

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.0.0
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<b>Note</b>	Incorporating Amendment 39-18

## PART 2

### CLASSIFICATION

#### Chapter 2.0

#### Introduction

Note: For the purposes of this Code, it has been necessary to classify dangerous goods in different classes, to subdivide a number of these classes and to define and describe characteristics and properties of the substances, materials and articles which would fall within each class or division. Moreover, in accordance with the criteria for the selection of marine pollutants for the purposes of Annex III of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL), a number of dangerous substances in the various classes have also been identified as substances harmful to the marine environment (MARINE POLLUTANTS).

#### 2.0.0 Responsibilities

2.0.0.1 The classification shall be made by the shipper/consignor or by the appropriate competent authority where specified in this Code.

2.0.0.2 A consignor who has identified, on the basis of test data, that a substance listed by name in column 2 of the Dangerous Goods List in chapter 3.2 meets classification criteria for a hazard class or division that is not identified in the list, may, with the approval of the competent authority, consign the substance:

- under the most appropriate "generic" or "not otherwise specified" (N.O.S.) entry reflecting all hazards; or
- under the same UN number and name but with additional hazard communication information as appropriate to reflect the additional subsidiary hazard(s) (documentation, label, placard) provided that the primary hazard class remains unchanged and that any other transport conditions (e.g. limited quantity, packaging and tank provisions) that would normally apply to substances possessing such a combination of hazards are the same as those applicable to the substance listed.

**Note:** When a competent authority grants such approvals, it should inform the United Nations Sub-Committee of Experts on the Transport of Dangerous Goods\* accordingly and submit a relevant proposal of amendment to the Dangerous Goods List. Should the proposed amendment be rejected, the competent authority should withdraw its approval.

\* UNECE United Nations Economic Commission for Europe, Dangerous Goods and Special Cargoes Section, Transport Division. Palais des Nations, Bureau 418, CH-1211 Geneva 10, Switzerland. Tel: +41 22 917 24 56, Fax: +41 22 917 00 39. [www.unece.org/trans/danger/danger.html](http://www.unece.org/trans/danger/danger.html).

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.0.1
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<b>Note</b>	Incorporating Amendment 39-18

#### 2.0.1 Classes, divisions, packing groups

##### 2.0.1.1 Definitions

Substances (including mixtures and solutions) and articles subject to the provisions of this Code are assigned to one of the classes 1–9 according to the hazard or the most predominant of the hazards they present. Some of these classes are subdivided into divisions. These classes or divisions are as listed below:

Class 1: Explosives

Division 1.1: substances and articles which have a mass explosion hazard

Division 1.2: substances and articles which have a projection hazard but not a mass explosion hazard

Division 1.3: substances and articles which have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard

Division 1.4: substances and articles which present no significant hazard

Division 1.5: very insensitive substances which have a mass explosion hazard

Division 1.6: extremely insensitive articles which do not have a mass explosion hazard

Class 2: Gases

Class 2.1: flammable gases

Class 2.2: non-flammable, non-toxic gases

Class 2.3: toxic gases

Class 3: Flammable liquids

Class 4: Flammable solids; substances liable to spontaneous combustion; substances which, in contact with water, emit flammable gases

Class 4.1: flammable solids, self-reactive substances, solid desensitized explosives and polymerizing substances

Class 4.2: substances liable to spontaneous combustion

Class 4.3: substances which, in contact with water, emit flammable gases

Class 5: Oxidizing substances and organic peroxides

Class 5.1: oxidizing substances

Class 5.2: organic peroxides

Class 6: Toxic and infectious substances

Class 6.1: toxic substances

Class 6.2: infectious substances

Class 7: Radioactive material

Class 8: Corrosive substances

Class 9: Miscellaneous dangerous substances and articles

The numerical order of the classes and divisions is not that of the degree of danger.

2.0.1.2 Marine pollutants

2.0.1.2.1 Many of the substances assigned to classes 1 to 6.2, 8 and 9 are deemed as being marine pollutants (see chapter 2.10).

2.0.1.2.2 Known marine pollutants are noted in the Dangerous Goods List and are indicated in the Index.

2.0.1.3 For packing purposes, substances other than those of classes 1, 2, 5.2, 6.2 and 7, and other than self-reactive substances of class 4.1, are assigned to three packing groups in accordance with the degree of danger they present:

Packing group I: substances presenting high danger;

Packing group II: substances presenting medium danger; and

Packing group III: substances presenting low danger.

The packing group to which a substance is assigned is indicated in the Dangerous Goods List in chapter 3.2.

Articles are not assigned to packing groups. For packing purposes, any requirement for a specific packaging performance level is set out in the applicable packing instruction.

2.0.1.4 Dangerous goods are determined to present one or more of the dangers represented by classes 1 to 9, marine pollutants and, if applicable, the degree of danger (packing group) on the basis of the provisions in chapters 2.1 to 2.10.

2.0.1.5 Dangerous goods presenting a danger of a single class or division are assigned to that class or division and the packing group, if applicable, determined. When an article or substance is specifically listed by name in the Dangerous Goods List in chapter 3.2, its class or division, its subsidiary hazard(s) and, when applicable, its packing group are taken from this list.

2.0.1.6 Dangerous goods meeting the defining criteria of more than one hazard class or division and which are not listed by name in the Dangerous Goods List are assigned to a class or division and subsidiary hazard(s) on the basis of the precedence of hazard provisions prescribed in 2.0.3.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.0.2
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<b>Note</b>	Incorporating Amendment 39-18

## 2.0.2 UN Numbers and Proper Shipping Names

2.0.2.1 Dangerous goods are assigned to UN numbers and proper shipping names according to their hazard classification and their composition.

2.0.2.2 Dangerous goods commonly transported are listed in the Dangerous Goods List in chapter 3.2. Where an article or substance is specifically listed by name, it shall be identified in transport by the proper shipping name in the Dangerous Goods List. Such substances may contain technical impurities (for example those deriving from the production process) or additives for stability or other purposes that do not affect their classification. However, a substance listed by name containing technical impurities or additives for stability or other purposes affecting its classification shall be considered a mixture or solution (see 2.0.2.5). For dangerous goods not specifically listed by name, "generic" or "not otherwise specified" entries are provided (see 2.0.2.7) to identify the article or substance in transport. The substances listed by name in column (2) of the Dangerous Goods List of chapter 3.2 shall be transported according to their classification in the list or under the conditions specified in 2.0.0.2.

Each entry in the Dangerous Goods List is assigned a UN number. This list also contains relevant information for each entry, such as hazard class, subsidiary hazard(s) (if any), packing group (where assigned), packing and tank transport provisions, EmS, segregation and stowage, properties and observations, etc.

Entries in the Dangerous Goods List are of the following four types:

.1 single entries for well-defined substances or articles:

e.g. UN 1090 acetone  
UN 1194 ethyl nitrite solution

.2 generic entries for well-defined groups of substances or articles:

e.g. UN 1133 adhesives  
UN 1266 perfumery product

UN 2757 carbamate pesticide, solid, toxic  
UN 3101 organic peroxide type B, liquid

.3 specific N.O.S. entries covering a group of substances or articles of a particular chemical or technical nature:  
e.g. UN 1477 nitrates, inorganic, N.O.S.  
UN 1987 alcohols, N.O.S.

.4 general N.O.S. entries covering a group of substances or articles meeting the criteria of one or more classes:  
e.g. UN 1325 flammable solid, organic, N.O.S.  
UN 1993 flammable liquid, N.O.S.

2.0.2.3 All self-reactive substances of class 4.1 are assigned to one of 20 generic entries in accordance with the classification principles described in 2.4.2.3.3.

2.0.2.4 All organic peroxides of class 5.2 are assigned to one of 20 generic entries in accordance with the classification principles described in 2.5.3.3.

2.0.2.5 A mixture or solution meeting the classification criteria of this Code composed of a single predominant substance identified by name in the Dangerous Goods List and one or more substances not subject to the provisions of this Code and/or traces of one or more substances identified by name in the Dangerous Goods List, shall be assigned the UN number and proper shipping name of the predominant substance named in the Dangerous Goods List unless:

.1 the mixture or solution is identified by name in the Dangerous Goods List;

.2 the name and description of the substance named in the Dangerous Goods List specifically indicate that they apply only to the pure substance;

.3 the hazard class or division, subsidiary hazard(s), packing group, or physical state of the mixture or solution is different from that of the substance named in the Dangerous Goods List; or

.4 the hazard characteristics and properties of the mixture or solution necessitate emergency response measures that are different from those required for the substance identified by name in the Dangerous Goods List.

