

2.2.7 Class 7 Radioactive material

2.2.7.1 Definition of Class 7

2.2.7.1.1 *Radioactive material* means any material containing radionuclides where both the activity concentration and the total activity in the consignment exceed the values specified in 2.2.7.7.2.1 to 2.2.7.7.2.6.

2.2.7.1.2 The following radioactive materials are not included in Class 7 for the purposes of ADR:

- (a) Radioactive material that is an integral part of the means of transport;
- (b) Radioactive material moved within an establishment which is subject to appropriate safety regulations in force in the establishment and where the movement does not involve public roads or railways;
- (c) Radioactive material implanted or incorporated into a person or live animal for diagnosis or treatment;
- (d) Radioactive material in consumer products which have received regulatory approval, following their sale to the end user;
- (e) Natural material and ores containing naturally occurring radionuclides which are either in their natural state, or have only been processed for purposes other than for extraction of the radionuclides, and which are not intended to be processed for use of these radionuclides provided the activity concentration of the material does not exceed 10 times the values specified in 2.2.7.7.2;
- (f) Non-radioactive solid objects with radioactive substances present on any surfaces in quantities not in excess of the limit set out in the definition for "contamination" in 2.2.7.2.

2.2.7.2 Definitions

A_1 and A_2

A_1 means the activity value of special form radioactive material which is listed in Table 2.2.7.7.2.1 or derived in 2.2.7.7.2 and is used to determine the activity limits for the requirements of ADR.

A_2 means the activity value of radioactive material, other than special form radioactive material, which is listed in Table 2.2.7.7.2.1 or derived in 2.2.7.7.2 and is used to determine the activity limits for the requirements of ADR.

Approval

Multilateral approval means approval by the relevant competent authority both of the country of origin of the design or shipment and of each country through or into which the consignment is to be carried.

Unilateral approval means an approval of a design which is required to be given by the competent authority of the country of origin of the design only. If the country of origin is not a Contracting Party to ADR, the approval shall require validation by the competent authority of the first country Contracting Party to ADR reached by the consignment (see 6.4.22.6).

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

Containment system means the assembly of components of the packaging specified by the designer as intended to retain the radioactive material during carriage.

Contamination:

Contamination means the presence of a radioactive substance on a surface in quantities in excess of 0.4 Bq/cm² for beta and gamma emitters and low toxicity alpha emitters, or 0.04 Bq/cm² for all other alpha emitters.

Non-fixed contamination means contamination that can be removed from a surface during routine conditions of carriage.

Fixed contamination means contamination other than non-fixed contamination.

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

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

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

Fissile material means uranium-233, uranium-235, plutonium-239, plutonium-241, or any combination of these radionuclides. Excepted from this definition is:

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

Large container means a container which is not a small container according to the definitions of this Sub-section.

Low dispersible radioactive material means either a solid radioactive material or a solid radioactive material in a sealed capsule, that has limited dispersibility and is not in powder form.

NOTE: *Low dispersible radioactive material may be carried by air in Type B(U) or B(M) packages in quantities as authorised for the package design as specified in the certificate of approval. This definition is included here since such packages carrying low dispersible radioactive material may also be carried by road.*

Low specific activity (LSA) material, see 2.2.7.3.

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

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

Package in the case of radioactive material means the packaging with its radioactive contents as presented for carriage. The types of packages covered by ADR, which are subject to the activity limits and material restrictions of 2.2.7.7 and meet the corresponding requirements, are:

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

Packages containing fissile material or uranium hexafluoride are subject to additional requirements (see 2.2.7.7.1.7 and 2.2.7.7.1.8).

NOTE: For “packages” for other dangerous goods see definitions under 1.2.1.

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

NOTE: For “packagings” for other dangerous goods see definitions under 1.2.1

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

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

Shipment means the specific movement of a consignment from origin to destination.

Small container means a container which has either any overall outer dimension less than 1.5 m, or an internal volume of not more than 3 m³.

Special form radioactive material, see 2.2.7.4.1.

Specific activity of a radionuclide means the activity per unit mass of that nuclide. The specific activity of a material shall mean the activity per unit mass or volume of the material in which the radionuclides are essentially uniformly distributed.

Surface contaminated object (SCO), see 2.2.7.5.

Transport index (TI) assigned to a package, overpack or container, or to unpackaged LSA-I or SCO-I, means a number which is used to provide control over radiation exposure.

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

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

Uranium - natural, depleted, enriched means the following:

Natural uranium means chemically separated uranium containing the naturally occurring distribution of uranium isotopes (approximately 99.28% uranium-238, and 0.72% uranium-235 by mass). *Depleted uranium* means uranium containing a lesser mass percentage of uranium-235 than in natural uranium. *Enriched uranium* means uranium containing a greater mass percentage of uranium-235 than 0.72%. In all cases, a very small mass percentage of uranium-234 is present.

2.2.7.3 Low specific activity (LSA) material, determination of groups

2.2.7.3.1 Radioactive material which by its nature has a limited specific activity, or radioactive material for which limits of estimated average specific activity apply, is termed low specific activity or LSA material. External shielding materials surrounding the LSA material shall not be considered in determining the estimated average specific activity.

2.2.7.3.2 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) solid unirradiated natural uranium or depleted uranium or natural thorium or their solid or liquid compounds or mixtures;
 - (iii) radioactive material for which the A_2 value is unlimited, excluding fissile material in quantities not excepted under 6.4.11.2; 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 2.2.7.7.2.1 to 2.2.7.7.2.6, excluding fissile material in quantities not excepted under 6.4.11.2.
- (b) LSA-II
 - (i) water with tritium concentration up to 0.8 TBq/l; or

- (ii) other material in which the activity is distributed throughout and the estimated average specific activity does not exceed 10^{-4} A₂/g for solids and gases, and 10^{-5} A₂/g for liquids;
- (c) LSA-III - Solids (e.g. consolidated wastes, activated materials), excluding powders, in which:
 - (i) the radioactive material is distributed throughout a solid or a collection of solid objects, or is essentially uniformly distributed in a solid compact binding agent (such as concrete, bitumen, ceramic, etc.);
 - (ii) the radioactive material is relatively insoluble, or it is intrinsically contained in a relatively insoluble matrix, so that, even under loss of packaging, the loss of radioactive material per package by leaching when placed in water for seven days would not exceed 0.1 A₂; and
 - (iii) the estimated average specific activity of the solid, excluding any shielding material, does not exceed 2×10^{-3} A₂/g.

2.2.7.3.3 LSA-III material shall be a solid of such a nature that if the entire contents of a package were subjected to the test specified in 2.2.7.3.4 the activity in the water would not exceed 0.1 A₂.

2.2.7.3.4 LSA-III material shall be tested as follows:

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

2.2.7.3.5 Demonstration of compliance with the performance standards in 2.2.7.3.4 shall be in accordance with 6.4.12.1 and 6.4.12.2.

2.2.7.4 Requirements for special form radioactive material

2.2.7.4.1 *Special form radioactive material* means either:

- (a) An indispersible solid radioactive material; or
- (b) A sealed capsule containing radioactive material that shall be so manufactured that it can be opened only by destroying the capsule.

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

2.2.7.4.2 Special form radioactive material shall be of such a nature or shall be so designed that if it is subjected to the tests specified in 2.2.7.4.4 to 2.2.7.4.8, it shall meet the following requirements:

- (a) It would not break or shatter under the impact, percussion and bending tests 2.2.7.4.5 (a)(b)(c), 2.2.7.4.6 (a) as applicable;
- (b) It would not melt or disperse in the applicable heat test 2.2.7.4.5 (d) or 2.2.7.4.6 (b) as applicable; and

- (c) The activity in the water from the leaching tests specified in 2.2.7.4.7 and 2.2.7.4.8 would not exceed 2 kBq; or alternatively for sealed sources, the leakage rate for the volumetric leakage assessment test specified in ISO 9978:1992 "Radiation Protection - Sealed Radioactive Sources - Leakage Test Methods", would not exceed the applicable acceptance threshold acceptable to the competent authority.

2.2.7.4.3 Demonstration of compliance with the performance standards in 2.2.7.4.2 shall be in accordance with 6.4.12.1 and 6.4.12.2.

2.2.7.4.4 Specimens that comprise or simulate special form radioactive material shall be subjected to the impact test, the percussion test, the bending test, and the heat test specified in 2.2.7.4.5 or alternative tests as authorized in 2.2.7.4.6. A different specimen may be used for each of the tests. Following each test, a leaching assessment or volumetric leakage test shall be performed on the specimen by a method no less sensitive than the methods given in 2.2.7.4.7 for indispersible solid material or 2.2.7.4.8 for encapsulated material.

2.2.7.4.5 The relevant test methods are:

- (a) Impact test: The specimen shall drop onto the target from a height of 9 m. The target shall be as defined in 6.4.14;
- (b) Percussion test: The specimen shall be placed on a sheet of lead which is supported by a smooth solid surface and struck by the flat face of a mild steel bar so as to cause an impact equivalent to that resulting from a free drop of 1.4 kg through 1 m. The lower part of the bar shall be 25 mm in diameter with the edges rounded off to a radius of (3.0 ± 0.3) mm. The lead, of hardness number 3.5 to 4.5 on the Vickers scale and not more than 25 mm thick, shall cover an area greater than that covered by the specimen. A fresh surface of lead shall be used for each impact. The bar shall strike the specimen so as to cause maximum damage;
- (c) Bending test: The test shall apply only to long, slender sources with both a minimum length of 10 cm and a length to minimum width ratio of not less than 10. The specimen shall be rigidly clamped in a horizontal position so that one half of its length protrudes from the face of the clamp. The orientation of the specimen shall be such that the specimen will suffer maximum damage when its free end is struck by the flat face of a steel bar. The bar shall strike the specimen so as to cause an impact equivalent to that resulting from a free vertical drop of 1.4 kg through 1 m. The lower part of the bar shall be 25 mm in diameter with the edges rounded off to a radius of (3.0 ± 0.3) mm;
- (d) Heat test: The specimen shall be heated in air to a temperature of 800°C and held at that temperature for a period of 10 minutes and shall then be allowed to cool.

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

- (a) The tests prescribed in 2.2.7.4.5 (a) and 2.2.7.4.5 (b) provided the mass of the special form radioactive material is less than 200 g and they are alternatively subjected to the Class 4 impact test prescribed in ISO 2919:1980 "Radiation protection - Sealed radioactive sources – General requirements and classification"; and
- (b) The test prescribed in 2.2.7.4.5 (d) provided they are alternatively subjected to the Class 6 temperature test specified in ISO 2919:1980 " Radiation protection - Sealed radioactive sources – General requirements and classification ".

2.2.7.4.7

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

- (a) The specimen shall be immersed for 7 days in water at ambient temperature. The volume of water to be used in the test shall be sufficient to ensure that at the end of the 7 day test period the free volume of the unabsorbed and unreacted water remaining shall be at least 10% of the volume of the solid test sample itself. The water shall have an initial pH of 6-8 and a maximum conductivity of 1 mS/m at 20 °C;
- (b) The water with specimen shall then be heated to a temperature of (50 ± 5) °C and maintained at this temperature for 4 hours;
- (c) The activity of the water shall then be determined;
- (d) The specimen shall then be kept for at least 7 days in still air at not less than 30 °C and relative humidity not less than 90%;
- (e) The specimen shall then be immersed in water of the same specification as in (a) above and the water with the specimen heated to (50 ± 5) °C and maintained at this temperature for 4 hours;
- (f) The activity of the water shall then be determined.

2.2.7.4.8

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

- (a) The leaching assessment shall consist of the following steps:
 - (i) the specimen shall be immersed in water at ambient temperature. The water shall have an initial pH of 6-8 with a maximum conductivity of 1 mS/m at 20 °C;
 - (ii) the water and specimen shall be heated to a temperature of (50 ± 5) °C and maintained at this temperature for 4 hours;
 - (iii) the activity of the water shall then be determined;
 - (iv) the specimen shall then be kept for at least 7 days in still air at not less than 30 °C and relative humidity of not less than 90%;
 - (v) the process in (i), (ii) and (iii) shall be repeated;
- (b) The alternative volumetric leakage assessment shall comprise any of the tests prescribed in ISO 9978:1992 "Radiation Protection - Sealed radioactive sources - Leakage test methods", which are acceptable to the competent authority.

2.2.7.5

Surface contaminated object (SCO), determination of groups

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

- (a) SCO-I: A solid object on which:
- (i) the non-fixed contamination on the accessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 4 Bq/cm² for beta and gamma emitters and low toxicity alpha emitters, or 0.4 Bq/cm² for all other alpha emitters; and
 - (ii) the fixed contamination on the accessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 4×10^4 Bq/cm² for beta and gamma emitters and low toxicity alpha emitters, or 4×10^3 Bq/cm² for all other alpha emitters; and
 - (iii) the non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 4×10^4 Bq/cm² for beta and gamma emitters and low toxicity alpha emitters, or 4×10^3 Bq/cm² for all other alpha emitters;
- (b) SCO-II: A solid object on which either the fixed or non-fixed contamination on the surface exceeds the applicable limits specified for SCO-I in (a) above and on which:
- (i) the non-fixed contamination on the accessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 400 Bq/cm² for beta and gamma emitters and low toxicity alpha emitters, or 40 Bq/cm² for all other alpha emitters; and
 - (ii) the fixed contamination on the accessible surface, averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 8×10^5 Bq/cm² for beta and gamma emitters and low toxicity alpha emitters, or 8×10^4 Bq/cm² for all other alpha emitters; and
 - (iii) the non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 8×10^5 Bq/cm² for beta and gamma emitters and low toxicity alpha emitters, or 8×10^4 Bq/cm² for all other alpha emitters.

2.2.7.6 **Determination of transport index (TI) and criticality safety index (CSI)**

2.2.7.6.1 *Determination of transport index*

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

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

- (b) For tanks, containers and unpackaged LSA-I and SCO-I, the value determined in step (a) above shall be multiplied by the appropriate factor from Table 2.2.7.6.1.1;
- (c) The value obtained in steps (a) and (b) above shall be rounded up to the first decimal place (e.g. 1.13 becomes 1.2), except that a value of 0.05 or less may be considered as zero.

Table 2.2.7.6.1.1

Multiplication factor for tanks, containers and unpackaged LSA-I and SCO-I

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

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

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

2.2.7.6.2 *Determination of criticality safety index (CSI)*

2.2.7.6.2.1 The criticality safety index (CSI) for packages containing fissile material shall be obtained by dividing the number 50 by the smaller of the two values of N derived in 6.4.11.11 and 6.4.11.12 (i.e. CSI = 50/N). The value of the criticality safety index may be zero, provided that an unlimited number of packages is subcritical (i.e. N is effectively equal to infinity in both cases).

