up of the package, should also be provided, accompanied by a brief
28 description of the *packaging*, including materials of manufacture, gross mass, general outside
29 dimensions and appearance.

30 (k) Specification of the *design* by reference to the drawings.

31 (l) A specification of the authorized radioactive contents, including any restrictions on the
32 radioactive contents which might not be obvious from the nature of the *packaging*. This shall

- 1 include the physical and chemical forms, the activities involved (including those of the various
2 isotopes, if appropriate), amounts in grams (for *fissile material* or for each *fissile nuclide* when
3 appropriate), and whether special form radioactive material or *low dispersible radioactive*
4 *material*, if applicable.
- 5 (m) A description of the *containment system*.
- 6 (n) Additionally, for packages containing *fissile material*:
- 7 (i) A detailed description of the authorized radioactive contents;
- 8 (ii) A description of the *confinement system*;
- 9 (iii) The value of the *criticality safety index*;
- 10 (iv) Reference to the documentation that demonstrates the criticality safety of the contents;
- 11 (v) Any special features on the basis of which the absence of water from certain void spaces has
12 been assumed in the criticality assessment;
- 13 (vi) Any allowance (based on para. 673(b)) for a change in neutron multiplication assumed in the
14 criticality assessment as a result of actual irradiation experience; and
- 15 (vii) The ambient temperature range for which the package *design* has been approved.
- 16 (o) For Type B(M) packages, a statement specifying those prescriptions of paras 637, 653–655
17 and 658–664 with which the package does not conform and any amplifying information which
18 may be useful to other competent authorities.
- 19 (p) For packages containing more than 0.1 kg of uranium hexafluoride, a statement specifying
20 those prescriptions of para. 632 that apply, if any, and any amplifying information which may be
21 useful to other competent authorities.
- 22 (q) A detailed listing of any supplementary operational controls required for preparation, loading,
23 carriage, unloading and handling of the *consignment*, including any special stowage provisions
24 for the safe dissipation of heat.
- 25 (r) Reference to information provided by the applicant relating to the use of the *packaging* or
26 specific actions to be taken prior to *shipment*.
- 27 (s) A statement regarding the ambient conditions assumed for purposes of *design* if these are not
28 in accordance with those specified in paras 654, 655 and 664, as applicable.
- 29 (t) A specification of the applicable quality assurance programme as required in para. 306.
- 30 (u) Any emergency arrangements deemed necessary by the *competent authority*.
- 31 (v) If deemed appropriate by the *competent authority*, reference to the identity of the applicant.
- 32 (w) Signature and identification of the certifying official.

1 VALIDATION OF CERTIFICATES

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

DRAFT

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