In those other cases, except the one described in .1, the mixture or solution shall be treated as a dangerous substance not specifically listed by name in the Dangerous Goods List.

2.0.2.6 When the class, physical state or packing group has changed in comparison with the pure substance, the solution or mixture shall be shipped in accordance with the provisions for the changed hazard under an appropriate N.O.S. entry.

2.0.2.7 Substances or articles which are not specifically listed by name in the Dangerous Goods List shall be classified under a "generic" or "not otherwise specified" (N.O.S.) proper shipping name. The substance or article shall be classified according to the class definitions and test criteria in this part, and the article or substance classified under the generic or "N.O.S." proper shipping name in the Dangerous Goods List which most appropriately describes the article or substance. This means that a substance is only to be assigned to an entry of type .3, as defined in 2.0.2.2, if it cannot be assigned to an entry of type .2, and to an entry of type .4 if it cannot be assigned to an entry of type .2 or .3.\*

\* See also the generic or N.O.S. proper shipping name in appendix A.

2.0.2.8 When considering a solution or mixture in accordance with 2.0.2.5, due account shall be given to whether the dangerous constituent comprising the solution or mixture has been identified as a marine pollutant. If this is the case, the provisions of chapter 2.10 are also applicable.

2.0.2.9 A mixture or solution, containing one or more substances identified by name in this Code or classified under an N.O.S. or generic entry and one or more substances not subject to the provisions of this Code, is not subject to the provisions of this Code if the hazard characteristics of the mixture or solution are such that they do not meet the criteria (including human experience criteria) for any class.

2.0.2.10 A mixture or solution meeting the classification criteria of this Code that is not identified by name in the Dangerous Goods List and that is composed of two or more dangerous goods shall be assigned to an entry that has the proper shipping name, description, hazard class or division, subsidiary hazard(s) and packing group that most precisely describe the mixture or solution.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.0.3
<b>Effective Date</b>	1/1/2020
<b>Note</b>	Incorporating Amendment 39-18

## 2.0.3 Classification of substances, mixtures and solutions with multiple hazards (precedence of hazard characteristics)

2.0.3.1 The table of precedence of hazard characteristics in 2.0.3.6 shall be used to determine the class of a substance, mixture or solution having more than one hazard when it is not specifically listed by name in this Code or to assign the appropriate entry for articles containing dangerous goods N.O.S (UN 3537 to 3548, see 2.0.6). For substances, mixtures or solutions having multiple hazards which are not specifically listed by name, the most stringent packing group of those assigned to the respective hazards of the goods takes precedence over other packing groups, irrespective of the precedence of hazard table in 2.0.3.6.

2.0.3.2 The precedence of hazard table indicates which of the hazards shall be regarded as the primary hazard. The class which appears at the intersection of the horizontal line and the vertical column is the primary hazard and the remaining class is the subsidiary hazard. The packing groups for each of the hazards associated with the substance, mixture or solution shall be determined by reference to the appropriate criteria. The most stringent of the groups so indicated shall then become the packing group of the substance, mixture or solution.

2.0.3.3 The proper shipping name (see 3.1.2) of a substance, mixture or solution when classified in accordance with 2.0.3.1 and 2.0.3.2 shall be the most appropriate N.O.S. ("not otherwise specified") entry in this Code for the class shown as the primary hazard.

2.0.3.4 The precedence of hazard characteristics of the following substances, materials and articles have not been dealt with in the precedence of hazard table, as these primary hazards always take precedence:

- .1 substances and articles of class 1;
- .2 gases of class 2;
- .3 liquid desensitized explosives of class 3;
- .4 self-reactive substances and solid desensitized explosives of class 4.1;
- .5 pyrophoric substances of class 4.2;
- .6 substances of class 5.2;
- .7 substances of class 6.1 with a packing group I vapour inhalation toxicity;
- .8 substances of class 6.2; and
- .9 materials of class 7.

2.0.3.5 Apart from excepted radioactive material (where the other hazardous properties take precedence), radioactive material having other hazardous properties shall always be classified in class 7, with the greatest of the additional hazards being identified. For radioactive material in excepted packages, except for UN 3507, URANIUM HEXAFLUORIDE, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, special provision 290 of chapter 3.3 applies.

### 2.0.3.6 Precedence of hazards

Class and Packing Group	4.2			5.1			6.1, I			8, I		8, II		8, III	
	4.2	4.3	I	II	III	Dermal	Oral	II	III	Liquid	Solid	Liquid	Solid	Liquid	Solid
3 I*		4.3				3	3	3	3	3	-	3	-	3	-
3 II*		4.3				3	3	3	3	8	-	3	-	3	-
3 III*		4.3				6.1	6.1	6.1	3†	8	-	8	-	3	-
4.1 II*	4.2	4.3	5.1	4.1	4.1	6.1	6.1	4.1	4.1	-	8	-	4.1	-	4.1
4.1 III*	4.2	4.3	5.1	4.1	4.1	6.1	6.1	6.1	4.1	-	8	-	8	-	4.1
4.2 II		4.3	5.1	4.2	4.2	6.1	6.1	4.2	4.2	8	8	4.2	4.2	4.2	4.2

4.2 III		4.3	5.1	5.1	4.2	6.1	6.1	6.1	4.2	8	8	8	8	4.2	4.2
4.3 I			5.1	4.3	4.3	6.1	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
4.3 II			5.1	4.3	4.3	6.1	4.3	4.3	4.3	8	8	4.3	4.3	4.3	4.3
4.3 III			5.1	5.1	4.3	6.1	6.1	6.1	4.3	8	8	8	8	4.3	4.3
5.1 I						5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
5.1 II						6.1	5.1	5.1	5.1	8	8	5.1	5.1	5.1	5.1
5.1 III						6.1	6.1	6.1	5.1	8	8	8	8	5.1	5.1
6.1 I, Dermal										8	6.1	6.1	6.1	6.1	6.1
6.1 I, Oral										8	6.1	6.1	6.1	6.1	6.1
6.1 II, Inhalation										8	6.1	6.1	6.1	6.1	6.1
6.1 II, Dermal										8	6.1	8	6.1	6.1	6.1
6.1 II, Oral										8	8	8	6.1	6.1	6.1
6.1 III										8	8	8	8	8	8

\* Substances of class 4.1 other than self-reactive substances and solid desensitized explosives and substances of class 3 other than liquid desensitized explosives.

† 6.1 for pesticides.

– Denotes an impossible combination.

For hazards not shown in this table, see 2.0.3.4 and 2.0.3.5.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.0.4
<b>Effective Date</b>	1/1/2020
<b>Note</b>	Incorporating Amendment 39-18

## 2.0.4 Transport of samples

2.0.4.1 When the hazard class of a substance is uncertain and it is being transported for further testing, a tentative hazard class, proper shipping name and identification number shall be assigned on the basis of the consignor's knowledge of the substances and application of:

- .1 the classification criteria of this Code; and
- .2 the precedence of hazards given in 2.0.3.

The most severe packing group possible for the proper shipping name chosen shall be used.

Where this provision is used, the proper shipping name shall be supplemented with the word "SAMPLE" (such as FLAMMABLE LIQUID, N.O.S., SAMPLE). In certain instances, where a specific proper shipping name is provided for a sample of a substance considered to meet certain classification criteria (such as UN 3167, GAS SAMPLE, NON-PRESSURIZED, FLAMMABLE), that proper shipping name shall be used. When an N.O.S. entry is used to transport the sample, the proper shipping name need not be supplemented with the technical name as required by special provision 274.

2.0.4.2 Samples of the substance shall be transported in accordance with the provisions applicable to the tentative assigned proper shipping name provided:

- .1 the substance is not considered to be a substance prohibited for transport by 1.1.3;
- .2 the substance is not considered to meet the criteria for class 1 or considered to be an infectious substance or a radioactive material;
- .3 the substance is in compliance with 2.4.2.3.2.4.2 or 2.5.3.2.5.1 if it is a self-reactive substance or an organic peroxide, respectively;
- .4 the sample is transported in a combination packaging with a net mass per package not exceeding 2.5 kg; and
- .5 the sample is not packed together with other goods.