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

2.2.7.7 *Activity limits and material restrictions*

2.2.7.7.1 *Contents limits for packages*

2.2.7.7.1.1 General

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

2.2.7.7.1.2 Excepted packages

2.2.7.7.1.2.1 For radioactive material other than articles manufactured of natural uranium, depleted uranium or natural thorium, an excepted package shall not contain activities greater than the following:

- (a) Where the radioactive material is enclosed in or is included as a component part of an instrument or other manufactured article, such as a clock or electronic apparatus, the limits specified in columns 2 and 3 of Table 2.2.7.7.1.2.1 for each individual item and each package, respectively; and

- (b) Where the radioactive material is not so enclosed in or is not included as a component of an instrument or other manufactured article, the package limits specified in column 4 of Table 2.2.7.7.1.2.1.

Table 2.2.7.7.1.2.1

ACTIVITY LIMITS FOR EXCEPTED PACKAGES

Physical state of contents	Instruments or article		Materials
	Item limits ^a	Package limits ^a	Package limits
Solids			
special form	$10^{-2} A_1$	A_1	$10^{-3} A_1$
other form	$10^{-2} A_2$	A_2	$10^{-3} A_2$
Liquids	$10^{-3} A_2$	$10^{-1} A_2$	$10^{-4} A_2$
Gases			
tritium	$2 \times 10^{-2} A_2$	$2 \times 10^{-1} A_2$	$2 \times 10^{-2} A_2$
special form	$10^{-3} A_1$	$10^{-2} A_1$	$10^{-3} A_1$
other forms	$10^{-3} A_2$	$10^{-2} A_2$	$10^{-3} A_2$

^a For mixtures of radionuclides, see 2.2.7.7.2.4 to 2.2.7.7.2.6.

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

2.2.7.7.1.3 Industrial packages

The radioactive contents in a single package of LSA material or in a single package of SCO shall be so restricted that the radiation level specified in 4.1.9.2.1 shall not be exceeded, and the activity in a single package shall also be so restricted that the activity limits for a vehicle specified in 7.5.11, CV33 (2) shall not be exceeded.

2.2.7.7.1.4 Type A packages

2.2.7.7.1.4.1 Type A packages shall not contain activities greater than the following:

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

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

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

where

B(i) is the activity of radionuclide i as special form radioactive material and $A_1(i)$ is the A_1 value for radionuclide i; and

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

2.2.7.7.1.5 Type B(U) and Type B(M) packages

2.2.7.7.1.5.1 Type B(U) and Type B(M) packages shall not contain:

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

as specified in their certificates of approval.

2.2.7.7.1.6 Type C packages

NOTE: Type C packages may be transported by air carrying radioactive material in quantities exceeding either $3\ 000A_1$ or $100\ 000A_2$, whichever is the lower for special form radioactive material, or $3\ 000A_2$ for all other radioactive material. Whilst Type C packages are not required for carriage of radioactive material by road in such quantities (Type B(U) or Type B(M) packages suffice), the following requirements are presented since such packages may also be carried by road.

Type C packages shall not contain:

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

as specified in their certificates of approval.

2.2.7.7.1.7 Packages containing fissile material

Packages containing fissile material shall not contain:

- (a) A mass of fissile material different from that authorized for the package design;
- (b) Any radionuclide or fissile material different from those authorized for the package design; or
- (c) Contents in a form or physical or chemical state, or in a spatial arrangement, different from those authorized for the package design;

as specified in their certificates of approval where appropriate.

2.2.7.7.1.8 Packages containing uranium hexafluoride

The mass of uranium hexafluoride in a package shall not exceed a value that would lead to an ullage smaller than 5% at the maximum temperature of the package as specified for the plant systems where the package shall be used. The uranium hexafluoride shall be in solid form and the internal pressure of the package shall be below atmospheric pressure when presented for carriage.

2.2.7.7.2 *Activity levels*

2.2.7.7.2.1 The following basic values for individual radionuclides are given in Table 2.2.7.7.2.1:

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

Table 2.2.7.7.2.1

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

Radionuclide (atomic number)	A₁ (TBq)	A₂ (TBq)	Activity concentration for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
Au-194	1×10^0	1×10^0	1×10^1	1×10^6
Au-195	1×10^1	6×10^0	1×10^2	1×10^7
Au-198	1×10^0	6×10^{-1}	1×10^2	1×10^6
Au-199	1×10^1	6×10^{-1}	1×10^2	1×10^6
Barium (56)				
Ba-131 (a)	2×10^0	2×10^0	1×10^2	1×10^6
Ba-133	3×10^0	3×10^0	1×10^2	1×10^6
Ba-133m	2×10^1	6×10^{-1}	1×10^2	1×10^6
Ba-140 (a)	5×10^{-1}	3×10^{-1}	1×10^1 (b)	1×10^5 (b)
Beryllium (4)				
Be-7	2×10^1	2×10^1	1×10^3	1×10^7
Be-10	4×10^1	6×10^{-1}	1×10^4	1×10^6
Bismuth (83)				
Bi-205	7×10^{-1}	7×10^{-1}	1×10^1	1×10^6
Bi-206	3×10^{-1}	3×10^{-1}	1×10^1	1×10^5
Bi-207	7×10^{-1}	7×10^{-1}	1×10^1	1×10^6
Bi-210	1×10^0	6×10^{-1}	1×10^3	1×10^6
Bi-210m (a)	6×10^{-1}	2×10^{-2}	1×10^1	1×10^5
Bi-212 (a)	7×10^{-1}	6×10^{-1}	1×10^1 (b)	1×10^5 (b)
Berkelium (97)				
Bk-247	8×10^0	8×10^{-4}	1×10^0	1×10^4
Bk-249 (a)	4×10^1	3×10^{-1}	1×10^3	1×10^6
Bromine (35)				
Br-76	4×10^{-1}	4×10^{-1}	1×10^1	1×10^5
Br-77	3×10^0	3×10^0	1×10^2	1×10^6
Br-82	4×10^{-1}	4×10^{-1}	1×10^1	1×10^6
Carbon (6)				
C-11	1×10^0	6×10^{-1}	1×10^1	1×10^6
C-14	4×10^1	3×10^0	1×10^4	1×10^7
Calcium (20)				
Ca-41	Unlimited	Unlimited	1×10^5	1×10^7

Radionuclide (atomic number)	A₁ (TBq)	A₂ (TBq)	Activity concentration for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
Ca-45	4×10^1	1×10^0	1×10^4	1×10^7
Ca-47 (a)	3×10^0	3×10^{-1}	1×10^1	1×10^6
Cadmium (48)				
Cd-109	3×10^1	2×10^0	1×10^4	1×10^6
Cd-113m	4×10^1	5×10^{-1}	1×10^3	1×10^6
Cd-115 (a)	3×10^0	4×10^{-1}	1×10^2	1×10^6
Cd-115m	5×10^{-1}	5×10^{-1}	1×10^3	1×10^6
Cerium (58)				
Ce-139	7×10^0	2×10^0	1×10^2	1×10^6
Ce-141	2×10^1	6×10^{-1}	1×10^2	1×10^7
Ce-143	9×10^{-1}	6×10^{-1}	1×10^2	1×10^6
Ce-144 (a)	2×10^{-1}	2×10^{-1}	1×10^2 (b)	1×10^5 (b)
Californium (98)				
Cf-248	4×10^1	6×10^{-3}	1×10^1	1×10^4
Cf-249	3×10^0	8×10^{-4}	1×10^0	1×10^3
Cf-250	2×10^1	2×10^{-3}	1×10^1	1×10^4
Cf-251	7×10^0	7×10^{-4}	1×10^0	1×10^3
Cf-252	1×10^{-1}	3×10^{-3}	1×10^1	1×10^4
Cf-253 (a)	4×10^1	4×10^{-2}	1×10^2	1×10^5
Cf-254	1×10^{-3}	1×10^{-3}	1×10^0	1×10^3
Chlorine (17)				
Cl-36	1×10^1	6×10^{-1}	1×10^4	1×10^6
Cl-38	2×10^{-1}	2×10^{-1}	1×10^1	1×10^5
Curium (96)				
Cm-240	4×10^1	2×10^{-2}	1×10^2	1×10^5
Cm-241	2×10^0	1×10^0	1×10^2	1×10^6
Cm-242	4×10^1	1×10^{-2}	1×10^2	1×10^5
Cm-243	9×10^0	1×10^{-3}	1×10^0	1×10^4
Cm-244	2×10^1	2×10^{-3}	1×10^1	1×10^4
Cm-245	9×10^0	9×10^{-4}	1×10^0	1×10^3
Cm-246	9×10^0	9×10^{-4}	1×10^0	1×10^3

Radionuclide (atomic number)	A₁ (TBq)	A₂ (TBq)	Activity concentration for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
Cm-247 (a)	3×10^0	1×10^{-3}	1×10^0	1×10^4
Cm-248	2×10^{-2}	3×10^{-4}	1×10^0	1×10^3
Cobalt (27)				
Co-55	5×10^{-1}	5×10^{-1}	1×10^1	1×10^6
Co-56	3×10^{-1}	3×10^{-1}	1×10^1	1×10^5
Co-57	1×10^1	1×10^1	1×10^2	1×10^6
Co-58	1×10^0	1×10^0	1×10^1	1×10^6
Co-58m	4×10^1	4×10^1	1×10^4	1×10^7
Co-60	4×10^{-1}	4×10^{-1}	1×10^1	1×10^5
Chromium (24)				
Cr-51	3×10^1	3×10^1	1×10^3	1×10^7
Caesium (55)				
Cs-129	4×10^0	4×10^0	1×10^2	1×10^5
Cs-131	3×10^1	3×10^1	1×10^3	1×10^6
Cs-132	1×10^0	1×10^0	1×10^1	1×10^5
Cs-134	7×10^{-1}	7×10^{-1}	1×10^1	1×10^4
Cs-134m	4×10^1	6×10^{-1}	1×10^3	1×10^5
Cs-135	4×10^1	1×10^0	1×10^4	1×10^7
Cs-136	5×10^{-1}	5×10^{-1}	1×10^1	1×10^5
Cs-137 (a)	2×10^0	6×10^{-1}	1×10^1 (b)	1×10^4 (b)
Copper (29)				
Cu-64	6×10^0	1×10^0	1×10^2	1×10^6
Cu-67	1×10^1	7×10^{-1}	1×10^2	1×10^6
Dysprosium (66)				
Dy-159	2×10^1	2×10^1	1×10^3	1×10^7
Dy-165	9×10^{-1}	6×10^{-1}	1×10^3	1×10^6
Dy-166 (a)	9×10^{-1}	3×10^{-1}	1×10^3	1×10^6
Erbium (68)				
Er-169	4×10^1	1×10^0	1×10^4	1×10^7
Er-171	8×10^{-1}	5×10^{-1}	1×10^2	1×10^6

Radionuclide (atomic number)	A₁ (TBq)	A₂ (TBq)	Activity concentration for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
Europium (63)				
Eu-147	2×10^0	2×10^0	1×10^2	1×10^6
Eu-148	5×10^{-1}	5×10^{-1}	1×10^1	1×10^6
Eu-149	2×10^1	2×10^1	1×10^2	1×10^7
Eu-150(short lived)	2×10^0	7×10^{-1}	1×10^3	1×10^6
Eu-150(long lived)	7×10^{-1}	7×10^{-1}	1×10^1	1×10^6
Eu-152	1×10^0	1×10^0	1×10^1	1×10^6
Eu-152m	8×10^{-1}	8×10^{-1}	1×10^2	1×10^6
Eu-154	9×10^{-1}	6×10^{-1}	1×10^1	1×10^6
Eu-155	2×10^1	3×10^0	1×10^2	1×10^7
Eu-156	7×10^{-1}	7×10^{-1}	1×10^1	1×10^6
Fluorine (9)				
F-18	1×10^0	6×10^{-1}	1×10^1	1×10^6
Iron (26)				
Fe-52 (a)	3×10^{-1}	3×10^{-1}	1×10^1	1×10^6
Fe-55	4×10^1	4×10^1	1×10^4	1×10^6
Fe-59	9×10^{-1}	9×10^{-1}	1×10^1	1×10^6
Fe-60 (a)	4×10^1	2×10^{-1}	1×10^2	1×10^5
Gallium (31)				
Ga-67	7×10^0	3×10^0	1×10^2	1×10^6
Ga-68	5×10^{-1}	5×10^{-1}	1×10^1	1×10^5
Ga-72	4×10^{-1}	4×10^{-1}	1×10^1	1×10^5
Gadolinium (64)				
Gd-146 (a)	5×10^{-1}	5×10^{-1}	1×10^1	1×10^6
Gd-148	2×10^1	2×10^{-3}	1×10^1	1×10^4
Gd-153	1×10^1	9×10^0	1×10^2	1×10^7
Gd-159	3×10^0	6×10^{-1}	1×10^3	1×10^6
Germanium (32)				
Ge-68 (a)	5×10^{-1}	5×10^{-1}	1×10^1	1×10^5
Ge-71	4×10^1	4×10^1	1×10^4	1×10^8
Ge-77	3×10^{-1}	3×10^{-1}	1×10^1	1×10^5

Radionuclide (atomic number)	A₁ (TBq)	A₂ (TBq)	Activity concentration for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
Hafnium (72)				
Hf-172 (a)	6×10^{-1}	6×10^{-1}	1×10^1	1×10^6
Hf-175	3×10^0	3×10^0	1×10^2	1×10^6
Hf-181	2×10^0	5×10^{-1}	1×10^1	1×10^6
Hf-182	Unlimited	Unlimited	1×10^2	1×10^6
Mercury (80)				
Hg-194 (a)	1×10^0	1×10^0	1×10^1	1×10^6
Hg-195m (a)	3×10^0	7×10^{-1}	1×10^2	1×10^6
Hg-197	2×10^1	1×10^1	1×10^2	1×10^7
Hg-197m	1×10^1	4×10^{-1}	1×10^2	1×10^6
Hg-203	5×10^0	1×10^0	1×10^2	1×10^5
Holmium (67)				
Ho-166	4×10^{-1}	4×10^{-1}	1×10^3	1×10^5
Ho-166m	6×10^{-1}	5×10^{-1}	1×10^1	1×10^6
Iodine (53)				
I-123	6×10^0	3×10^0	1×10^2	1×10^7
I-124	1×10^0	1×10^0	1×10^1	1×10^6
I-125	2×10^1	3×10^0	1×10^3	1×10^6
I-126	2×10^0	1×10^0	1×10^2	1×10^6
I-129	Unlimited	Unlimited	1×10^2	1×10^5
I-131	3×10^0	7×10^{-1}	1×10^2	1×10^6
I-132	4×10^{-1}	4×10^{-1}	1×10^1	1×10^5
I-133	7×10^{-1}	6×10^{-1}	1×10^1	1×10^6
I-134	3×10^{-1}	3×10^{-1}	1×10^1	1×10^5
I-135 (a)	6×10^{-1}	6×10^{-1}	1×10^1	1×10^6
Indium (49)				
In-111	3×10^0	3×10^0	1×10^2	1×10^6
In-113m	4×10^0	2×10^0	1×10^2	1×10^6
In-114m (a)	1×10^1	5×10^{-1}	1×10^2	1×10^6
In-115m	7×10^0	1×10^0	1×10^2	1×10^6