### 2.0.4.3 Samples of energetic materials for testing purposes

2.0.4.3.1 Samples of organic substances carrying functional groups listed in tables A6.1 and/or A6.3 in appendix 6 (Screening Procedures) of the Manual of Tests and Criteria may be transported under UN 3224 (self-reactive solid type C) or UN 3223 (self-reactive liquid type C), as applicable, of class 4.1 provided that:

.1 the samples do not contain any:

- known explosives;
- substances showing explosive effects in testing;
- compounds designed with the view of producing a practical explosive or pyrotechnic effect; or
- components consisting of synthetic precursors of intentional explosives;

.2 for mixtures, complexes or salts of inorganic oxidizing substances of class 5.1 with organic material(s), the concentration of the inorganic oxidizing substance is:

- less than 15%, by mass, if assigned to packing group I (high hazard) or II (medium hazard); or
- less than 30%, by mass, if assigned to packing group III (low hazard);

.3 available data do not allow a more precise classification;

.4 the sample is not packed together with other goods; and

.5 the sample is packed in accordance with packing instruction P520 and special packing provisions PP94 or PP95 of 4.1.4.1, as applicable.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.0.5
<b>Effective Date</b>	1/1/2020
<b>Note</b>	Incorporating Amendment 39-18

## 2.0.5 Transport of wastes

### 2.0.5.1 Preamble

Wastes, which are dangerous goods, shall be transported in accordance with the relevant international recommendations and conventions and, in particular, where it concerns transport by sea, with the provisions of this Code.

### 2.0.5.2 Applicability

2.0.5.2.1 The provisions of this chapter are applicable to the transport of wastes by ships and shall be considered in conjunction with all other provisions of this Code.

2.0.5.2.2 Substances, solutions, mixtures or articles containing or contaminated with radioactive material are subject to the applicable provisions for radioactive material in class 7, and are not to be considered as wastes for the purposes of this chapter.

### 2.0.5.3 Transboundary movements under the Basel Convention\*

\* Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989).

2.0.5.3.1 Transboundary movement of wastes is permitted to commence only when:

.1 notification has been sent by the competent authority of the country of origin, or by the generator or exporter through the channel of the competent authority of the country of origin, to the country of final destination; and

.2 the competent authority of the country of origin, having received the written consent of the country of final destination stating that the wastes will be safely incinerated or treated by other methods of disposal, has given authorization to the movement.

2.0.5.3.2 In addition to the transport document required in chapter 5.4, all transboundary movements of wastes shall be accompanied by a waste movement document from the point at which a transboundary movement commences to the point of disposal. This document shall be available at all times to the competent authorities and to all persons involved in the management of waste transport operations.

2.0.5.3.3 The transport of solid wastes in bulk in cargo transport units and road vehicles is only permitted with the approval of the competent authority of the country of origin.

2.0.5.3.4 In the event that packages and cargo transport units containing wastes are suffering from leakage or spillage, the competent authorities of the countries of origin and destination shall be immediately informed and advice on the action to be taken obtained from them.

#### 2.0.5.4 Classification of wastes

2.0.5.4.1 A waste containing only one constituent which is a dangerous substance subject to the provisions of this Code shall be regarded as being that particular substance. If the concentration of the constituent is such that the waste continues to present a hazard inherent in the constituent itself, it shall be classified according to the criteria of the applicable classes.

2.0.5.4.2 A waste containing two or more constituents which are dangerous substances subject to the provisions of this Code shall be classified under the applicable class in accordance with their dangerous characteristics and properties as described in 2.0.5.4.3 and 2.0.5.4.4.

2.0.5.4.3 The classification according to the dangerous characteristics and properties shall be carried out as follows:

.1 determination of the physical and chemical characteristics and physiological properties by measurement or calculation followed by classification according to the criteria of the applicable class(es); or

.2 if the determination is not practicable, the waste shall be classified according to the constituent presenting the predominant hazard.

2.0.5.4.4 In determining the predominant hazard, the following criteria shall be taken into account:

.1 if one or more constituents fall within a certain class and the waste presents a hazard inherent in these constituents, the waste shall be included in that class; or

.2 if there are constituents falling under two or more classes, the classification of the waste shall take into account the order of precedence applicable to dangerous substances with multiple hazards set out in 2.0.3.

2.0.5.4.5 Wastes harmful to the marine environment only shall be transported under the class 9 entries for ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S., UN 3082, or ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S., UN 3077, with the addition of the word "WASTE". However, this is not applicable to substances which are covered by individual entries in this Code.

2.0.5.4.6 Wastes not otherwise subject to the provisions of this Code but covered under the Basel Convention may be transported under the class 9 entries for ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S., UN 3082 or ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S., UN 3077 with the addition of the word WASTE.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.0.6
<b>Effective Date</b>	1/1/2020
<b>Note</b>	Incorporating Amendment 39-18

## 2.0.6 Classification of articles as articles containing dangerous goods N.O.S.

**Note:** For articles which do not have an existing proper shipping name and which contain only dangerous goods within the permitted limited quantity amounts specified in column 7a of the Dangerous Goods List, see UN 3363 and special provision 301 of chapter 3.3.

2.0.6.1 Articles containing dangerous goods may be classified as otherwise provided by this Code under the proper shipping name for the dangerous goods they contain or in accordance with this section. For the purposes of this section "article" means machinery, apparatus or other devices containing one or more dangerous goods (or residues thereof) that are an integral element of the article, necessary for its functioning, and that cannot be removed for the purpose of transport. An inner packaging shall not be an article.

2.0.6.2 Such articles may in addition contain batteries. Lithium batteries that are integral to the article shall be of a type proven to meet the testing requirements of the Manual of Tests and Criteria, part III, subsection 38.3, except when pre-production prototype batteries or batteries of a small production run, consisting of not more than 100 batteries, are installed in the article. Where a lithium battery installed in an article is damaged or defective, the battery shall be removed.

2.0.6.3 This section does not apply to articles for which a more specific proper shipping name already exists in the Dangerous Goods List of chapter 3.2.

2.0.6.4 This section does not apply to dangerous goods of class 1, class 6.2, class 7 or radioactive material contained in articles.

2.0.6.5 Articles containing dangerous goods shall be assigned to the appropriate class determined by the hazards present using, where applicable, the Precedence of Hazards table in 2.0.3.6 for each of the dangerous goods contained in the article. If dangerous goods classified as class 9 are contained within the article, all other dangerous goods present in the article shall be considered to present a higher hazard.

2.0.6.6 Subsidiary hazards shall be representative of the primary hazard posed by the other dangerous goods contained within the article. When only one dangerous good is present in the article, the subsidiary hazard(s), if any, shall be the subsidiary hazard(s) identified in column 4 of the Dangerous Goods List. If the article contains more than one dangerous good and these could react dangerously with one another during transport, each of the dangerous goods shall be enclosed separately (see 4.1.1.6)."

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.1.0
<b>Effective Date</b>	1/1/2020
<b>Note</b>	Incorporating Amendment 39-18

## Chapter 2.1

### Class 1 – Explosives

#### 2.1.0 Introductory notes (these notes are not mandatory)

Note 1: Class 1 is a restricted class, that is, only those explosive substances and articles that are listed in the Dangerous Goods List in chapter 3.2 may be accepted for transport. However, the competent authorities retain the right by mutual agreement to approve transport of explosive substances and articles for special purposes under special conditions. Therefore entries have been included in the Dangerous Goods List for "Substances, explosive, not otherwise specified" and "Articles, explosive, not otherwise specified". It is intended that these entries should only be used when no other method of operation is possible.

Note 2: General entries such as "Explosive, blasting, type A" are used to allow for the transport of new substances. In preparing these provisions, military ammunition and explosives have been taken into consideration to the extent that they are likely to be transported by commercial carriers.

Note 3: A number of substances and articles in class 1 are described in appendix B. These descriptions are given because a term may not be well-known or may be at variance with its usage for regulatory purposes.

Note 4: Class 1 is unique in that the type of packaging frequently has a decisive effect on the hazard and therefore on the assignment to a particular division. The correct division is determined by use of the procedures provided in this chapter.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.1.1
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<b>Note</b>	Incorporating Amendment 39-18

## 2.1.1 Definitions and general provisions

### 2.1.1.1 Class 1 comprises:

.1 explosive substances (a substance which is not itself an explosive but which can form an explosive atmosphere of gas, vapour or dust is not included in class 1), except those which are too dangerous to transport or those where the predominant hazard is one appropriate to another class;

.2 explosive articles, except devices containing explosive substances in such quantity or of such a character that their inadvertent or accidental ignition or initiation during transport shall not cause any effect external to the device either by projection, fire, smoke, heat or loud noise (see 2.1.3.4); and

.3 substances and articles not mentioned under .1 and .2 which are manufactured with a view to producing a practical explosive or pyrotechnic effect.

2.1.1.2 Transport of explosive substances which are unduly sensitive, or so reactive as to be subject to spontaneous reaction, is prohibited.