Radionuclide (atomic number)	A₁ (TBq)	A₂ (TBq)	Activity concentration for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
Iridium (77)				
Ir-189 (a)	1×10^1	1×10^1	1×10^2	1×10^7
Ir-190	7×10^{-1}	7×10^{-1}	1×10^1	1×10^6
Ir-192	1×10^0 (c)	6×10^{-1}	1×10^1	1×10^4
Ir-194	3×10^{-1}	3×10^{-1}	1×10^2	1×10^5
Potassium (19)				
K-40	9×10^{-1}	9×10^{-1}	1×10^2	1×10^6
K-42	2×10^{-1}	2×10^{-1}	1×10^2	1×10^6
K-43	7×10^{-1}	6×10^{-1}	1×10^1	1×10^6
Krypton (36)				
Kr-79	4×10^0	1×10^0	1×10^3	1×10^5
Kr-81	4×10^1	4×10^1	1×10^4	1×10^7
Kr-85	1×10^1	1×10^1	1×10^5	1×10^4
Kr-85m	8×10^0	3×10^0	1×10^3	1×10^{10}
Kr-87	2×10^{-1}	2×10^{-1}	1×10^2	1×10^9
Lanthanum (57)				
La-137	3×10^1	6×10^0	1×10^3	1×10^7
La-140	4×10^{-1}	4×10^{-1}	1×10^1	1×10^5
Lutetium (71)				
Lu-172	6×10^{-1}	6×10^{-1}	1×10^1	1×10^6
Lu-173	8×10^0	8×10^0	1×10^2	1×10^7
Lu-174	9×10^0	9×10^0	1×10^2	1×10^7
Lu-174m	2×10^1	1×10^1	1×10^2	1×10^7
Lu-177	3×10^1	7×10^{-1}	1×10^3	1×10^7
Magnesium (12)				
Mg-28 (a)	3×10^{-1}	3×10^{-1}	1×10^1	1×10^5
Manganese (25)				
Mn-52	3×10^{-1}	3×10^{-1}	1×10^1	1×10^5
Mn-53	Unlimited	Unlimited	1×10^4	1×10^9
Mn-54	1×10^0	1×10^0	1×10^1	1×10^6
Mn-56	3×10^{-1}	3×10^{-1}	1×10^1	1×10^5

Radionuclide (atomic number)	A₁ (TBq)	A₂ (TBq)	Activity concentration for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
Molybdenum (42)				
Mo-93	4×10^1	2×10^1	1×10^3	1×10^8
Mo-99 (a)	1×10^0	6×10^{-1}	1×10^2	1×10^6
Nitrogen (7)				
N-13	9×10^{-1}	6×10^{-1}	1×10^2	1×10^9
Sodium (11)				
Na-22	5×10^{-1}	5×10^{-1}	1×10^1	1×10^6
Na-24	2×10^{-1}	2×10^{-1}	1×10^1	1×10^5
Niobium (41)				
Nb-93m	4×10^1	3×10^1	1×10^4	1×10^7
Nb-94	7×10^{-1}	7×10^{-1}	1×10^1	1×10^6
Nb-95	1×10^0	1×10^0	1×10^1	1×10^6
Nb-97	9×10^{-1}	6×10^{-1}	1×10^1	1×10^6
Neodymium (60)				
Nd-147	6×10^0	6×10^{-1}	1×10^2	1×10^6
Nd-149	6×10^{-1}	5×10^{-1}	1×10^2	1×10^6
Nickel (28)				
Ni-59	Unlimited	Unlimited	1×10^4	1×10^8
Ni-63	4×10^1	3×10^1	1×10^5	1×10^8
Ni-65	4×10^{-1}	4×10^{-1}	1×10^1	1×10^6
Neptunium (93)				
Np-235	4×10^1	4×10^1	1×10^3	1×10^7
Np-236(short-lived)	2×10^1	2×10^0	1×10^3	1×10^7
Np-236(long-lived)	9×10^0	2×10^{-2}	1×10^2	1×10^5
Np-237	2×10^1	2×10^{-3}	1×10^0 (b)	1×10^3 (b)
Np-239	7×10^0	4×10^{-1}	1×10^2	1×10^7
Osmium (76)				
Os-185	1×10^0	1×10^0	1×10^1	1×10^6
Os-191	1×10^1	2×10^0	1×10^2	1×10^7
Os-191m	4×10^1	3×10^1	1×10^3	1×10^7
Os-193	2×10^0	6×10^{-1}	1×10^2	1×10^6

Radionuclide (atomic number)	A₁ (TBq)	A₂ (TBq)	Activity concentration for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
Os-194 (a)	3×10^{-1}	3×10^{-1}	1×10^2	1×10^5
Phosphorus (15)				
P-32	5×10^{-1}	5×10^{-1}	1×10^3	1×10^5
P-33	4×10^1	1×10^0	1×10^5	1×10^8
Protactinium (91)				
Pa-230 (a)	2×10^0	7×10^{-2}	1×10^1	1×10^6
Pa-231	4×10^0	4×10^{-4}	1×10^0	1×10^3
Pa-233	5×10^0	7×10^{-1}	1×10^2	1×10^7
Lead (82)				
Pb-201	1×10^0	1×10^0	1×10^1	1×10^6
Pb-202	4×10^1	2×10^1	1×10^3	1×10^6
Pb-203	4×10^0	3×10^0	1×10^2	1×10^6
Pb-205	Unlimited	Unlimited	1×10^4	1×10^7
Pb-210 (a)	1×10^0	5×10^{-2}	1×10^1 (b)	1×10^4 (b)
Pb-212 (a)	7×10^{-1}	2×10^{-1}	1×10^1 (b)	1×10^5 (b)
Palladium (46)				
Pd-103 (a)	4×10^1	4×10^1	1×10^3	1×10^8
Pd-107	Unlimited	Unlimited	1×10^5	1×10^8
Pd-109	2×10^0	5×10^{-1}	1×10^3	1×10^6
Promethium (61)				
Pm-143	3×10^0	3×10^0	1×10^2	1×10^6
Pm-144	7×10^{-1}	7×10^{-1}	1×10^1	1×10^6
Pm-145	3×10^1	1×10^1	1×10^3	1×10^7
Pm-147	4×10^1	2×10^0	1×10^4	1×10^7
Pm-148m (a)	8×10^{-1}	7×10^{-1}	1×10^1	1×10^6
Pm-149	2×10^0	6×10^{-1}	1×10^3	1×10^6
Pm-151	2×10^0	6×10^{-1}	1×10^2	1×10^6
Polonium (84)				
Po-210	4×10^1	2×10^{-2}	1×10^1	1×10^4
Praseodymium (59)				
Pr-142	4×10^{-1}	4×10^{-1}	1×10^2	1×10^5

Radionuclide (atomic number)	A₁ (TBq)	A₂ (TBq)	Activity concentration for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
Pr-143	3×10^0	6×10^{-1}	1×10^4	1×10^6
Platinum (78)				
Pt-188 (a)	1×10^0	8×10^{-1}	1×10^1	1×10^6
Pt-191	4×10^0	3×10^0	1×10^2	1×10^6
Pt-193	4×10^1	4×10^1	1×10^4	1×10^7
Pt-193m	4×10^1	5×10^{-1}	1×10^3	1×10^7
Pt-195m	1×10^1	5×10^{-1}	1×10^2	1×10^6
Pt-197	2×10^1	6×10^{-1}	1×10^3	1×10^6
Pt-197m	1×10^1	6×10^{-1}	1×10^2	1×10^6
Plutonium (94)				
Pu-236	3×10^1	3×10^{-3}	1×10^1	1×10^4
Pu-237	2×10^1	2×10^1	1×10^3	1×10^7
Pu-238	1×10^1	1×10^{-3}	1×10^0	1×10^4
Pu-239	1×10^1	1×10^{-3}	1×10^0	1×10^4
Pu-240	1×10^1	1×10^{-3}	1×10^0	1×10^3
Pu-241 (a)	4×10^1	6×10^{-2}	1×10^2	1×10^5
Pu-242	1×10^1	1×10^{-3}	1×10^0	1×10^4
Pu-244 (a)	4×10^{-1}	1×10^{-3}	1×10^0	1×10^4
Radium (88)				
Ra-223 (a)	4×10^{-1}	7×10^{-3}	1×10^2 (b)	1×10^5 (b)
Ra-224 (a)	4×10^{-1}	2×10^{-2}	1×10^1 (b)	1×10^5 (b)
Ra-225 (a)	2×10^{-1}	4×10^{-3}	1×10^2	1×10^5
Ra-226 (a)	2×10^{-1}	3×10^{-3}	1×10^1 (b)	1×10^4 (b)
Ra-228 (a)	6×10^{-1}	2×10^{-2}	1×10^1 (b)	1×10^5 (b)
Rubidium (37)				
Rb-81	2×10^0	8×10^{-1}	1×10^1	1×10^6
Rb-83 (a)	2×10^0	2×10^0	1×10^2	1×10^6
Rb-84	1×10^0	1×10^0	1×10^1	1×10^6
Rb-86	5×10^{-1}	5×10^{-1}	1×10^2	1×10^5
Rb-87	Unlimited	Unlimited	1×10^4	1×10^7
Rb(nat)	Unlimited	Unlimited	1×10^4	1×10^7

Radionuclide (atomic number)	A₁ (TBq)	A₂ (TBq)	Activity concentration for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
Rhenium (75)				
Re-184	1×10^0	1×10^0	1×10^1	1×10^6
Re-184m	3×10^0	1×10^0	1×10^2	1×10^6
Re-186	2×10^0	6×10^{-1}	1×10^3	1×10^6
Re-187	Unlimited	Unlimited	1×10^6	1×10^9
Re-188	4×10^{-1}	4×10^{-1}	1×10^2	1×10^5
Re-189 (a)	3×10^0	6×10^{-1}	1×10^2	1×10^6
Re(nat)	Unlimited	Unlimited	1×10^6	1×10^9
Rhodium (45)				
Rh-99	2×10^0	2×10^0	1×10^1	1×10^6
Rh-101	4×10^0	3×10^0	1×10^2	1×10^7
Rh-102	5×10^{-1}	5×10^{-1}	1×10^1	1×10^6
Rh-102m	2×10^0	2×10^0	1×10^2	1×10^6
Rh-103m	4×10^1	4×10^1	1×10^4	1×10^8
Rh-105	1×10^1	8×10^{-1}	1×10^2	1×10^7
Radon (86)				
Rn-222 (a)	3×10^{-1}	4×10^{-3}	1×10^1 (b)	1×10^8 (b)
Ruthenium (44)				
Ru-97	5×10^0	5×10^0	1×10^2	1×10^7
Ru-103 (a)	2×10^0	2×10^0	1×10^2	1×10^6
Ru-105	1×10^0	6×10^{-1}	1×10^1	1×10^6
Ru-106 (a)	2×10^{-1}	2×10^{-1}	1×10^2 (b)	1×10^5 (b)
Sulphur (16)				
S-35	4×10^1	3×10^0	1×10^5	1×10^8
Antimony (51)				
Sb-122	4×10^{-1}	4×10^{-1}	1×10^2	1×10^4
Sb-124	6×10^{-1}	6×10^{-1}	1×10^1	1×10^6
Sb-125	2×10^0	1×10^0	1×10^2	1×10^6
Sb-126	4×10^{-1}	4×10^{-1}	1×10^1	1×10^5
Scandium (21)				
Sc-44	5×10^{-1}	5×10^{-1}	1×10^1	1×10^5

Radionuclide (atomic number)	A₁ (TBq)	A₂ (TBq)	Activity concentration for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
Sc-46	5×10^{-1}	5×10^{-1}	1×10^1	1×10^6
Sc-47	1×10^1	7×10^{-1}	1×10^2	1×10^6
Sc-48	3×10^{-1}	3×10^{-1}	1×10^1	1×10^5
Selenium (34)				
Se-75	3×10^0	3×10^0	1×10^2	1×10^6
Se-79	4×10^1	2×10^0	1×10^4	1×10^7
Silicon (14)				
Si-31	6×10^{-1}	6×10^{-1}	1×10^3	1×10^6
Si-32	4×10^1	5×10^{-1}	1×10^3	1×10^6
Samarium (62)				
Sm-145	1×10^1	1×10^1	1×10^2	1×10^7
Sm-147	Unlimited	Unlimited	1×10^1	1×10^4
Sm-151	4×10^1	1×10^1	1×10^4	1×10^8
Sm-153	9×10^0	6×10^{-1}	1×10^2	1×10^6
Tin (50)				
Sn-113 (a)	4×10^0	2×10^0	1×10^3	1×10^7
Sn-117m	7×10^0	4×10^{-1}	1×10^2	1×10^6
Sn-119m	4×10^1	3×10^1	1×10^3	1×10^7
Sn-121m (a)	4×10^1	9×10^{-1}	1×10^3	1×10^7
Sn-123	8×10^{-1}	6×10^{-1}	1×10^3	1×10^6
Sn-125	4×10^{-1}	4×10^{-1}	1×10^2	1×10^5
Sn-126 (a)	6×10^{-1}	4×10^{-1}	1×10^1	1×10^5
Strontium (38)				
Sr-82 (a)	2×10^{-1}	2×10^{-1}	1×10^1	1×10^5
Sr-85	2×10^0	2×10^0	1×10^2	1×10^6
Sr-85m	5×10^0	5×10^0	1×10^2	1×10^7
Sr-87m	3×10^0	3×10^0	1×10^2	1×10^6
Sr-89	6×10^{-1}	6×10^{-1}	1×10^3	1×10^6
Sr-90 (a)	3×10^{-1}	3×10^{-1}	1×10^2 (b)	1×10^4 (b)
Sr-91 (a)	3×10^{-1}	3×10^{-1}	1×10^1	1×10^5
Sr-92 (a)	1×10^0	3×10^{-1}	1×10^1	1×10^6

Radionuclide (atomic number)	A₁ (TBq)	A₂ (TBq)	Activity concentration for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
Tritium (1)				
T(H-3)	4×10^1	4×10^1	1×10^6	1×10^9
Tantalum (73)				
Ta-178(long-lived)	1×10^0	8×10^{-1}	1×10^1	1×10^6
Ta-179	3×10^1	3×10^1	1×10^3	1×10^7
Ta-182	9×10^{-1}	5×10^{-1}	1×10^1	1×10^4
Terbium (65)				
Tb-157	4×10^1	4×10^1	1×10^4	1×10^7
Tb-158	1×10^0	1×10^0	1×10^1	1×10^6
Tb-160	1×10^0	6×10^{-1}	1×10^1	1×10^6
Technetium (43)				
Tc-95m (a)	2×10^0	2×10^0	1×10^1	1×10^6
Tc-96	4×10^{-1}	4×10^{-1}	1×10^1	1×10^6
Tc-96m (a)	4×10^{-1}	4×10^{-1}	1×10^3	1×10^7
Tc-97	Unlimited	Unlimited	1×10^3	1×10^8
Tc-97m	4×10^1	1×10^0	1×10^3	1×10^7
Tc-98	8×10^{-1}	7×10^{-1}	1×10^1	1×10^6
Tc-99	4×10^1	9×10^{-1}	1×10^4	1×10^7
Tc-99m	1×10^1	4×10^0	1×10^2	1×10^7
Tellurium (52)				
Te-121	2×10^0	2×10^0	1×10^1	1×10^6
Te-121m	5×10^0	3×10^0	1×10^2	1×10^5
Te-123m	8×10^0	1×10^0	1×10^2	1×10^7
Te-125m	2×10^1	9×10^{-1}	1×10^3	1×10^7
Te-127	2×10^1	7×10^{-1}	1×10^3	1×10^6
Te-127m (a)	2×10^1	5×10^{-1}	1×10^3	1×10^7
Te-129	7×10^{-1}	6×10^{-1}	1×10^2	1×10^6
Te-129m (a)	8×10^{-1}	4×10^{-1}	1×10^3	1×10^6
Te-131m (a)	7×10^{-1}	5×10^{-1}	1×10^1	1×10^6
Te-132 (a)	5×10^{-1}	4×10^{-1}	1×10^2	1×10^7

Radionuclide (atomic number)	A₁ (TBq)	A₂ (TBq)	Activity concentration for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
Thorium (90)				
Th-227	1×10^1	5×10^{-3}	1×10^1	1×10^4
Th-228 (a)	5×10^{-1}	1×10^{-3}	1×10^0 (b)	1×10^4 (b)
Th-229	5×10^0	5×10^{-4}	1×10^0 (b)	1×10^3 (b)
Th-230	1×10^1	1×10^{-3}	1×10^0	1×10^4
Th-231	4×10^1	2×10^{-2}	1×10^3	1×10^7
Th-232	Unlimited	Unlimited	1×10^1	1×10^4
Th-234 (a)	3×10^{-1}	3×10^{-1}	1×10^3 (b)	1×10^5 (b)
Th(nat)	Unlimited	Unlimited	1×10^0 (b)	1×10^3 (b)
Titanium (22)				
Ti-44 (a)	5×10^{-1}	4×10^{-1}	1×10^1	1×10^5
Thallium (81)				
Tl-200	9×10^{-1}	9×10^{-1}	1×10^1	1×10^6
Tl-201	1×10^1	4×10^0	1×10^2	1×10^6
Tl-202	2×10^0	2×10^0	1×10^2	1×10^6
Tl-204	1×10^1	7×10^{-1}	1×10^4	1×10^4
Thulium (69)				
Tm-167	7×10^0	8×10^{-1}	1×10^2	1×10^6
Tm-170	3×10^0	6×10^{-1}	1×10^3	1×10^6
Tm-171	4×10^1	4×10^1	1×10^4	1×10^8
Uranium (92)				
U-230 (fast lung absorption) (a)(d)	4×10^1	1×10^{-1}	1×10^1 (b)	1×10^5 (b)
U-230 (medium lung absorption) (a)(e)	4×10^1	4×10^{-3}	1×10^1	1×10^4
U-230 (slow lung absorption) (a)(f)	3×10^1	3×10^{-3}	1×10^1	1×10^4
U-232 (fast lung absorption) (d)	4×10^1	1×10^{-2}	1×10^0 (b)	1×10^3 (b)
U-232 (medium lung absorption) (e)	4×10^1	7×10^{-3}	1×10^1	1×10^4
U-232 (slow lung absorption) (f)	1×10^1	1×10^{-3}	1×10^1	1×10^4
U-233 (fast lung absorption) (d)	4×10^1	9×10^{-2}	1×10^1	1×10^4
U-233 (medium lung absorption) (e)	4×10^1	2×10^{-2}	1×10^2	1×10^5
U-233 (slow lung absorption) (f)	4×10^1	6×10^{-3}	1×10^1	1×10^5
U-234 (fast lung absorption) (d)	4×10^1	9×10^{-2}	1×10^1	1×10^4

Radionuclide (atomic number)	A₁ (TBq)	A₂ (TBq)	Activity concentration for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
U-234 (medium lung absorption) (e)	4×10^1	2×10^{-2}	1×10^2	1×10^5
U-234 (slow lung absorption) (f)	4×10^1	6×10^{-3}	1×10^1	1×10^5
U-235 (all lung absorption types) (a)(d)(e)(f)	Unlimited	Unlimited	1×10^1 (b)	1×10^4 (b)
U-236 (fast lung absorption) (d)	Unlimited	Unlimited	1×10^1	1×10^4
U-236 (medium lung absorption) (e)	4×10^1	2×10^{-2}	1×10^2	1×10^5
U-236 (slow lung absorption) (f)	4×10^1	6×10^{-3}	1×10^1	1×10^4
U-238 (all lung absorption types) (d)(e)(f)	Unlimited	Unlimited	1×10^1 (b)	1×10^4 (b)
U (nat)	Unlimited	Unlimited	1×10^0 (b)	1×10^3 (b)
U (enriched to 20% or less) (g)	Unlimited	Unlimited	1×10^0	1×10^3
U (dep)	Unlimited	Unlimited	1×10^0	1×10^3
Vanadium (23)				
V-48	4×10^{-1}	4×10^{-1}	1×10^1	1×10^5
V-49	4×10^1	4×10^1	1×10^4	1×10^7
Tungsten (74)				
W-178 (a)	9×10^0	5×10^0	1×10^1	1×10^6
W-181	3×10^1	3×10^1	1×10^3	1×10^7
W-185	4×10^1	8×10^{-1}	1×10^4	1×10^7
W-187	2×10^0	6×10^{-1}	1×10^2	1×10^6
W-188 (a)	4×10^{-1}	3×10^{-1}	1×10^2	1×10^5
Xenon (54)				
Xe-122 (a)	4×10^{-1}	4×10^{-1}	1×10^2	1×10^9
Xe-123	2×10^0	7×10^{-1}	1×10^2	1×10^9
Xe-127	4×10^0	2×10^0	1×10^3	1×10^5
Xe-131m	4×10^1	4×10^1	1×10^4	1×10^4
Xe-133	2×10^1	1×10^1	1×10^3	1×10^4
Xe-135	3×10^0	2×10^0	1×10^3	1×10^{10}
Yttrium (39)				
Y-87 (a)	1×10^0	1×10^0	1×10^1	1×10^6
Y-88	4×10^{-1}	4×10^{-1}	1×10^1	1×10^6

Radionuclide (atomic number)	A₁ (TBq)	A₂ (TBq)	Activity concentration for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
Y-90	3×10^{-1}	3×10^{-1}	1×10^3	1×10^5
Y-91	6×10^{-1}	6×10^{-1}	1×10^3	1×10^6
Y-91m	2×10^0	2×10^0	1×10^2	1×10^6
Y-92	2×10^{-1}	2×10^{-1}	1×10^2	1×10^5
Y-93	3×10^{-1}	3×10^{-1}	1×10^2	1×10^5
Ytterbium (70)				
Yb-169	4×10^0	1×10^0	1×10^2	1×10^7
Yb-175	3×10^1	9×10^{-1}	1×10^3	1×10^7
Zinc (30)				
Zn-65	2×10^0	2×10^0	1×10^1	1×10^6
Zn-69	3×10^0	6×10^{-1}	1×10^4	1×10^6
Zn-69m (a)	3×10^0	6×10^{-1}	1×10^2	1×10^6
Zirconium (40)				
Zr-88	3×10^0	3×10^0	1×10^2	1×10^6
Zr-93	Unlimited	Unlimited	1×10^3 (b)	1×10^7 (b)
Zr-95 (a)	2×10^0	8×10^{-1}	1×10^1	1×10^6
Zr-97 (a)	4×10^{-1}	4×10^{-1}	1×10^1 (b)	1×10^5 (b)

(a) A₁ and/or A₂ values include contributions from daughter nuclides with half-lives less than 10 days.

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

Sr-90	Y-90
Zr-93	Nb-93m
Zr-97	Nb-97
Ru-106	Rh-106
Cs-137	Ba-137m
Ce-134	La-134
Ce-144	Pr-144
Ba-140	La-140
Bi-212	Tl-208 (0.36), Po-212 (0.64)
Pb-210	Bi-210, Po-210
Pb-212	Bi-212, Tl-208 (0.36), Po-212 (0.64)
Rn-220	Po-216
Rn-222	Po-218, Pb-214, Bi-214, Po-214
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Tl-207
Ra-224	Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)

Ra-226	Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210
Ra-228	Ac-228
Th-226	Ra-222, Rn-218, Po-214
Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
Th-229	Ra-225, Ac-225, Fr-221, At-217, Bi-213, Po-213, Pb-209
Th-nat	Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
Th-234	Pa-234m
U-230	Th-226, Ra-222, Rn-218, Po-214
U-232	Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
U-235	Th-231
U-238	Th-234, Pa-234m
U-nat	Th-234, Pa-234m, U-234, Th-230, Ra-226, Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210
U-240	Np-240m
Np-237	Pa-233
Am-242m	Am-242
Am-243	Np-239

- (c) The quantity may be determined from a measurement of the rate of decay or a measurement of the radiation level at a prescribed distance from the source.
- (d) These values apply only to compounds of uranium that take the chemical form of UF_6 , UO_2F_2 and $UO_2(NO_3)_2$ in both normal and accident conditions of carriage.
- (e) These values apply only to compounds of uranium that take the chemical form of UO_3 , UF_4 , UCl_4 and hexavalent compounds in both normal and accident conditions of carriage.
- (f) These values apply to all compounds of uranium other than those specified in (d) and (e) above.
- (g) These values apply to unirradiated uranium only.

2.2.7.7.2.2 For individual radionuclides which are not listed in Table 2.2.7.7.2.1 the determination of the basic radionuclide values referred to in 2.2.7.7.2.1 shall require competent authority approval or, for international carriage, multilateral approval. Where the chemical form of each radionuclide is known, it is permissible to use the A_2 value related to its solubility class as recommended by the International Commission on Radiological Protection, if the chemical forms under both normal and accident conditions of carriage are taken into consideration. Alternatively, the radionuclide values in Table 2.2.7.7.2.2 may be used without obtaining competent authority approval.

Table 2.2.7.7.2.2

BASIC RADIONUCLIDE VALUES FOR UNKNOWN RADIONUCLIDES OR MIXTURES

Radioactive contents	A ₁ TBq	A ₂ TBq	Activity concentration for exempt material Bq/g	Activity limit for an exempt consignment Bq
Only beta or gamma emitting nuclides are known to be present	0.1	0.02	1 × 10 ¹	1 × 10 ⁴
Only alpha emitting nuclides are known to be present	0.2	9 × 10 ⁻⁵	1 × 10 ⁻¹	1 × 10 ³
No relevant data are available	0.001	9 × 10 ⁻⁵	1 × 10 ⁻¹	1 × 10 ³

2.2.7.7.2.3 In the calculations of A₁ and A₂ for a radionuclide not in Table 2.2.7.7.2.1, a single radioactive decay chain in which the radionuclides are present in their naturally occurring proportions, and in which no daughter nuclide has a half-life either longer than 10 days or longer than that of the parent nuclide, shall be considered as a single radionuclide; and the activity to be taken into account and the A₁ or A₂ value to be applied shall be those corresponding to the parent nuclide of that chain. In the case of radioactive decay chains in which any daughter nuclide has a half-life either longer than 10 days or greater than that of the parent nuclide, the parent and such daughter nuclides shall be considered as mixtures of different nuclides.

2.2.7.7.2.4 For mixtures of radionuclides, the determination of the basic radionuclide values referred to in 2.2.7.7.2.1 may be determined as follows:

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

where,

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

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

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

2.2.7.7.2.5 When the identity of each radionuclide is known but the individual activities of some of the radionuclides are not known, the radionuclides may be grouped and the lowest radionuclide value, as appropriate, for the radionuclides in each group may be used in applying the formulas in 2.2.7.7.2.4 and 2.2.7.7.1.4.2. Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest radionuclide values for the alpha emitters or beta/gamma emitters, respectively.

2.2.7.7.2.6 For individual radionuclides or for mixtures of radionuclides for which relevant data are not available, the values shown in Table 2.2.7.7.2.2 shall be used.

2.2.7.8 *Limits on transport index (TI), criticality safety index (CSI), radiation levels for packages and overpacks*

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

2.2.7.8.2 Except for packages or overpacks carried under exclusive use by road under the conditions specified in 7.5.11, CV33 (3.5)(a), the maximum radiation level at any point on any external surface of a package or overpack shall not exceed 2 mSv/h.

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

2.2.7.8.4 Packages and overpacks shall be assigned to either category I-WHITE, II-YELLOW or III-YELLOW in accordance with the conditions specified in Table 2.2.7.8.4 and with the following requirements:

- (a) For a package or overpack, both the transport index and the surface radiation level conditions shall be taken into account in determining which is the appropriate category. Where the transport index satisfies the condition for one category but the surface radiation level satisfies the condition for a different category, the package or overpack shall be assigned to the higher category. For this purpose, category I-WHITE shall be regarded as the lowest category;
- (b) The transport index shall be determined following the procedures specified in 2.2.7.6.1.1 and 2.2.7.6.1.2;
- (c) If the surface radiation level is greater than 2 mSv/h, the package or overpack shall be carried under exclusive use and under the provisions of 7.5.11, CV33 (3.5) (a);
- (d) A package carried under a special arrangement shall be assigned to category III-YELLOW;
- (e) An overpack which contains packages carried under special arrangement shall be assigned to category III-YELLOW.

**Table 2.2.7.8.4
CATEGORIES OF PACKAGES AND OVERPACKS**

Conditions		
Transport index (TI)	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

^a *If the measured TI is not greater than 0.05, the value quoted may be zero in accordance with 2.2.7.6.1.1(c).*

^b *Shall also be carried under exclusive use.*

2.2.7.9 *Requirements and controls for carriage of excepted packages*

2.2.7.9.1 Excepted packages which may contain radioactive material in limited quantities, instruments, manufactured articles as specified in 2.2.7.7.1.2 and empty packagings as specified in 2.2.7.9.6 may be carried under the following conditions:

- (a) The applicable requirements specified in 2.2.7.9.2, 3.3.1 (special provision 290, if relevant), 4.1.9.1.2, 5.2.1.2, 5.2.1.7.1, 5.2.1.7.2, 5.2.1.7.3, 5.4.1.1.1 (a), 7.5.11 CV33 (5.2) and, as applicable 2.2.7.9.3 to 2.2.7.9.6;
- (b) The requirements for excepted packages specified in 6.4.4;
- (c) If the excepted package contains fissile material, one of the fissile exceptions provided by 6.4.11.2 shall apply and the requirement of 6.4.7.2 shall be met.