### 2.1.1.3 Definitions

For the purposes of this Code, the following definitions apply:

.1 Explosive substance means a solid or liquid substance (or a mixture of substances) which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings. Pyrotechnic substances are included even when they do not evolve gases.

.2 Pyrotechnic substance means a substance or a mixture of substances designed to produce an effect by heat, light, sound, gas or smoke or a combination of these as the result of non-detonative self-sustaining exothermic chemical reactions.

.3 Explosive article means an article containing one or more explosive substances.

.4 Mass explosion means one which affects almost the entire load virtually instantaneously.

.5 Phlegmatized means that a substance (or "phlegmatizer") has been added to an explosive to enhance its safety in handling and transport. The phlegmatizer renders the explosive insensitive, or less sensitive, to the following actions: heat, shock, impact, percussion or friction. Typical phlegmatizing agents include, but are not limited to: wax, paper, water, polymers (such as chlorofluoropolymers), alcohol and oils (such as petroleum jelly and paraffin).

### 2.1.1.4 Hazard divisions

The six hazard divisions of class 1 are:

Division 1.1 Substances and articles which have a mass explosion hazard

Division 1.2 Substances and articles which have a projection hazard but not a mass explosion hazard

Division 1.3 Substances and articles which have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard

This division comprises substances and articles:

- . 1 which give rise to considerable radiant heat; or
- . 2 which burn one after another, producing minor blast or projection effects or both.

Division 1.4 Substances and articles which present no significant hazard This division comprises substances and articles which present only a small hazard in the event of ignition or initiation during transport. The effects are largely confined to the package and no projection of fragments of appreciable size or range is to be expected. An external fire must not cause virtually instantaneous explosion of almost the entire contents of the package.

Note: Substances and articles in this division are in compatibility group S if they are so packaged or designed that any hazardous effects arising from the accidental functioning are confined within the package unless the package has been degraded by fire, in which case all blast or projection effects are limited to the extent that they do not significantly hinder fire fighting or other emergency response efforts in the immediate vicinity of the package.

Division 1.5 Very insensitive substances which have a mass explosion hazard

This division comprises substances which have a mass explosion hazard but are so insensitive that there is very little probability of initiation or of transition from burning to detonation under normal conditions of transport.

Note: The probability of transition from burning to detonation is greater when large quantities are transported in a ship. As a consequence, the stowage provisions for explosive substances in division 1.1 and for those in division 1.5 are identical.

Division 1.6 Extremely insensitive articles which do not have a mass explosion hazard

This division comprises articles which predominantly contain extremely insensitive substances and which demonstrate a negligible probability of accidental initiation or propagation.

Note: The hazard from articles of division 1.6 is limited to the explosion of a single article.

2.1.1.5 Any substance or article having or suspected of having explosive characteristics shall first be considered for classification in class 1 in accordance with the procedures in 2.1.3. Goods are not classified in class 1 when:

- .1 unless specially authorized, the transport of an explosive substance is prohibited because sensitivity of the substance is excessive;
- .2 the substance or article comes within the scope of those explosive substances and articles which are specifically excluded from class 1 by the definition of this class; or
- .3 the substance or article has no explosive properties.

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## 2.1.2 Compatibility groups and classification codes

2.1.2.1 Goods of class 1 are considered to be "compatible" if they can be safely stowed or transported together without significantly increasing either the probability of an accident or, for a given quantity, the magnitude of the effects of such an accident. By this criterion, goods listed in this class have been divided into a number of compatibility groups, each denoted by a letter from A to L (excluding I), N and S. These are described in 2.1.2.2 and 2.1.2.3.

2.1.2.2 Compatibility groups and classification codes

Description of substance or articles to be classified	Compatibility group	Classification code
Primary explosive substance	A	1.1A
Article containing a primary explosive substance and not containing two or more effective protective features. Some articles, such as detonators for blasting, detonator assemblies for blasting and primers, cap-type, are included even though they do not contain primary explosives	B	1.1B
		1.2B
		1.4B
Propellant explosive substance or other deflagrating explosive substance or article containing such explosive substance	C	1.1C
		1.2C
		1.3C
		1.4C
Secondary detonating explosive substance or black powder or article containing a secondary detonating explosive substance, in each case without means of initiation and without a propelling charge, or article containing a primary explosive substance and containing two or more effective protective features	D	1.1D
		1.2D
		1.4D
		1.5D
Article containing a secondary detonating explosive substance, without means of initiation, with a propelling charge (other than one containing a flammable liquid or gel or hypergolic liquids)	E	1.1E
		1.2E
		1.4E
Article containing a secondary detonating explosive substance with its own means of initiation, with a propelling charge (other than one containing a flammable liquid or gel or hypergolic liquids) or without a propelling charge	F	1.1F
		1.2F
		1.3F
		1.4F
Pyrotechnic substance, or article containing a pyrotechnic substance, or article containing both an explosive substance and an illuminating, incendiary, tear- or smoke-producing substance (other than a water-activated article or one containing white phosphorus, phosphides, a pyrophoric substance, a flammable liquid or gel, or hypergolic liquids)	G	1.1G
		1.2G
		1.3G
		1.4G
Article containing both an explosive substance and white phosphorus	H	1.2H
		1.3H
Article containing both an explosive substance and a flammable liquid or gel	J	1.1J
		1.2J
		1.3J
Article containing both an explosive substance and a toxic chemical agent	K	1.2K
		1.3K
Explosive substance or article containing an explosive substance and presenting a special hazard (such as due to water-activation or presence of hypergolic liquids, phosphides or a pyrophoric substance) and needing isolation of each type (see 7.2.7.1.4, note 2)	L	1.1L
		1.2L
		1.3L
Articles predominantly containing extremely insensitive substances	N	1.6N
Substance or article so packaged or designed that any hazardous effects arising from accidental functioning are confined within the package unless the package has been degraded by fire, in which case all blast or projection effects are limited to the extent that they do not significantly hinder or prohibit fire fighting or other emergency response efforts in the immediate vicinity of the package	S	1.4S

Note 1: Articles of compatibility groups D and E may be fitted or packed together with their own means of initiation provided that such means have at least two effective protective features designed to prevent an explosion in the event of accidental functioning of the means of initiation. Such articles and packages shall be assigned to compatibility groups D or E.

Note 2: Articles of compatibility groups D and E may be packed together with their own means of initiation, which do not have two effective protective features when, in the opinion of the competent authority of the country of origin, the accidental functioning of the means of initiation does not cause the explosion of an article under normal conditions of transport. Such packages shall be assigned to compatibility groups D or E.

### 2.1.2.3 Scheme of classification of explosives, combination of hazard division with compatibility group

Hazard division	Compatibility group													Σ A-S
	A	B	C	D	E	F	G	H	J	K	L	N	S	
1.1	1.1A	1.1B	1.1C	1.1D	1.1E	1.1F	1.1G		1.1J		1.1L			9
1.2		1.2B	1.2C	1.2D	1.2E	1.2F	1.2G	1.2H	1.2J	1.2K	1.2L			10
1.3			1.3C			1.3F	1.3G	1.3H	1.3J	1.3K	1.3L			7
1.4		1.4B	1.4C	1.4D	1.4E	1.4F	1.4G						1.4S	7
1.5				1.5D										1
1.6												1.6N		1
Σ 1.1-1.6	1	3	4	4	3	4	4	2	3	2	3	1	1	35

2.1.2.4 The definitions of compatibility groups in 2.1.2.2 are intended to be mutually exclusive, except for a substance or article which qualifies for compatibility group S. Since the criterion of compatibility group S is an empirical one, assignment to this group is necessarily linked to the tests for assignment to division 1.4.

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### 2.1.3 Classification procedure

2.1.3.1 Any substance or article having or suspected of having explosive characteristics shall be considered for classification in class 1. Substances and articles classified in class 1 shall be assigned to the appropriate division and compatibility group. Goods of class 1 shall be classified in accordance with the latest version of the Manual of Tests and Criteria.

2.1.3.2 Prior to transport, the classification of all explosive substances and articles, together with the compatibility group assignment and the proper shipping name under which the substance or article is to be transported, shall have been approved by the competent authority of the country of manufacture. A new approval would be required for:

- .1 a new explosive substance; or
- .2 a new combination or mixture of explosive substances which is significantly different from other combinations or mixtures previously manufactured and approved; or
- .3 a new design of an explosive article, an article containing a new explosive substance, or an article containing a new combination or mixture of explosive substances; or
- .4 an explosive substance or article with a new design or type of packaging, including a new type of inner packaging.