2.2.7.9.2 The radiation level at any point on the external surface of an excepted package shall not exceed 5 μ Sv/h.

2.2.7.9.3 Radioactive material which is enclosed in or is included as a component part of an instrument or other manufactured article, with activity not exceeding the item and package limits specified in columns 2 and 3 respectively of Table 2.2.7.7.1.2.1, may be carried in an excepted package provided that:

- (a) The radiation level at 10 cm from any point on the external surface of any unpackaged instrument or article is not greater than 0.1 mSv/h; and
- (b) Each instrument or manufactured article bears the marking "RADIOACTIVE" except:
 - (i) radioluminescent time-pieces or devices;
 - (ii) consumer products that either have received regulatory approval according to 2.2.7.1.2 (d) or do not individually exceed the activity limit for an exempt consignment in column (5) of Table 2.2.7.7.2.1, provided such products are carried in a package that bears the marking "RADIOACTIVE" on an internal surface in such a manner that warning of the presence of radioactive material is visible on opening the package; and
- (c) The active material is completely enclosed by non-active components (a device performing the sole function of containing radioactive material shall not be considered to be an instrument or manufactured article).

2.2.7.9.4 Radioactive material in forms other than as specified in 2.2.7.9.3, with an activity not exceeding the limit specified in column 4 of Table 2.2.7.7.1.2.1, may be carried in an excepted package provided that:

- (a) The package retains its radioactive contents under routine conditions of carriage; and
- (b) The package bears the marking "RADIOACTIVE" on an internal surface in such a manner that a warning of the presence of radioactive material is visible on opening the package.

2.2.7.9.5 A manufactured article in which the sole radioactive material is unirradiated natural uranium, unirradiated depleted uranium or unirradiated natural thorium may be carried as an excepted package provided that the outer surface of the uranium or thorium is enclosed in an inactive sheath made of metal or some other substantial material.

- 2.2.7.9.6 An empty packaging which had previously contained radioactive material may be carried as an excepted package provided that:
- (a) It is in a well maintained condition and securely closed;
 - (b) The outer surface of any uranium or thorium in its structure is covered with an inactive sheath made of metal or some other substantial material;
 - (c) The level of internal non-fixed contamination does not exceed one hundred times the levels specified in 4.1.9.1.2; and
 - (d) Any labels which may have been displayed on it in conformity with 5.2.2.1.11.1 are no longer visible.
- 2.2.7.9.7 The following provisions do not apply to excepted packages and the controls for carriage of excepted packages:
- 2.2.7.4.1, 2.2.7.4.2, 4.1.9.1.3, 4.1.9.1.4, 5.1.3.2, 5.1.5.1.1, 5.1.5.1.2, 5.2.2.1.11.1, 5.4.1.1.1, except (a), 5.4.1.2.5.1, 5.4.1.2.5.2, 5.4.3, 6.4.6.1, 7.5.11 CV 33 except for para. (5.2).
- 2.2.7.10 *(Reserved)*

2.2.8 Class 8 Corrosive substances

2.2.8.1 Criteria

2.2.8.1.1 The heading of Class 8 covers substances and articles containing substances of this Class which by chemical action attack epithelial tissue - of skin or mucous membranes - with which they are in contact, or which in the event of leakage are capable of damaging or destroying other goods, or means of transport. The heading of this Class also covers other substances which form a corrosive liquid only in the presence of water, or which produce corrosive vapour or mist in the presence of natural moisture of the air.

2.2.8.1.2 Substances and articles of Class 8 are subdivided as follows:

C1-C10 Corrosive substances without subsidiary risk:

C1-C4 Acid substances:
C1 Inorganic, liquid;
C2 Inorganic, solid;
C3 Organic, liquid;
C4 Organic, solid;

C5-C8 Basic substances:
C5 Inorganic, liquid;
C6 Inorganic, solid;
C7 Organic, liquid;
C8 Organic, solid;

C9-C10 Other corrosive substances:
C9 Liquid;
C10 Solid;

C11 Articles;

CF Corrosive substances, flammable:
CF1 Liquid;
CF2 Solid;

CS Corrosive substances, self-heating:
CS1 Liquid;
CS2 Solid;

CW Corrosive substances which, in contact with water, emit flammable gases:
CW1 Liquid;
CW2 Solid;

CO Corrosive substances, oxidizing:
CO1 Liquid;
CO2 Solid;

CT Corrosive substances, toxic:
CT1 Liquid;
CT2 Solid;

CFT Corrosive substances, flammable, liquid, toxic;

COT Corrosive substances, oxidizing, toxic.

Classification and assignment of packing groups

2.2.8.1.3 Substances of Class 8 shall be classified in three packing groups according to the degree of danger they present for carriage, as follows:

Packing group I: highly corrosive substances
Packing group II: corrosive substances
Packing group III: slightly corrosive substances.

2.2.8.1.4 Substances and articles classified in Class 8 are listed in Table A of Chapter 3.2. Allocation of substances to packing groups I, II and III has been made on the basis of experience taking into account such additional factors as inhalation risk (see 2.2.8.1.5) and reactivity with water (including the formation of dangerous decomposition products).

2.2.8.1.5 A substance or preparation meeting the criteria of Class 8 having an inhalation toxicity of dusts and mists (LC₅₀) in the range of packing group I, but toxicity through oral ingestion or dermal contact only in the range of packing group III or less, shall be allocated to Class 8.

2.2.8.1.6 Substances, including mixtures, not mentioned by name in Table A of Chapter 3.2 can be assigned to the relevant entry of sub-section 2.2.8.3, and to the relevant packing group on the basis of the length of time of contact necessary to produce full thickness destruction of human skin in accordance with the criteria of (a) to (c) below.

Substances which are judged not to cause full thickness destruction of human skin shall still be considered for their potential to cause corrosion to certain metal surfaces. In assigning the packing group, account shall be taken of human experience in instances of accidental exposure. In the absence of human experience, the grouping shall be based on data obtained from experiments in accordance with OECD Guideline 404⁵.

- (a) Packing group I is assigned to substances that cause full thickness destruction of intact skin tissue within an observation period up to 60 minutes starting after the exposure time of 3 minutes or less;
- (b) Packing group II is assigned to substances that cause full thickness destruction of intact skin tissue within an observation period up to 14 days starting after the exposure time of more than 3 minutes but not more than 60 minutes;
- (c) Packing group III is assigned to substances that:
 - cause full thickness destruction of intact skin tissue within an observation period up to 14 days starting after the exposure time of more than 60 minutes but not more than 4 hours; or
 - are judged not to cause full thickness destruction of intact skin tissue, but which exhibit a corrosion rate on steel or aluminium surfaces exceeding 6.25 mm a year at a test temperature of 55 °C. For the purposes of testing steel, type S235JR+CR (1.0037 resp. St 37-2), S275J2G3+CR (1.0144 resp. St 44-3), ISO 3574, Unified Numbering System (UNS) G10200 or SAE 1020, and for testing aluminium, non-clad, types 7075-T6 or AZ5GU-T6 shall be used. An acceptable test is prescribed in the Manual of Tests and Criteria, Part III, Section 37.

⁵ *OECD guidelines for Testing of Chemicals, No. 404 "Acute Dermal Irritation/Corrosion" (1992).*

2.2.8.1.7 If substances of Class 8, as a result of admixtures, come into categories of risk different from those to which the substances mentioned by name in Table A of Chapter 3.2 belong, these mixtures or solutions shall be assigned to the entries to which they belong, on the basis of their actual degree of danger.

NOTE: For the classification of solutions and mixtures (such as preparations and wastes), see also 2.1.3.

2.2.8.1.8 On the basis of the criteria set out in paragraph 2.2.8.1.6, it may also be determined whether the nature of a solution or mixture mentioned by name or containing a substance mentioned by name is such that the solution or mixture is not subject to the provisions for this Class.

2.2.8.1.9 Substances, solutions and mixtures, which

- do not meet the criteria of Directives 67/548/EEC² or 88/379/EEC³ as amended and therefore are not classified as corrosive according to these directives, as amended; and
- do not exhibit a corrosive effect on steel or aluminium;

may be considered as substances not belonging to Class 8.

NOTE: UN No. 1910 calcium oxide and UN No. 2812 sodium aluminate, listed in the UN Model Regulations, are not subject to the provisions of ADR.

2.2.8.2 Substances not accepted for carriage

2.2.8.2.1 The chemically unstable substances of Class 8 shall not be accepted for carriage unless the necessary steps have been taken to prevent their dangerous decomposition or polymerization during carriage. To this end it shall in particular be ensured that receptacles and tanks do not contain any substance liable to promote these reactions.

2.2.8.2.2 The following substances shall not be accepted for carriage:

- UN No. 1798 NITROHYDROCHLORIC ACID;
- chemically unstable mixtures of spent sulphuric acid;
- chemically unstable mixtures of nitrating acid or mixtures of residual sulphuric and nitric acids, not denitrated;
- perchloric acid aqueous solution with more than 72 % pure acid, by mass, or mixtures of perchloric acid with any liquid other than water.

² Council Directive 67/548/EEC of 27 June 1967 on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances (Official Journal of the European Communities No. L 196 of 16.08.1967, page 1).

³ Council Directive 88/379/EEC on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous preparations (Official Journal of the European Communities No. L 187 of 16.07.1988, page 14).

2.2.8.3 List of collective entries

Corrosive substances without subsidiary risk

Acid	inorganic	liquid C1	2584 ALKYL SULPHONIC ACIDS, LIQUID with more than 5% free sulphuric acid or 2584 ARYL SULPHONIC ACIDS, LIQUID with more than 5% free sulphuric acid 2693 BISULPHITES, AQUEOUS SOLUTION, N.O.S. 2837 BISULPHATES, AQUEOUS SOLUTION 3264 CORROSIVE LIQUID, ACIDIC, INORGANIC, N.O.S.
		solid C2	1740 HYDROGEN DIFLUORIDES, N.O.S. 2583 ARYL SULPHONIC ACIDS, SOLID with more than 5% free sulphuric acid or 2583 ARYL SULPHONIC ACIDS, SOLID with more than 5% free sulphuric acid 3260 CORROSIVE SOLID, ACIDIC, INORGANIC, N.O.S.
C1-C4	organic	liquid C3	2586 ALKYL SULPHONIC ACIDS, LIQUID with not more than 5% free sulphuric acid or 2586 ARYL SULPHONIC ACIDS, LIQUID with not more than 5% free sulphuric acid 2987 CHLOROSILANES, CORROSIVE, N.O.S. 3145 ALKYL PHENOLS, LIQUID, N.O.S. (including C ₂ -C ₁₂ homologues) 3265 CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S.
		solid C4	2430 ALKYL PHENOLS, SOLID, N.O.S. (including C ₂ -C ₁₂ homologues) 2585 ARYL SULPHONIC ACIDS, SOLID with not more than 5% free sulphuric acid or 2585 ARYL SULPHONIC ACIDS, SOLID with not more than 5% free sulphuric acid 3261 CORROSIVE SOLID, ACIDIC, ORGANIC, N.O.S.
Basic	inorganic	liquid C5	1719 CAUSTIC ALKALI LIQUID, N.O.S. 2797 BATTERY FLUID, ALKALI 3266 CORROSIVE LIQUID, BASIC, INORGANIC, N.O.S.
		solid C6	3262 CORROSIVE SOLID, BASIC, INORGANIC, N.O.S.
C5-C8	organic	liquid C7	2735 AMINES, LIQUID, CORROSIVE, N.O.S. or 2735 POLYAMINES, LIQUID, CORROSIVE, N.O.S. 3267 CORROSIVE LIQUID, BASIC, ORGANIC, N.O.S.
		solid C8	3259 AMINES, SOLID, CORROSIVE, N.O.S., or 3259 POLYAMINES, SOLID, CORROSIVE, N.O.S. 3263 CORROSIVE SOLID, BASIC, ORGANIC, N.O.S.
Other corrosive substances C9-C10		liquid C9	1903 DISINFECTANT, LIQUID, CORROSIVE, N.O.S. 2801 DYE, LIQUID, CORROSIVE, N.O.S. or 2801 DYE INTERMEDIATE, LIQUID, CORROSIVE, N.O.S. 3066 PAINT (including paint, enamel, stain, shellac, varnish, polish, liquid filler and lacquer base) or 3066 PAINT RELATED MATERIAL (including paint thinning or reducing compound) 1760 CORROSIVE LIQUID, N.O.S.
		solid ^a C10	3147 DYE, SOLID, CORROSIVE, N.O.S. or 3147 DYE INTERMEDIATE, SOLID, CORROSIVE, N.O.S. 3244 SOLIDS CONTAINING CORROSIVE LIQUID, N.O.S. 1759 CORROSIVE SOLID, N.O.S.
Articles		C11	2794 BATTERIES, WET, FILLED WITH ACID, electric storage 2795 BATTERIES, WET, FILLED WITH ALKALI, electric storage 2800 BATTERIES, WET, NON-SPILLABLE, electric storage 3028 BATTERIES, DRY, CONTAINING POTASSIUM HYDROXIDE SOLID, electric storage

(cont'd on next page)

^a Mixtures of solids which are not subject to the provisions of ADR and of corrosive liquids may be carried under UN No. 3244 without being subject to the classification criteria of Class 8, provided there is no free liquid visible at the time the substance is loaded or at the time the packaging, container or transport unit is closed. Each packaging shall correspond to a design type which has passed the leakproofness test for Packing group II level.

Corrosive substances with subsidiary risk(s)

Flammable^b	liquid	CF1	2734 AMINES, LIQUID, CORROSIVE, FLAMMABLE, N.O.S. or 2734 POLYAMINES, LIQUID, CORROSIVE, FLAMMABLE, N.O.S. 2986 CHLOROSILANES, CORROSIVE, FLAMMABLE, N.O.S. 2920 CORROSIVE LIQUID, FLAMMABLE, N.O.S.
	solid	CF2	2921 CORROSIVE SOLID, FLAMMABLE, N.O.S.
Self-heating	liquid	CS1	3301 CORROSIVE LIQUID, SELF-HEATING, N.O.S.
	solid	CS2	3095 CORROSIVE SOLID, SELF-HEATING, N.O.S.
Water-reactive	liquid^b	CW1	3094 CORROSIVE LIQUID, WATER-REACTIVE, N.O.S.
	solid	CW2	3096 CORROSIVE SOLID, WATER-REACTIVE, N.O.S.
Oxidizing	liquid	CO1	3093 CORROSIVE LIQUID, OXIDIZING, N.O.S.
	solid	CO2	3084 CORROSIVE SOLID, OXIDIZING, N.O.S.
Toxic^d	liquid^c	CT1	2922 CORROSIVE LIQUID, TOXIC, N.O.S.
	solid^e	CT2	2923 CORROSIVE SOLID, TOXIC, N.O.S.
Flammable, liquid, toxic^d		CFT	No collective entry with this classification code available; if need be, classification under a collective entry with a classification code to be determined according to table of precedence of hazard in 2.1.3.10.
Oxidizing, toxic^{d,e}		COT	No collective entry with this classification code available; if need be, classification under a collective entry with a classification code to be determined according to table of precedence of hazard in 2.1.3.10.

^b Chlorosilanes which, in contact with water or moist air, emit flammable gases, are substances of Class 4.3.

^c Chloroformates having predominantly toxic properties are substances of Class 6.1.

^d Corrosive substances which are highly toxic by inhalation, as defined in 2.2.61.1.4 to 2.2.61.1.9 are substances of Class 6.1.

^e UN No. 2505 AMMONIUM FLUORIDE, UN No. 1812 POTASSIUM FLUORIDE, SOLID, UN No. 1690 SODIUM FLUORIDE, SOLID, UN No. 2674 SODIUM FLUOROSILICATE, UN No. 2856 FLUOROSILICATES, N.O.S., UN No. 3415 SODIUM FLUORIDE SOLUTION and UN No. 3422 POTASSIUM FLUORIDE SOLUTION are substances of Class 6.1.

2.2.9 Class 9 Miscellaneous dangerous substances and articles

2.2.9.1 Criteria

2.2.9.1.1 The heading of Class 9 covers substances and articles which, during carriage, present a danger not covered by the heading of other classes.

2.2.9.1.2 The substances and articles of Class 9 are subdivided as follows:

M1 Substances which, on inhalation as fine dust, may endanger health;

M2 Substances and apparatus which, in the event of fire, may form dioxins;

M3 Substances evolving flammable vapour;

M4 Lithium batteries;

M5 Life-saving appliances;

M6-M8 Environmentally hazardous substances:

M6 Pollutant to the aquatic environment, liquid;

M7 Pollutant to the aquatic environment, solid;

M8 Genetically modified micro-organisms and organisms;

M9-M10 Elevated temperature substances:

M9 Liquid;

M10 Solid;

M11 Other substances presenting a danger during carriage, but not meeting the definitions of another class.

Definitions and classification

2.2.9.1.3 Substances and articles classified in Class 9 are listed in Table A of Chapter 3.2. The assignment of substances and articles not mentioned by name in Table A of Chapter 3.2 to the relevant entry of that Table or of sub-section 2.2.9.3 shall be done in accordance with 2.2.9.1.4 to 2.2.9.1.14 below.

Substances which, on inhalation as fine dust, may endanger health

2.2.9.1.4 Substances which, on inhalation as fine dust, may endanger health include asbestos and mixtures containing asbestos.

Substances and apparatus which, in the event of fire, may form dioxins

2.2.9.1.5 Substances and apparatus which, in the event of fire, may form dioxins include polychlorinated biphenyls (PCBs) and terphenyls (PCTs) and polyhalogenated biphenyls and terphenyls and mixtures containing these substances, as well as apparatus such as transformers, condensers and apparatus containing those substances or mixtures.

NOTE: *Mixtures with a PCB or PCT content of not more than 50 mg/kg are not subject to the provisions of ADR.*

Substances evolving flammable vapour

- 2.2.9.1.6 Substances evolving flammable vapour include polymers containing flammable liquids with a flash-point not exceeding 55 °C.

Lithium batteries

- 2.2.9.1.7 Lithium cells and batteries may be assigned to Class 9 if they meet the requirements of special provision 230 of Chapter 3.3. They are not subject to the provisions of ADR if they meet the requirements of special provision 188 of Chapter 3.3. They shall be classified in accordance with the procedures of Section 38.3 of the Manual of Tests and Criteria.

Life-saving appliances

- 2.2.9.1.8 Life-saving appliances include life-saving appliances and motor vehicle components which meet the descriptions of special provisions 235 or 296 of Chapter 3.3.

Environmentally hazardous substances

- 2.2.9.1.9 Environmentally hazardous substances include liquid or solid substances pollutant to the aquatic environment and solutions and mixtures of such substances (such as preparations and wastes), which cannot be classified in the other classes or under any other entry of Class 9 listed in Table A of Chapter 3.2. It also includes genetically modified micro-organisms and organisms.

Pollutants to the aquatic environment

- 2.2.9.1.10 Assignment of a substance to the entries UN No. 3082 ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S and UN No. 3077 ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. as pollutant to the aquatic environment shall be as indicated in 2.3.5. Notwithstanding the provisions of 2.3.5, substances which cannot be assigned to other classes of ADR or to other entries of Class 9, and which are not identified in Council Directive 67/548/EEC of 27 June 1967 on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances⁶, as amended, as substances to which letter N "Environmentally hazardous" (R50; R50/53; R51/53) has been allocated, are not subject to ADR.

Notwithstanding the provisions of 2.1.3.8, solutions and mixtures (such as preparations and wastes) of substances to which letter N "Environmentally hazardous" (R50; R50/53; R51/53) has been allocated in Directive 67/548/EEC, as amended, need only be assigned to UN Nos. 3077 or 3082 if, according to Directive 1999/45/EC of the European Parliament and of the Council of 31 May 1999 concerning the approximation of the laws, regulations and administrative provisions of the Member States relating to the classification, packaging and labelling of dangerous preparations⁷, as amended, they are also allocated letter N "Environmentally hazardous" (R50; R50/53; R51/53) and they cannot be assigned to one of classes 1 to 8 or to any other entry of Class 9.

Genetically modified micro-organisms or organisms

- 2.2.9.1.11 Genetically modified micro-organisms (GMMOs) and genetically modified organisms (GMOs) are micro-organisms and organisms in which genetic material has been purposely altered through genetic engineering in a way that does not occur naturally. They are assigned

⁶ Official Journal of the European Communities No.196, of 16 August 1967, pp. 1 – 5.

⁷ Official Journal of the European Communities No. L 200, of 30 July 1999, pp. 1 – 68.

to Class 9 (UN No. 3245) if they do not meet the definition of infectious substances, but are capable of altering animals, plants or microbiological substances in a way not normally the result of natural reproduction.

NOTE 1: *GMMOs which are infectious are substances of Class 6.2, UN Nos. 2814 and 2900.*

NOTE 2: *GMMOs or GMOs are not subject to the provisions of ADR when authorized for use by the competent authorities of the countries of origin, transit and destination⁸.*

NOTE 3: *Live animals shall not be used to carry genetically modified micro-organisms classified in Class 9 unless the substance can be carried no other way.*

2.2.9.1.12 Genetically modified organisms, which are known or suspected to be dangerous to the environment shall be carried in accordance with conditions specified by the competent authority of the country of origin.

Elevated temperature substances

2.2.9.1.13 Elevated temperature substances include substances which are carried or handed over for carriage in the liquid state at or above 100 °C and, in the case of those with a flash-point, below their flash-point. They also include solids which are carried or handed over for carriage at or above 240 °C.

NOTE: *Elevated temperature substances may be assigned to Class 9 only if they do not meet the criteria of any other class.*

Other substances presenting a danger during carriage but not meeting the definitions of another class.

2.2.9.1.14 The following other miscellaneous substances not meeting the definitions of another class are assigned to Class 9:

Solid ammonia compounds having a flash-point below 61 °C;

Low hazard dithionites;

Highly volatile liquids;

Substances emitting noxious fumes;

Substances containing allergens;

Chemical kits and first aid kits;

NOTE: *UN No. 1845 carbon dioxide, solid (dry ice), UN No. 2071 ammonium nitrate fertilizers, UN No. 2216 fish meal (fish scrap), stabilized, UN No. 2807 magnetized material, UN No. 3166 engine, internal combustion or vehicle, flammable gas powered or vehicle, flammable liquid powered, UN No. 3171 battery-powered vehicle or 3171 battery-powered equipment (wet battery), UN No. 3334 aviation regulated liquid, n.o.s., UN No. 3335 aviation regulated solid, n.o.s. and UN No. 3363 dangerous goods in machinery or dangerous goods in apparatus listed in the UN Model Regulations, are not subject to the provisions of ADR.*

⁸ See in particular Part C of Directive 2001/18/EC of the European Parliament and of the Council on the deliberate release into the environment of genetically modified organisms and repealing Council Directive 90/220/EEC (Official Journal of the European Communities, No. L 106, of 17 April 2001, pp. 8-14), which sets out the authorization procedures for the European Community.

Assignment of the packing groups

2.2.9.1.15 The substances and articles of Class 9 listed as such in Table A of Chapter 3.2 shall be assigned to one of the following packing groups according to their degree of danger:

Packing group II: substances presenting medium danger;

Packing group III: substances presenting low danger.

2.2.9.2 *Substances and articles not accepted for carriage*

The following substances and articles shall not be accepted for carriage:

- Lithium batteries which do not meet the relevant conditions of special provisions 188, 230 or 636 of Chapter 3.3;
- Uncleaned empty containment vessels for apparatus such as transformers and condensers containing substances assigned to UN Nos. 2315, 3151 or 3152.

2.2.9.3 List of collective entries

Substances which, on inhalation as fine dust, may endanger health	M1	2212 BLUE ASBESTOS (crocidolite) or 2212 BROWN ASBESTOS (amosite, mysorite) 2590 WHITE ASBESTOS (chrysotile, actinolite, anthophyllite, tremolite)	
Substances and apparatus which, in the event of fire, may form dioxins	M2	2315 POLYCHLORINATED BIPHENYLS, LIQUID 3432 POLYCHLORINATED BIPHENYLS, SOLID 3151 POLYHALOGENATED BIPHENYLS, LIQUID or 3151 POLYHALOGENATED TERPHENYLS, LIQUID 3152 POLYHALOGENATED BIPHENYLS, SOLID or 3152 POLYHALOGENATED TERPHENYLS, SOLID	
Substances evolving flammable vapour	M3	2211 POLYMERIC BEADS, EXPANDABLE, evolving flammable vapour 3314 PLASTICS MOULDING COMPOUND in dough, sheet or extruded rope form evolving flammable vapour	
Lithium batteries	M4	3090 LITHIUM BATTERIES 3091 LITHIUM BATTERIES CONTAINED IN EQUIPMENT or 3091 LITHIUM BATTERIES PACKED WITH EQUIPMENT	
Live-saving appliances	M5	2990 LIFE-SAVING APPLIANCES, SELF-INFLATING 3072 LIFE-SAVING APPLIANCES NOT SELF-INFLATING containing dangerous goods as equipment 3268 AIR BAG INFLATORS or 3268 AIR BAG MODULES or 3268 SEAT-BELT PRETENSIONERS	
Environmentally hazardous substances	pollutant to the aquatic environment, liquid	M6	3082 ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S.
	pollutant to the aquatic environment, solid	M7	3077 ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S.
Elevated temperature substances	genetically modified micro-organisms and organisms	M8	3245 GENETICALLY MODIFIED MICRO-ORGANISMS
	liquid	M9	3257 ELEVATED TEMPERATURE LIQUID, N.O.S., at or above 100 °C and below its flash-point (including molten metal, molten salts, etc.)
	solid	M10	3258 ELEVATED TEMPERATURE SOLID, N.O.S., at or above 240 °C
Other substances or articles presenting a danger during carriage, but not meeting the definitions of another class	M11	No collective entry available. Only substances listed in Table A of Chapter 3.2 are subject to the provisions for Class 9 under this classification code, as follows: 1841 ACETALDEHYDE AMMONIA 1931 ZINC DITHIONITE (ZINC HYDROSULPHITE) 1941 DIBROMODIFLUOROMETHANE 1990 BENZALDEHYDE 2969 CASTOR BEANS, or 2969 CASTOR MEAL, or 2969 CASTOR POMACE, or 2969 CASTOR FLAKE 3316 CHEMICAL KIT, or 3316 FIRST AID KIT 3359 FUMIGATED UNIT	

CHAPTER 2.3

TEST METHODS

2.3.0 General

Unless otherwise provided for in Chapter 2.2 or in this Chapter, the test methods to be used for the classification of dangerous goods are those described in the Manual of Tests and Criteria.

2.3.1 Exudation test for blasting explosives of Type A

2.3.1.1 Blasting explosives of type A (UN No. 0081) shall, if they contain more than 40% liquid nitric ester, in addition to the testing specified in the Manual of Tests and Criteria, satisfy the following exudation test.

2.3.1.2 The apparatus for testing blasting explosive for exudation (figs. 1 to 3) consists of a hollow bronze cylinder. This cylinder, which is closed at one end by a plate of the same metal, has an internal diameter of 15.7 mm and a depth of 40 mm.

It is pierced by 20 holes 0.5 mm in diameter (four sets of five holes) on the circumference. A bronze piston, cylindrically fashioned over a length of 48 mm and having a total length of 52 mm, slides into the vertically placed cylinder.

The piston, whose diameter is 15.6 mm, is loaded with a mass of 2 220 g so that a pressure of 120 kPa (1.20 bar) is exerted on the base of the cylinder.

2.3.1.3 A small plug of blasting explosive weighing 5 to 8 g, 30 mm long and 15 mm in diameter, is wrapped in very fine gauze and placed in the cylinder; the piston and its loading mass are then placed on it so that the blasting explosive is subjected to a pressure of 120 kPa (1.20 bar). The time taken for the appearance of the first signs of oily droplets (nitroglycerine) at the outer orifices of the cylinder holes is noted.

2.3.1.4 The blasting explosive is considered satisfactory if the time elapsing before the appearance of the liquid exudations is more than five minutes, the test having been carried out at a temperature of 15 °C to 25 °C.