2.1.3.3 Assessment of the hazard division is usually made on the basis of test results. A substance or article shall be assigned to the hazard division which corresponds to the results of the tests to which the substance or article, as offered for transport, has been subjected. Other test results, and data assembled from accidents which have occurred, may also be taken into account.

#### 2.1.3.4 Exclusion from Class 1

2.1.3.4.1 The competent authority may exclude an article or substance from class 1 by virtue of test results and the class 1 definition.

2.1.3.4.2 An article may be excluded from class 1 by the competent authority when three unpackaged articles, each individually activated by its own means of initiation or ignition or external means to function in the designed mode, meet the following test criteria:

- .1 no external surface shall have a temperature of more than 65°C. A momentary spike in temperature up to 200°C is acceptable;

.2 no rupture or fragmentation of the external casing or movement of the article or detached parts thereof of more than one metre in any direction;

Note: Where the integrity of the article may be affected in the event of an external fire these criteria shall be examined by a fire test, such as described in ISO 12097-3.

.3 no audible report exceeding 135 dB(C) peak at a distance of one metre;

.4 no flash or flame capable of igniting a material such as a sheet of  $80 \pm 10$  g/m<sup>2</sup> paper in contact with the article; and

.5 no production of smoke, fumes or dust in such quantities that the visibility in a one cubic metre chamber equipped with appropriately sized blow out panels is reduced more than 50% as measured by a calibrated light (lux) meter or radiometer located one metre from a constant light source located at the midpoint on opposite walls. The general guidance on Optical Density Testing in ISO 5659-1 and the general guidance on the Photometric System described in Section 7.5 in ISO 5659-2 may be used or similar optical density measurement methods designed to accomplish the same purpose may also be employed. A suitable hood cover surrounding the back and sides of the light meter shall be used to minimize effects of scattered or leaking light not emitted directly from the source.

Note 1: If during the tests addressing criteria .1, .2, .3 and .4 no or very little smoke is observed the test described in .5 may be waived.

Note 2: The competent authority may require testing in packaged form if it is determined that, as packaged for transport, the article may pose a greater hazard.

#### 2.1.3.5 Assignment of fireworks to hazard divisions

2.1.3.5.1 Fireworks shall normally be assigned to hazard divisions 1.1, 1.2, 1.3, and 1.4 on the basis of test data derived from Test Series 6 of the Manual of Tests and Criteria. However:

.1 waterfalls containing flash composition (see note 2 of 2.1.3.5.5) shall be classified as 1.1G regardless of the results of Test Series 6;

.2 since the range of fireworks is very extensive and the availability of test facilities may be limited, assignment to hazard divisions may also be made in accordance with the procedure in 2.1.3.5.2.

2.1.3.5.2 Assignment of fireworks to UN Nos. 0333, 0334, 0335 or 0336 may be made on the basis of analogy, without the need for Test Series 6 testing, in accordance with the default fireworks classification table in 2.1.3.5.5. Such assignment shall be made with the agreement of the competent authority. Items not specified in the table shall be classified on the basis of test data derived from Test Series 6 of the Manual of Tests and Criteria.

Note: The addition of other types of fireworks to column 1 of the table in 2.1.3.5.5 shall only be made on the basis of full test data submitted to the UN Sub-Committee of Experts on the Transport of Dangerous Goods for consideration.

2.1.3.5.3 Where fireworks of more than one hazard division are packed in the same package they shall be classified on the basis of the highest hazard division unless test data derived from Test Series 6 of the Manual of Tests and Criteria indicate otherwise.

2.1.3.5.4 The classification shown in the table in 2.1.3.5.5 applies only for articles packed in fibreboard boxes (4G).

#### 2.1.3.5.5 Default fireworks classification table\*

\* This table contains a list of firework classifications that may be used in the absence of Test Series 6, of the Manual of Tests and Criteria, data (see 2.1.3.5.2).

Note 1: References to percentages in the table, unless otherwise stated, are to the mass of all pyrotechnic substances (e.g. rocket motors, lifting charge, bursting charge and effect charge).

Note 2: "Flash composition" in this table refers to pyrotechnic substances in powder form or as pyrotechnic units as presented in the fireworks that are used in waterfalls, or to produce an aural effect or used as a bursting charge, or propellant charge unless:

(a) the time taken for the pressure rise in the HSL Flash Composition Test in appendix 7 of the Manual of Tests and Criteria is demonstrated to be more than 6 ms for 0.5 g of pyrotechnic substance; or

(b) the pyrotechnic substance gives a negative "-" result in the US Flash Composition Test in Appendix 7 of the Manual of Tests and Criteria."

Note 3: Dimensions in mm refers to:

- for spherical and peanut shells, the diameter of the sphere of the shell;
- for cylinder shells, the length of the shell;
- for a shell in mortar, Roman candle, shot tube firework or mine, the inside diameter of the tube comprising or containing the firework;
- for a bag mine or cylinder mine, the inside diameter of the mortar intended to contain the mine.

Type	Includes: / Synonym:	Definition	Specification	Classification
Shell, spherical or cylindrical	Spherical display shell: aerial shell, colour shell, dye shell, multi-break shell, multieffect shell, nautical shell, parachute shell, smoke shell, star shell; report shell: maroon, salute, sound shell, thunderclap, aerial shell kit	Device with or without propellant charge, with delay fuse and bursting charge, pyrotechnic unit(s) or loose pyrotechnic substance and designed to be projected from a mortar	All report shells	1.1G
			Colour shell: $\geq 180$ mm	1.1G
			Colour shell: $< 180$ mm with $> 25\%$ flash composition, as loose powder and/or report effects	1.1G
			Colour shell: $< 180$ mm with $\leq 25\%$ flash composition, as loose powder and/or report effects	1.3G
			Colour shell: $\leq 50$ mm, or $\leq 60$ g pyrotechnic substance, with $\leq 2\%$ flash composition as loose powder and/or report effects	1.4G
	Peanut shell	Device with two or more spherical aerial shells in a common wrapper propelled by the same propellant charge with separate external delay fuses	The most hazardous spherical aerial shell determines the classification	
	Preloaded mortar, shell in mortar	Assembly comprising a spherical or cylindrical shell inside a mortar from which the shell is designed to be projected	All report shells	
			Colour shell: $\geq 180$ mm	1.1G
			Colour shell: $> 25\%$ flash composition as loose powder and/or report effects	1.1G
			Colour shell: $> 50$ mm and $< 180$ mm	1.2G
	Shell of shells (spherical) (Reference to percentages for shell of shells are to the gross mass of the fireworks article)	Device without propellant charge, with delay fuse and bursting charge, containing report shells and inert materials and designed to be projected from a mortar	$> 120$ mm	1.1G
			$\leq 120$ mm	1.3G
			$> 300$ mm	1.1G
			$> 200$ mm and $\leq 300$ mm	1.3G
			$\leq 200$ mm	1.3G
Device without propellant charge, with delay fuse and bursting charge, containing report shells $\leq 25$ g flash composition per report unit, with $\leq 33\%$ flash composition and $\geq 60\%$ inert materials and designed to be projected from a mortar	Device without propellant charge, with delay fuse and bursting charge, containing colour shells and/or pyrotechnic units and designed to be projected from a mortar	$> 300$ mm	1.1G	
		$> 200$ mm and $\leq 300$ mm	1.3G	
		$> 200$ mm and $\leq 300$ mm	1.3G	
		$> 200$ mm and $\leq 300$ mm	1.3G	
Device without propellant charge, with delay fuse and bursting charge, containing colour shells $\leq 70$ mm and/or pyrotechnic units, with $\leq 25\%$ flash composition and $\leq 60\%$ pyrotechnic substance and designed to be projected from a mortar	Device with propellant charge, with delay fuse and bursting	$> 300$ mm	1.1G	
		$> 200$ mm and $\leq 300$ mm	1.3G	
		Device with propellant charge, with delay fuse and bursting	$\leq 200$ mm	1.3G