Test of blasting explosive for exudation

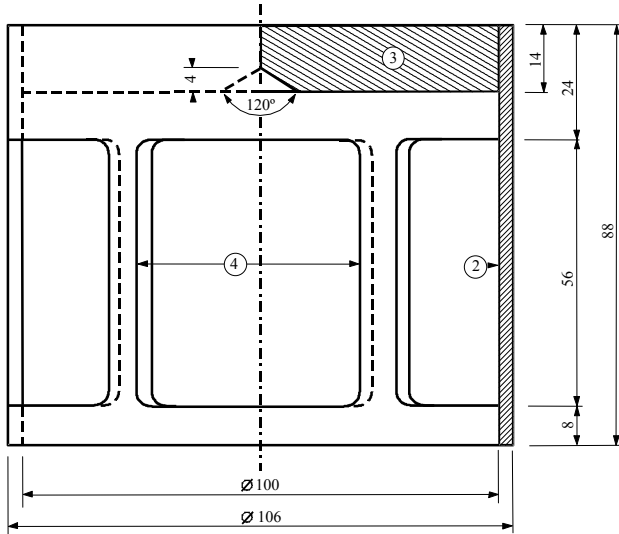


Fig.1: Bell-form charge, mass 2220 g, capable of being suspended from a bronze piston

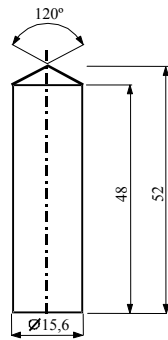


Fig.2: Cylindrical bronze piston, dimensions in mm

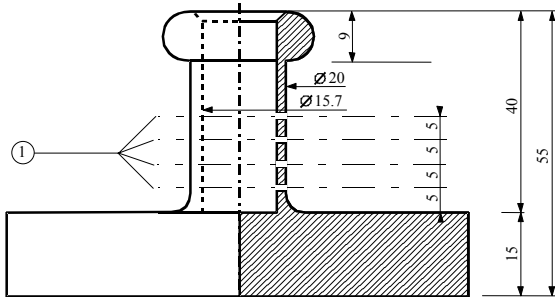


Fig.3: Hollow bronze cylinder, closed at one end; Plan and cut dimensions in mm

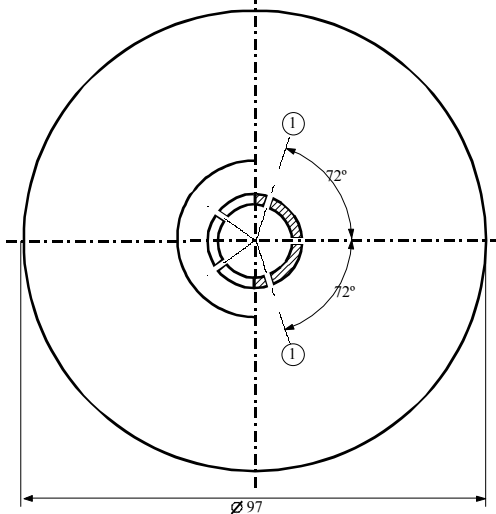


Fig. 1 to 3

- (1) 4 series of 5 holes at 0.5 N
- (2) copper
- (3) iron plate with centre cone at the inferior face
- (4) 4 openings, approximately 46x56, set at even intervals on the periphery

2.3.2 Tests relating to nitrated cellulose mixtures of Class 4.1

- 2.3.2.1 Nitrocellulose heated for half an hour at 132 °C shall not give off visible yellowish-brown nitrous fumes (nitrous gases). The ignition temperature shall be above 180 °C. See 2.3.2.3 to 2.3.2.8, 2.3.2.9 (a) and 2.3.2.10 below.
- 2.3.2.2 3 g of plasticized nitrocellulose, heated for one hour at 132 °C, shall not give off visible yellowish-brown nitrous fumes (nitrous gases). The ignition temperature shall be above 170 °C. See 2.3.2.3 to 2.3.2.8, 2.3.2.9 (b) and 2.3.2.10 below.
- 2.3.2.3 The test procedures set out below are to be applied when differences of opinion arise as to the acceptability of substances for carriage by road.
- 2.3.2.4 If other methods or test procedures are used to verify the conditions of stability prescribed above in this section, those methods shall lead to the same findings as could be reached by the methods specified below.
- 2.3.2.5 In carrying out the stability tests by heating described below, the temperature of the oven containing the sample under test shall not deviate by more than 2 °C from the prescribed temperature; the prescribed duration of a 30-minute or 60-minute test shall be observed to within two minutes. The oven shall be such that the required temperature is restored not more than five minutes after insertion of the sample.
- 2.3.2.6 Before undergoing the tests in 2.3.2.9 and 2.3.2.10, the samples shall be dried for not less than 15 hours at the ambient temperature in a vacuum desiccator containing fused and granulated calcium chloride, the sample substance being spread in a thin layer; for this purpose, substances which are neither in powder form nor fibrous shall be ground, or grated, or cut into small pieces. The pressure in the desiccator shall be brought below 6.5 kPa (0.065 bar).
- 2.3.2.7 Before being dried as prescribed in 2.3.2.6 above, substances conforming to 2.3.2.2 shall undergo preliminary drying in a well-ventilated oven, with its temperature set at 70 °C, until the loss of mass per quarter-hour is less than 0.3 % of the original mass.
- 2.3.2.8 Weakly nitrated nitrocellulose conforming to 2.3.2.1 shall first undergo preliminary drying as prescribed in 2.3.2.7 above; drying shall then be completed by keeping the nitrocellulose for at least 15 hours over concentrated sulphuric acid in a desiccator.

2.3.2.9 *Test of chemical stability under heat*

(a) *Test of the substance listed in paragraph 2.3.2.1 above.*

(i) In each of two glass test tubes having the following dimensions:

length	350	mm
internal diameter	16	mm
thickness of wall	1.5	mm

is placed 1 g of substance dried over calcium chloride (if necessary the drying shall be carried out after reducing the substance to pieces weighing not more than 0.05 g each).

Both test tubes, completely covered with loose-fitting closures, are then so placed in an oven that at least four-fifths of their length is visible, and are kept at a constant temperature of 132 °C for 30 minutes. It is observed whether nitrous gases in the form of yellowish-brown fumes clearly visible against a white background are given off during this time;

(ii) In the absence of such fumes the substance is deemed to be stable;

- (b) *Test of plasticized nitrocellulose (see 2.3.2.2)*
- (i) 3 g of plasticized nitrocellulose are placed in glass test tubes, similar to those referred to in (a), which are then placed in an oven kept at a constant temperature of 132 °C;
 - (ii) The test tubes containing the plasticized nitrocellulose are kept in the oven for one hour. During this time no yellowish-brown nitrous fumes (nitrous gases) shall be visible. Observation and appraisal as in (a).

2.3.2.10 Ignition temperature (see 2.3.2.1 and 2.3.2.2)

- (a) The ignition temperature is determined by heating 0.2 g of substance enclosed in a glass test tube immersed in a Wood's alloy bath. The test tube is placed in the bath when the latter has reached 100 °C. The temperature of the bath is then progressively increased by 5 °C per minute;
- (b) The test tubes must have the following dimensions:

length	125 mm
internal diameter	15 mm
thickness of wall	0.5 mm

and shall be immersed to a depth of 20 mm;
- (c) The test shall be repeated three times, the temperature at which ignition of the substance occurs, i.e., slow or rapid combustion, deflagration or detonation, being noted each time;
- (d) The lowest temperature recorded in the three tests is the ignition temperature.

2.3.3 Tests relating to flammable liquids of Classes 3, 6.1 and 8

2.3.3.1 Test for determining flash-point

2.3.3.1.1 The flash-point shall be determined by means of one of the following types of apparatus:

- (a) Abel;
- (b) Abel-Pensky;
- (c) Tag;
- (d) Pensky-Martens;
- (e) Apparatus in accordance with ISO 3679: 1983 or ISO 3680: 1983.

2.3.3.1.2 To determine the flash-point of paints, gums and similar viscous products containing solvents, only apparatus and test methods suitable for determining the flash-point for viscous liquids shall be used, in accordance with the following standards:

- (a) International Standard ISO 3679: 1983;
- (b) International Standard ISO 3680: 1983;
- (c) International Standard ISO 1523: 1983;
- (d) German Standard DIN 53213: 1978, Part 1.

- 2.3.3.1.3 The test procedure shall be either according to an equilibrium method or according to a non-equilibrium method.
- 2.3.3.1.4 For the procedure according to an equilibrium method, see:
- (a) International Standard ISO 1516: 1981;
 - (b) International Standard ISO 3680: 1983;
 - (c) International Standard ISO 1523: 1983;
 - (d) International Standard ISO 3679: 1983.
- 2.3.3.1.5 The procedure according to a non-equilibrium method shall be:
- (a) for the Abel apparatus, see:
 - (i) British Standard BS 2000 Part 170: 1995;
 - (ii) French Standard NF MO7-011: 1988;
 - (iii) French Standard NF T66-009: 1969;
 - (b) for the Abel-Pensky apparatus, see:
 - (i) German Standard DIN 51755, Part 1: 1974 (for temperatures from 5 °C to 65 °C);
 - (ii) German Standard DIN 51755, Part 2: 1978 (for temperatures below 5 °C);
 - (iii) French Standard NF MO7-036: 1984;
 - (c) for the Tag apparatus, see American Standard ASTM D 56: 1993;
 - (d) for the Pensky-Martens apparatus, see:
 - (i) International Standard ISO 2719: 1988;
 - (ii) European Standard EN 22719 in each of its national versions (e.g. BS 2000, part 404/EN 22719): 1994;
 - (iii) American Standard ASTM D 93: 1994;
 - (iv) Institute of Petroleum Standard IP 34: 1988.
- 2.3.3.1.6 The test methods listed in 2.3.3.1.4 and 2.3.3.1.5 shall only be used for flash-point ranges which are specified in the individual methods. The possibility of chemical reactions between the substance and the sample holder shall be considered when selecting the method to be used. The apparatus shall, as far as is consistent with safety, be placed in a draught-free position. For safety, a method utilizing a small sample size, around 2 ml, shall be used for organic peroxides and self-reactive substances (also known as "energetic" substances), or for toxic substances.
- 2.3.3.1.7 When the flash-point, determined by a non-equilibrium method in accordance with 2.3.3.1.5 is found to be 23 ± 2 °C or 61 ± 2 °C, it shall be confirmed for each temperature range by an equilibrium method in accordance with 2.3.3.1.4.
- 2.3.3.1.8 In the event of a dispute as to the classification of a flammable liquid, the classification proposed by the consignor shall be accepted if a check-test of the flash-point, yields a result

not differing by more than 2 °C from the limits (23 °C and 61 °C respectively) stated in 2.2.3.1. If the difference is more than 2 °C, a second check-test shall be carried out, and the lowest figure of the flash-points obtained in either check-test shall be adopted.

2.3.3.2 *Test for determining peroxide content*

To determine the peroxide content of a liquid, the procedure is as follows:

A quantity p (about 5 g, weighed to the nearest 0.01 g) of the liquid to be titrated is placed in an Erlenmeyer flask; 20 cm³ of acetic anhydride and about 1 g of powdered solid potassium iodide are added; the flask is shaken and, after 10 minutes, heated for 3 minutes to about 60 °C. When it has been left to cool for 5 minutes, 25 cm³ of water are added. After this, it is left standing for half an hour, then the liberated iodine is titrated with a decinormal solution of sodium thiosulphate, no indicator being added; complete discoloration indicates the end of the reaction. If n is the number of cm³ of thiosulphate solution required, the percentage of peroxide (calculated as H₂O₂) present in the sample is obtained by the formula:

$$\frac{17n}{100p}$$

2.3.4 *Test for determining fluidity*

To determine the fluidity of liquid, viscous or pasty substances and mixtures, the following test method shall be used.

2.3.4.1 *Test apparatus*

Commercial penetrometer conforming to ISO 2137:1985, with a guide rod of 47.5 g ± 0.05 g; sieve disc of duralumin with conical bores and a mass of 102.5 g ± 0.05 g (see Figure 1); penetration vessel with an inside diameter of 72 mm to 80 mm for reception of the sample.

2.3.4.2 *Test procedure*

The sample is poured into the penetration vessel not less than half an hour before the measurement. The vessel is then hermetically closed and left standing until the measurement. The sample in the hermetically closed penetration vessel is heated to 35 °C ± 0.5 °C and is placed on the penetrometer table immediately prior to measurement (not more than two minutes). The point S of the sieve disc is then brought into contact with the surface of the liquid and the rate of penetration is measured.

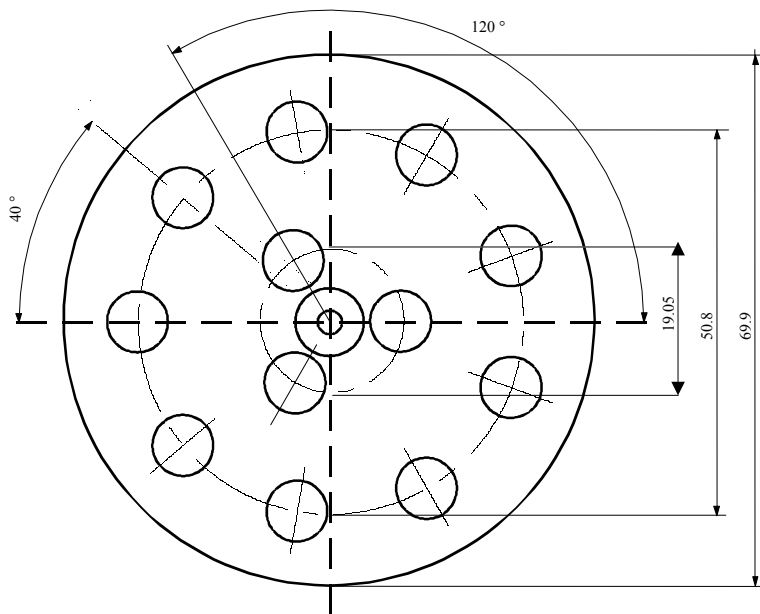
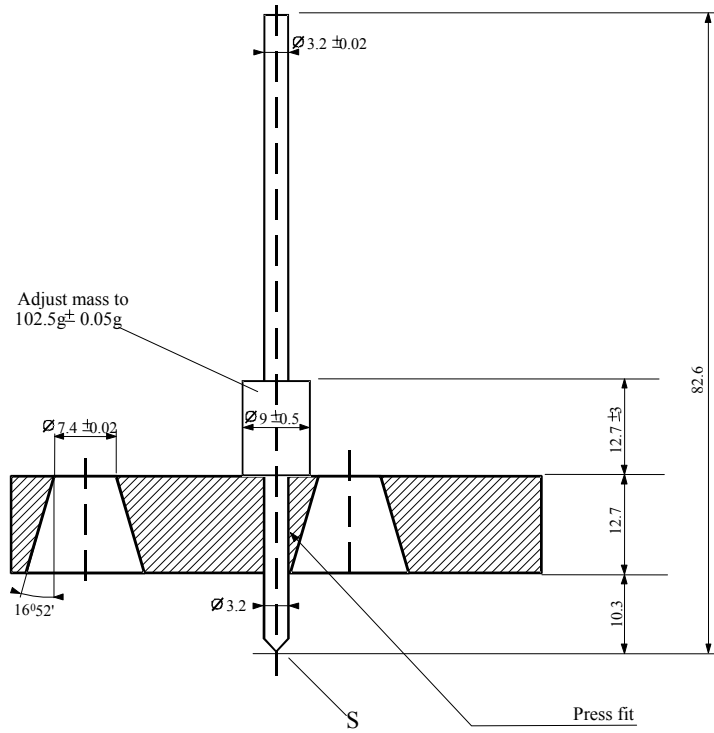
2.3.4.3 *Evaluation of test results*

A substance is pasty if, after the centre S has been brought into contact with the surface of the sample, the penetration indicated by the dial gauge:

- (a) after a loading time of 5 s ± 0.1 s, is less than 15.0 mm ± 0.3 mm; or
- (b) after a loading time of 5 s ± 0.1 s, is greater than 15.0 mm ± 0.3 mm, but the additional penetration after another 55 s ± 0.5 s is less than 5.0 mm ± 0.5 mm.