		charge, containing colour shells $\leq 70$ mm and/or pyrotechnic units, with $\leq 25\%$ flash composition and $\leq 60\%$ pyrotechnic substance and designed to be projected from a mortar		
Battery/ combination	Barrage, bombardos, cakes, finale box, flowerbed, hybrid, multiple tubes, shell cakes, banger batteries, flash banger batteries	Assembly including several elements either containing the same type or several types each corresponding to one of the types of fireworks listed in this table, with one or two points of ignition	The most hazardous firework type determines the classification	
Roman candle	Exhibition candle, candle, bombettes	Tube containing a series of pyrotechnic units consisting of alternate pyrotechnic substance, propellant charge, and transmitting fuse	$\geq 50$ mm inner diameter, containing flash composition, or $< 50$ mm with $> 25\%$ flash composition	1.1G
			$\geq 50$ mm inner diameter, containing no flash composition	1.2G
			$< 50$ mm inner diameter and $\leq 25\%$ flash composition	1.3G
			$\leq 30$ mm inner diameter, each pyrotechnic unit $\leq 25$ g and $\leq 5\%$ flash composition	1.4G
Shot tube	Single shot Roman candle, small preloaded mortar	Tube containing a pyrotechnic unit consisting of pyrotechnic substance, propellant charge with or without transmitting fuse	$\leq 30$ mm inner diameter and pyrotechnic unit $> 25$ g, or $> 5\%$ and $\leq 25\%$ flash composition	1.3G
			$\leq 30$ mm inner diameter, pyrotechnic unit $\leq 25$ g and $\leq 5\%$ flash composition	1.4G
Rocket	Avalanche rocket, signal rocket, whistling rocket, bottle rocket, sky rocket, missile type rocket, table rocket	Tube containing pyrotechnic substance and/or pyrotechnic units, equipped with stick(s) or other means for stabilization of flight, and designed to be propelled into the air	Flash composition effects only	1.1G
			Flash composition $> 25\%$ of the pyrotechnic substance	1.1G
			$> 20$ g pyrotechnic substance and flash composition $\leq 25\%$	1.3G
			$\leq 20$ g pyrotechnic substance, black powder bursting charge and $\leq 0.13$ g flash composition per report and $\leq 1$ g in total	1.4G
Mine	Pot-a-feu, ground mine, bag mine, cylinder mine	Tube containing propellant charge and pyrotechnic units and designed to be placed on the ground or to be fixed in the ground. The principal effect is ejection of all the pyrotechnic units in a single burst producing a widely dispersed visual and/or aural effect in the air or: Cloth or paper bag or cloth or paper cylinder containing propellant charge and pyrotechnic units, designed to be placed in a mortar and to function as a mine	$> 25\%$ flash composition, as loose powder and/or report effects	1.1G
			$\geq 180$ mm and $\leq 25\%$ flash composition, as loose powder and/or report effects	1.1G
			$< 180$ mm and $\leq 25\%$ flash composition, as loose powder and/or report effects	1.3G
			$\leq 150$ g pyrotechnic substance, containing $\leq 5\%$ flash composition as loose powder and/or report effects. Each pyrotechnic unit $\leq 25$ g, each report effect $< 2$ g; each whistle, if any, $\leq 3$ g	1.4G
Fountain	Volcanos, gerbs, lances, Bengal fire, flitter sparkle, cylindrical fountains, cone fountains, illuminating torch	Non-metallic case containing pressed or consolidated pyrotechnic substance producing sparks and flame <b>Note:</b> Fountains intended to produce a vertical cascade or curtain of sparks are considered to be waterfalls (see row below).	$\geq 1$ kg pyrotechnic substance	1.3G
			$< 1$ kg pyrotechnic substance	1.4G
Waterfall	Cascades, showers	Pyrotechnic fountain intended to produce a vertical cascade or curtain of sparks	Containing flash composition regardless of the results of Test Series 6 (see 2.1.3.5.1.1)	1.1G
			Not containing flash composition	1.3G
Sparkler	Handheld sparklers, non-handheld sparklers, wire sparklers	Rigid wire partially coated (along one end) with slow-burning pyrotechnic substance with or without an ignition tip	Perchlorate based sparklers: $> 5$ g per item or $> 10$ items per pack	1.3G
			Perchlorate based sparklers: $\leq 5$ g per item and $\leq 10$ items per pack	1.4G
			Nitrate based sparklers: $\leq 30$ g per item	
Bengal stick	Dipped stick	Non-metallic stick partially coated (along one end) with slow-burning pyrotechnic substance and designed to be held in the hand	Perchlorate based items: $> 5$ g per item or $> 10$ items per pack	1.3G
			Perchlorate based items: $\leq 5$ g per item and $\leq 10$ items per pack; nitrate based items: $\leq 30$ g per item	1.4G
Low hazard fireworks and novelties	Table bombs, throwdowns, crackling granules, smokes, fog, snakes, glow worm, serpents, snaps, party poppers	Device designed to produce very limited visible and/or audible effect which contains small amounts of pyrotechnic and/or explosive substance	Throwdowns and snaps may contain up to 1.6 mg of silver fulminate; snaps and party poppers may contain up to 16 mg of potassium chlorate/red phosphorus mixture; other articles may contain up to 5 g of pyrotechnic substance, but no	1.4G

			flash composition	
Spinner	Aerial spinner, helicopter, chaser, ground spinner	Non-metallic tube or tubes containing gas- or spark-producing pyrotechnic substance, with or without noise-producing substance, with or without aerofoils attached	Pyrotechnic substance per item > 20 g, containing ≤ 3% flash composition as report effects, or whistle composition ≤ 5 g	1.3G
			Pyrotechnic substance per item ≤ 20 g, containing ≤ 3% flash composition as report effects, or whistle composition ≤ 5 g	1.4G
Wheels	Catherine wheels, Saxon	Assembly including drivers containing pyrotechnic substance and provided with a means of attaching it to a support so that it can rotate	≥ 1 kg total pyrotechnic substance, no report effect, each whistle (if any) ≤ 25 g and ≤ 50 g whistle composition per wheel	1.3G
			< 1 kg total pyrotechnic substance, no report effect, each whistle (if any) ≤ 5 g and ≤ 10 g whistle composition per wheel	1.4G
Aerial wheel	Flying Saxon, UFOs, rising crown	Tubes containing propellant charges and sparks-, flame- and/or noise-producing pyrotechnic substances, the tubes being fixed to a supporting ring	> 200 g total pyrotechnic substance or > 60 g pyrotechnic substance per driver, ≤ 3% flash composition as report effects, each whistle (if any) ≤ 25 g and ≤ 50 g whistle composition per wheel	1.3G
			≤ 200 g total pyrotechnic substance and ≤ 60 g pyrotechnic substance per driver, ≤ 3% flash composition as report effects, each whistle (if any) ≤ 5 g and ≤ 10 g whistle composition per wheel	1.4G
Selection pack	Display selection box, display selection pack, garden selection box, indoor selection box; assortment	A pack of more than one type each corresponding to one of the types of fireworks listed in this table	The most hazardous firework type determines the classification	
Firecracker	Celebration cracker, celebration roll, string cracker	Assembly of tubes (paper or cardboard) linked by a pyrotechnic fuse, each tube intended to produce an aural effect	Each tube ≤ 140 mg of flash composition or ≤ 1 g black powder	1.4G
Banger	Salute, flash banger, lady cracker	Non-metallic tube containing report composition intended to produce an aural effect	> 2 g flash composition per item	1.1G
			≤ 2 g flash composition per item and ≤ 10 g per inner packaging	1.3G
			≤ 1 g flash composition per item and ≤ 10 g per inner packaging or ≤ 10 g black powder per item	1.4G

### 2.1.3.6 Classification documentation

2.1.3.6.1 A competent authority assigning an article or substance into class 1 should confirm with the applicant that classification in writing.

2.1.3.6.2 A competent authority classification document may be in any form and may consist of more than one page, provided pages are numbered consecutively. The document should have a unique reference.

2.1.3.6.3 The information provided shall be easy to identify, legible and durable.

2.1.3.6.4 Examples of the information that may be provided in the classification documents are as follows:

- .1 the name of the competent authority and the provisions in national legislation under which it is granted its authority;
- .2 the modal or national regulations for which the classification document is applicable;
- .3 confirmation that the classification has been approved, made or agreed in accordance with the United Nations Recommendations on the Transport of Dangerous Goods or the relevant modal regulations;
- .4 the name and address of the person in law to which the classification has been assigned and any company registration which uniquely identifies a company or other body corporate under national legislation;
- .5 the name under which the explosives will be placed on the market or otherwise supplied for transport;
- .6 the Proper Shipping Name, UN number, Class, Hazard Division and corresponding compatibility group of the explosives;

- .7 where appropriate, the maximum net explosive mass of the package or article;
- .8 the name, signature, stamp, seal or other identification of the person authorized by the competent authority to issue the classification document is clearly visible;
- .9 where safety in transport or the hazard division is assessed as being dependent upon the packaging, the packaging mark or a description of the permitted:
- inner packagings
  - intermediate packagings
  - outer packagings
- .10 the classification document states the part number, stock number or other identifying reference under which the explosives will be placed onto the market or otherwise supplied for transport;
- .11 the name and address of the person in law who manufactured the explosives and any company registration which uniquely identifies a company or other body corporate under national legislation;
- .12 any additional information regarding the applicable packing instruction and special packing provisions where appropriate;
- .13 the basis for assigning the classification, i.e. whether on the basis of test results, default for fireworks, analogy with classified explosive, by definition from the Dangerous Goods List etc.;
- .14 any special conditions or limitations that the competent authority has identified as relevant to the safety for transport of the explosives, the communication of the hazard and international transport; and
- .15 the expiry date of the classification document is given where the competent authority considers one to be appropriate.

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## Chapter 2.2

### Class 2 – Gases

#### 2.2.0 Introductory note

“Toxic” has the same meaning as “poisonous”.

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#### 2.2.1 Definitions and general provisions

2.2.1.1 A gas is a substance which:

- .1 at 50°C has a vapour pressure greater than 300 kPa; or
- .2 is completely gaseous at 20°C at a standard pressure of 101.3 kPa.

2.2.1.2 The transport condition of a gas is described according to its physical state as:

.1 compressed gas: a gas which when packaged under pressure for transport is entirely gaseous at -50°C; this category includes all gases with a critical temperature less than or equal to -50°C;

.2 liquefied gas: a gas which when packaged under pressure for transport is partially liquid at temperatures above -50 °C. A distinction is made between:

high pressure liquefied gas: a gas with a critical temperature between -50°C and +65°C, and

low pressure liquefied gas: a gas with a critical temperature above +65°C;

.3 refrigerated liquefied gas: a gas which when packaged for transport is made partially liquid because of its low temperature; or

.4 dissolved gas: a gas which when packaged under pressure for transport is dissolved in a liquid phase solvent;

.5 adsorbed gas: a gas which when packaged for transport is adsorbed onto a solid porous material resulting in an internal receptacle pressure of less than 101.3 kPa at 20°C and less than 300 kPa at 50°C.

2.2.1.3 The class comprises compressed gases, liquefied gases, dissolved gases, refrigerated liquefied gases, adsorbed gases, mixtures of one or more gases with one or more vapours of substances of other classes, articles charged with a gas and aerosols.

2.2.1.4 Gases are normally transported under pressure varying from high pressure in the case of compressed gases to low pressure in the case of refrigerated gases.

2.2.1.5 According to their chemical properties or physiological effects, which may vary widely, gases may be: flammable; non-flammable; non-toxic; toxic; supporters of combustion; corrosive; or may possess two or more of these properties simultaneously.

2.2.1.5.1 Some gases are chemically and physiologically inert. Such gases as well as other gases, normally accepted as non-toxic, will nevertheless be suffocating in high concentrations.

2.2.1.5.2 Many gases of this class have narcotic effects which may occur at comparatively low concentrations or may evolve highly toxic gases when involved in a fire.

2.2.1.5.3 All gases which are heavier than air will present a potential danger if allowed to accumulate in the bottom of cargo spaces.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.2.2
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<b>Note</b>	Incorporating Amendment 39-18

## 2.2.2 Class subdivisions

Class 2 is subdivided further according to the primary hazard of the gas during transport:

Note: For UN 1950 AEROSOLS, see also the criteria in special provision 63 and for UN 2037 RECEPTACLES, SMALL, CONTAINING GAS (GAS CARTRIDGES) see also special provision 303.

### 2.2.2.1 Class 2.1 Flammable gases

Gases which at 20°C and a standard pressure of 101.3 kPa:

.1 are ignitable when in a mixture of 13% or less by volume with air; or

.2 have a flammable range with air of at least 12 percentage points regardless of the lower flammable limit.

Flammability shall be determined by tests or calculation in accordance with methods adopted by the International

Organization for Standardization (see ISO 10156:2010). Where insufficient data are available to use these methods, tests by a comparable method recognized by a national competent authority may be used.

#### 2.2.2.2 Class 2.2 Non-flammable, non-toxic gases

Gases which:

- .1 are asphyxiant – gases which dilute or replace the oxygen normally in the atmosphere; or
- .2 are oxidizing – gases which may, generally by providing oxygen, cause or contribute to the combustion of other material more than air does; or
- .3 do not come under the other classes.

Note: In 2.2.2.2.2, “gases which cause or contribute to the combustion of other material more than air does” means pure gases or gas mixtures with an oxidizing power greater than 23.5% as determined by a method specified in ISO 10156:2010.

#### 2.2.2.3 Class 2.3 Toxic gases

Gases which:

- .1 are known to be so toxic or corrosive to humans as to pose a hazard to health; or
- .2 are presumed to be toxic or corrosive to humans because they have a LC<sub>50</sub> value (as defined in 2.6.2.1) equal to or less than 5,000 mL/m<sup>3</sup> (ppm).

Note: Gases meeting the above criteria owing to their corrosivity are to be classified as toxic with a subsidiary corrosive hazard.

#### 2.2.2.4 Gases and gas mixtures with hazards associated with more than one division take the following precedence:

- .1 class 2.3 takes precedence over all other classes;
- .2 class 2.1 takes precedence over class 2.2.

2.2.2.5 Gases of class 2.2 are not subject to the provisions of this Code if they are transported at a pressure of less than 200 kPa at 20°C and are not liquefied or refrigerated liquefied gases.

2.2.2.6 Gases of class 2.2 are not subject to the provisions of this Code when contained in the following:

- .1 foodstuffs (except UN 1950), including carbonated beverages;
- .2 balls intended for use in sports; or
- .3 tyres (except for air transport).

Note: This exemption does not apply to lamps. For lamps see 1.1.1.9.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.2.3
<b>Effective Date</b>	1/1/2020
<b>Note</b>	Incorporating Amendment 39-18

### 2.2.3 Mixtures of gases

For the classification of gas mixtures (including vapours of substances from other classes), the following principles shall be

used:

.1 Flammability shall be determined by tests or calculation in accordance with methods adopted by the International Organization for Standardization (see ISO 10156:2010). Where insufficient data are available to use these methods, tests by a comparable method recognized by a national competent authority may be used.

.2 The level of toxicity is determined either by tests to measure the LC<sub>50</sub> value (as defined in 2.6.2.1) or by a calculation method using the following formula:

$$LC_{50 \text{ Toxic (mixture)}} = \frac{1}{\sum_{i=1}^n \frac{f_i}{T_i}}$$

where:

$f_i$  = mole fraction of the  $i^{\text{th}}$  component substance of the mixture;

$T_i$  = toxicity index of the  $i^{\text{th}}$  component substance of the mixture (the  $T_i$  equals the LC<sub>50</sub> value when available).

When LC<sub>50</sub> values are unknown, the toxicity index is determined by using the lowest LC<sub>50</sub> value of substances of similar physiological and chemical effects, or through testing if this is the only practical possibility.

.3 A gas mixture has a subsidiary hazard of corrosivity when the mixture is known by human experience to be destructive to the skin, eyes or mucous membranes or when the LC<sub>50</sub> value of the corrosive components of the mixture is equal to or less than 5,000 mL/m<sup>3</sup> (ppm) when the LC<sub>50</sub> is calculated by the formula:

$$LC_{50 \text{ Corrosive (mixture)}} = \frac{1}{\sum_{i=1}^n \frac{f_{ci}}{T_{ci}}}$$

where:

$f_{ci}$  = mole fraction of the  $i^{\text{th}}$  corrosive component substance of the mixture;

$T_{ci}$  = toxicity index of the  $i^{\text{th}}$  corrosive component substance of the mixture (the  $T_{ci}$  equals the LC<sub>50</sub> value when available).

.4 Oxidizing ability is determined either by tests or by calculation methods adopted by the International Organization for Standardization (see note in 2.2.2.2).

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.2.4
<b>Effective Date</b>	1/1/2020
<b>Note</b>	Incorporating Amendment 39-18

#### 2.2.4 Gases not accepted for transport

Chemically unstable gases of class 2 shall not be accepted for transport unless the necessary precautions have been taken to prevent the possibility of a dangerous decomposition or polymerization under normal conditions of transport or unless transported in accordance with special packing provision (r) of packing instruction P200 (5) of 4.1.4.1, as applicable. For the precautions necessary to prevent polymerization, see special provision 386 of chapter 3.3. To this end particular care shall be taken to ensure that receptacles and tanks do not contain any substances liable to promote these reactions.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.3.0
<b>Effective Date</b>	1/1/2020



Note	Incorporating Amendment 39-18
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## Chapter 2.3

### Class 3 – Flammable liquids

#### 2.3.0 Introductory note

The flashpoint of a flammable liquid may be altered by the presence of an impurity. The substances listed in class 3 in the Dangerous Goods List in chapter 3.2 shall generally be regarded as chemically pure. Since commercial products may contain added substances or impurities, flashpoints may vary, and this may have an effect on classification or determination of the packing group for the product. In the event of doubt regarding the classification or packing group of a substance, the flashpoint of the substance shall be determined experimentally.