NOTE: In the case of samples having a flow point, it is often impossible to produce a steady level surface in the penetration vessel and, hence, to establish satisfactory initial measuring conditions for the contact of the point S. Furthermore, with some samples, the impact of the sieve disc can cause an elastic deformation of the surface and, in the first few seconds, simulate a deeper penetration. In all these cases, it may be appropriate to make the evaluation in paragraph (b) above.

Figure 1 – Penetrometer



Tolerances not specified are $\pm 0.1 \text{ mm}$.

2.3.5 Test for determining the ecotoxicity, persistence and bioaccumulation of substances in the aquatic environment for assignment to Class 9

NOTE: The test methods used shall be those adopted by the Organization for Economic Cooperation and Development (OECD) and the European Commission (EC). If other methods are used, they shall be internationally recognized, be equivalent to the OECD/EC tests and be referenced in test reports.

2.3.5.1 Acute toxicity for fish

The object is to determine the concentration which causes 50% mortality in the test species; this is the (LC₅₀) value, namely, the concentration of the substance in water which will cause the death of 50% of a test group of fish during a continuous period of testing of at least 96 hours. Appropriate types of fish include: striped brill (Brachydanio rerio), fathead minnow (Pimephales promelas) and rainbow trout (Oncorhynchus mykiss).

The fish are exposed to the test substance added to the water in varying concentrations (+1 control). Observations are recorded at least every 24 hours. At the end of the 96-hour activity and, if possible, at each observation, the concentration causing the death of 50% of the fish is calculated. The no observed effect concentration (NOEC) at 96 hours is also determined.

2.3.5.2 Acute toxicity for daphnia

The object is to determine the effective concentration of the substance in water which renders 50% of the daphnia unable to swim (EC₅₀). The appropriate test organisms are daphnia magna and daphnia pulex. The daphnia are exposed for 48 hours to the test substance added to the water in varying concentrations. The no observed effect concentration (NOEC) at 48 hours is also determined.

2.3.5.3 Algal growth inhibition

The object is to determine the effect of a chemical on the growth of algae under standard conditions. The change in biomass and the rate of growth with algae under the same conditions, but without the presence of the test chemical, are compared over 72 hours. The results are expressed as the effective concentration which reduces the rate of algal growth by 50% (IC_{50r}) and also the formation of the biomass (IC_{50b}).

2.3.5.4 Tests for ready biodegradability

The object is to determine the degree of biodegradation under standard aerobic conditions. The test substance is added in low concentrations to a nutrient solution containing aerobic bacteria. The progress of degradation is followed for 28 days by determining the parameter specified in the test method used. Several equivalent test methods are available. The parameters include reduction of dissolved organic carbon (DOC), carbon dioxide (CO₂) generation of oxygen (O₂) depletion.

A substance is considered to be readily biodegradable if within not more than 28 days the following criteria are satisfied - within 10 days from when degradation first reaches 10%:

Reduction of DOC:	70%
Generation of CO ₂ :	60% of theoretical CO ₂ production
Depletion of O ₂ :	60% of theoretical O ₂ requirement.

The test may be continued beyond 28 days if the above criteria are not satisfied, but the result will represent the inherent biodegradability of the test substance. For assignment purposes, the "ready" result is normally required.

Where only COD and BOD₅ data are available, a substance is considered to be readily biodegradable if:

$$\frac{\text{BOD}_5}{\text{COD}} \geq 0.5$$

BOD (Biochemical Oxygen Demand) is defined as the mass of dissolved oxygen required by a specific volume of solution of the substance for the process of biochemical oxidation under prescribed conditions. The result is expressed as grams of BOD per gram of test substance. The normal test period is five days (BOD₅) using a national standard test procedure.

COD (Chemical Oxygen Demand) is a measure of the oxidizability of a substance, expressed as the equivalent amount in oxygen of an oxidizing reagent consumed by the substance under fixed laboratory conditions. The results are expressed in grams of COD per gram of substance. A national standard procedure may be used.

2.3.5.5 Tests for bioaccumulation potential

2.3.5.5.1 The object is to determine the potential for bioaccumulation either by the ratio at equilibrium of the concentration (c) of a substance in a solvent to that in water or by the bioconcentration factor (BCF).

2.3.5.5.2 The ratio at equilibrium of the concentration (c) of a substance in a solvent to that in water is normally expressed as a log₁₀. The solvent and water shall have negligible miscibility and the substance shall not ionize in water. The solvent normally used is n-octanol.

In the case of n-octanol and water, the result is:

$$\log P_{ow} = \log_{10} [c_o/c_w]$$

where P_{ow} is the partition coefficient obtained by dividing the concentration of the substance in n-octanol (c_o) by the concentration of the substance in water (C_w).

If log P_{ow} ≥ 3.0 then the substance has a potential to bioaccumulate.

2.3.5.5.3 The bioconcentration factor (BCF) is defined as the ratio of the concentration of the test substance in the test fish (c_f) to the concentration in the test water (c_w) at steady state:

$$\text{BCF} = (c_f) / (c_w).$$

The principle of the test involves exposing fish to a solution or dispersion at known concentrations of the test substance in water. Continuous flow, static or semi-static procedures may be used according to the test procedure selected, based on the properties of the test substances. Fish are exposed to the test substances over a given period of time, followed by a period of no further exposure. During the second period, measurements are made of the rate of increase in the water of the test substance (i.e. the rate of excretion or depuration).

(Full details of the various test procedures and the calculation method for the BCF are given in the OECD Guidelines for Testing of Chemicals, methods 305A to 305E, 12 May 1981).

2.3.5.5.4 A substance may have a log P_{ow} greater than 3 and a BCF less than 100 which would indicate little or no potential to bioaccumulate. In cases of doubt, the BCF value takes precedence over log P_{ow}, as indicated in the flow chart of the procedure in 2.3.5.7.

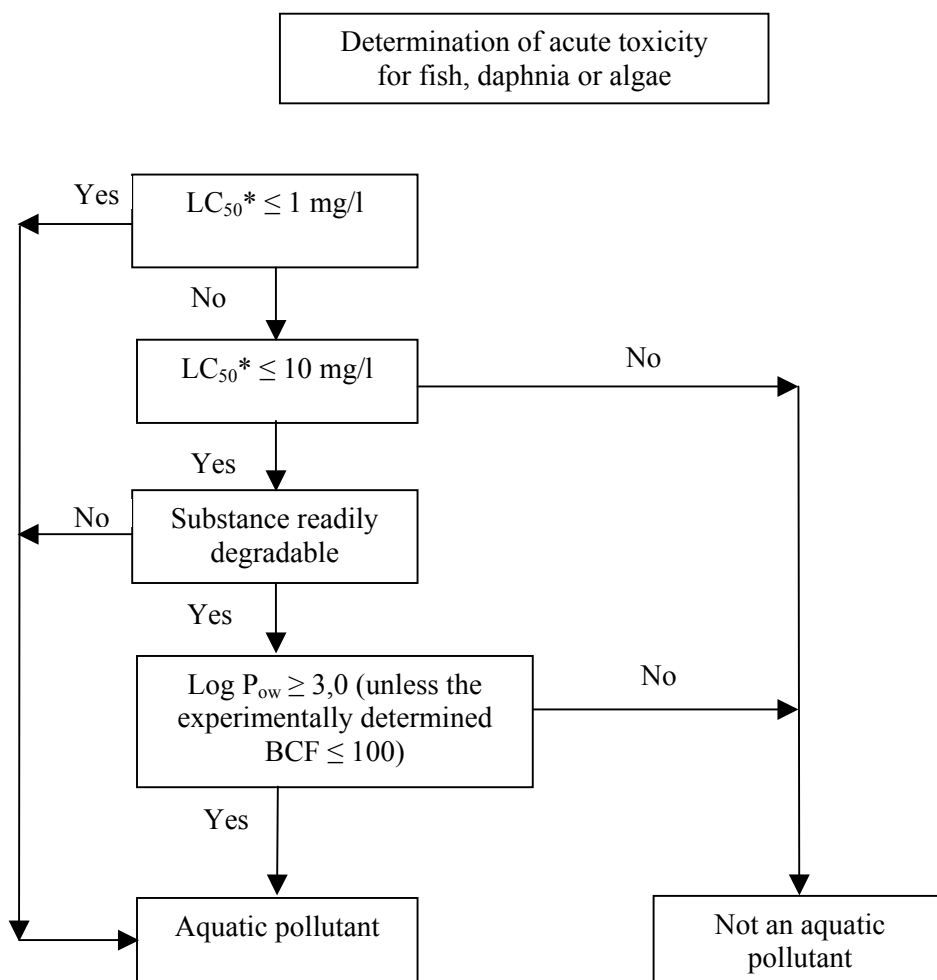
2.3.5.6 Criteria

A substance may be regarded as a pollutant to the aquatic environment if it satisfies one of the following criteria:

The lowest of the values of the 96-hour LC₅₀ for fish, the 48-hour EC₅₀ for daphnia or the 72-hour IC₅₀ for algae

- is less than or equal to 1 mg/l;
- is greater than 1 mg/l but less than or equal to 10 mg/l, and the substance is not biodegradable;
- is greater than 1 mg/l but less than or equal to 10 mg/l, and the log P_{ow} is greater than or equal to 3.0 (unless the experimentally determined BCF is less than or equal to 100).

2.3.5.7 Procedure to be followed



* Lowest value of 96-hour LC₅₀, 48-hour EC₅₀ or 72-hour IC₅₀ as appropriate.

BCF = bioconcentration factor

2.3.6

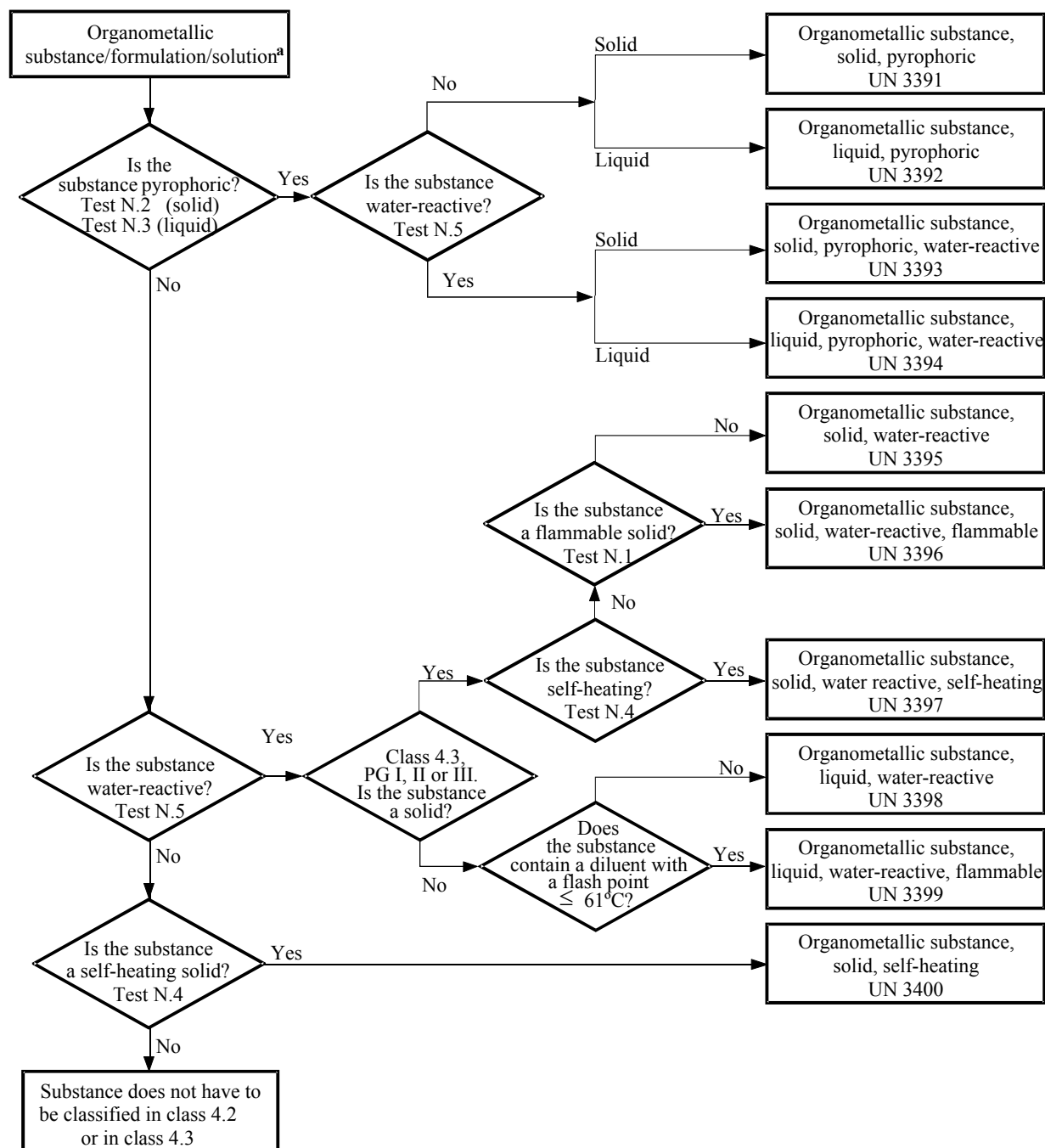
Classification of organometallic substances in Classes 4.2 and 4.3

Depending on their properties as determined in accordance with tests N.1 to N.5 of the Manual of Tests and Criteria, Part III, section 33, organometallic substances may be classified in Class 4.2 or 4.3, as appropriate, in accordance with the flowchart scheme given in Figure 2.3.6.

***NOTE 1:** Depending on their other properties and on the precedence of hazard table (see 2.1.3.10), organometallic substances may have to be classified in other classes as appropriate.*

***NOTE 2:** Flammable solutions with organometallic compounds in concentrations which are not liable to spontaneous combustion or, in contact with water, do not emit flammable gases in dangerous quantities, are substances of Class 3.*

Figure 2.3.6: Flowchart scheme for the classification of organometallic substances in Classes 4.2 and 4.3^b



^a If applicable and testing is relevant, taking into account reactivity properties, class 6.1 and 8 properties should be considered according to the precedence of hazard table of 2.1.3.10.

^b Test methods N.1 to N.5 can be found in the Manual of Tests and Criteria, Part III, Section 33.