Title	IMDG Code 2018 (39-18) / PART 2 / 2.3.1
Effective Date	1/1/2020
Note	Incorporating Amendment 39-18

#### 2.3.1 Definitions and general provisions

2.3.1.1 Class 3 includes the following substances:

- .1 flammable liquids (see 2.3.1.2 and 2.3.1.3);
- .2 liquid desensitized explosives (see 2.3.1.4).

2.3.1.2 Flammable liquids are liquids, or mixtures of liquids, or liquids containing solids in solution or suspension (such as paints, varnishes, lacquers, etc., but not including substances which, on account of their other dangerous characteristics, have been included in other classes) which give off a flammable vapour at or below 60°C closed-cup test (corresponding to 65.6°C open-cup test), normally referred to as the "flashpoint". This also includes:

- .1 liquids offered for transport at temperatures at or above their flashpoint; and
- .2 substances transported or offered for transport at elevated temperatures in a liquid state, which give off a flammable vapour at temperatures equal to or below the maximum transport temperature.

2.3.1.3 However, the provisions of this Code need not apply to such liquids with a flashpoint of more than 35°C which do not sustain combustion. Liquids are considered to be unable to sustain combustion for the purposes of the Code if:

- .1 they have passed the suitable combustibility test (see the Sustained Combustibility Test prescribed in part III, 32.5.2 of the Manual of Tests and Criteria); or
- .2 their fire point according to ISO 2592:1973 is greater than 100°C; or
- .3 they are water-miscible solutions with a water content of more than 90%, by mass.

2.3.1.4 Liquid desensitized explosives are explosive substances which are dissolved or suspended in water or other liquid substances, to form a homogeneous liquid mixture to suppress their explosive properties. Entries in the Dangerous Goods List for liquid desensitized explosives are UN 1204, UN 2059, UN 3064, UN 3343, UN 3357 and UN 3379.

Title	IMDG Code 2018 (39-18) / PART 2 / 2.3.2
Effective Date	1/1/2020
Note	Incorporating Amendment 39-18

#### 2.3.2 Assignment of packing group



2.3.2.1 The criteria in 2.3.2.6 are used to determine the hazard grouping of a liquid that presents a hazard due to flammability.

2.3.2.1.1 For liquids whose only hazard is flammability, the packing group for the substance is the hazard grouping shown in 2.3.2.6.

2.3.2.1.2 For a liquid with additional hazard(s), the hazard group determined from 2.3.2.6 and the hazard group based on the severity of the additional hazard(s) shall be considered, and the classification and packing group determined in accordance with the provisions in chapter 2.0.

2.3.2.2 Viscous flammable liquids such as paints, enamels, lacquers, varnishes, adhesives and polishes having a flashpoint of less than 23°C may be placed in packing group III in conformity with the procedures prescribed in the Manual of Tests and Criteria, part III, subsection 32.3, provided that:

.1 The viscosity\* and flashpoint are in accordance with the following table:

<b>Kinematic viscosity (extrapolated) v (at near-zero shear rate) mm<sup>2</sup>/s at 23°C</b>	<b>Flow-time t in seconds</b>	<b>Jet diameter (mm)</b>	<b>Flashpoint (closed- cup) in °C</b>
20 < v ≤ 80	20 < t ≤ 60	4	above 17
80 < v ≤ 135	60 < t ≤ 100	4	above 10
135 < v ≤ 220	20 < t ≤ 32	6	above 5
220 < v ≤ 300	32 < t ≤ 44	6	above -1
300 < v ≤ 700	44 < t ≤ 100	6	above -5
700 < t	100 < t	6	no limit

\* Viscosity determination: Where the substance concerned is non-Newtonian, or where a flow cup method of viscosity determination is otherwise unsuitable, a variable shear-rate viscometer shall be used to determine the dynamic viscosity coefficient of the substance, at 23 °C, at a number of shear rates. The values obtained are plotted against shear rate and then extrapolated to zero shear rate. The dynamic viscosity thus obtained, divided by the density, gives the apparent kinematic viscosity at near-zero shear rate.

.2 less than 3% of the clear solvent layer separates in the solvent separation test;

.3 the mixture or any separated solvent does not meet the criteria for class 6.1 or class 8;

.4 the substances are packed in receptacles of not more than 450-litre capacity.

2.3.2.3 [Reserved]

2.3.2.4 Substances classified as flammable liquids due to their being transported or offered for transport at elevated temperatures are included in packing group III.

2.3.2.5 Viscous liquids which:

- have a flashpoint of 23°C or above and less than or equal to 60°C;
- are not toxic or corrosive;
- are not environmentally hazardous or are environmentally hazardous transported in single or combination packagings containing a net quantity per single or inner packaging of 5 litres or less, provided the packagings meet the general provisions of 4.1.1.1, 4.1.1.2 and 4.1.1.4 to 4.1.1.8;
- contain not more than 20% nitrocellulose provided the nitrocellulose contains not more than 12.6% nitrogen by dry mass; and
- are packed in receptacles of not more than 450 litre capacity,

are not subject to the provisions for the marking, labelling and testing of packages in chapters 4.1, 5.2 and 6.1, if:

.1 in the solvent separation test (see part III, 32.5.1 of the Manual of Tests and Criteria) the height of the separated layer of solvent is less than 3% of the total height; and

.2 the flowtime in the viscosity test (see part III, 32.4.3 of the Manual of Tests and Criteria) with a jet diameter of 6 mm is equal to or greater than:

.1 60 s; or

.2 40 s if the viscous liquid contains not more than 60% of class 3 substances.

The following statement shall be included in the transport document: "Transport in accordance with 2.3.2.5 of the IMDG Code" (see 5.4.1.5.10).

### 2.3.2.6 Hazard grouping based on flammability

Flammable liquids are grouped for packing purposes according to their flashpoint, their boiling point, and their viscosity. This table shows the relationship between two of these characteristics.

Packing group	Flashpoint (closed-cup) in °C	Initial boiling point in °C
I	-	≤ 35
II	< 23	> 35
III	≥ 23 to ≤ 60	> 35

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.3.3
<b>Effective Date</b>	1/1/2020
<b>Note</b>	Incorporating Amendment 39-18

### 2.3.3 Determination of flashpoint

Note: The provisions of this section are not mandatory.

2.3.3.1 The flashpoint of a flammable liquid is the lowest temperature of the liquid at which its vapour forms an ignitable mixture with air. It gives a measure of the risk of formation of explosive or ignitable mixtures when the liquid escapes from its packing. A flammable liquid cannot be ignited so long as its temperature remains below the flashpoint.

Note: Do not confuse the flashpoint with the ignition temperature, which is the temperature to which an explosive vapour-air mixture must be heated to cause actual explosion. There is no relationship between the flashpoint and the ignition temperature.

2.3.3.2 The flashpoint is not an exact physical constant for a given liquid. It depends to some extent on the construction of the test apparatus used and on the testing procedure. Therefore, when providing flashpoint data, specify the name of the test apparatus.

2.3.3.3 Several standard apparatuses are in current use. They all operate on the same principle: a specified quantity of the liquid is introduced into a receptacle at a temperature well below the flashpoint to be expected, then slowly heated; periodically, a small flame is brought near to the surface of the liquid. The flashpoint is the lowest temperature at which a "flash" is observed.

2.3.3.4 The test methods can be divided into two groups, depending on the use in an apparatus of an open receptacle (open-cup methods) or a closed one which is only opened to admit the flame (closed-cup methods). As a rule, the flashpoints found in an open-cup test are a few degrees higher than in a closed-cup test.

2.3.3.5 In general, reproducibility in closed-cup apparatus is better than in open-cup.

2.3.3.5.1 It is therefore recommended that flashpoints, especially in the range around 23°C, shall be determined by means of closed-cup (c.c) methods.

2.3.3.5.2 Flashpoint data in this Code are generally based on closed-cup methods. In countries where it is customary to determine flashpoints by the open-cup method, the temperatures given by that method would need to be reduced to

correspond with those in this Code.

### 2.3.3.6 Determination of flashpoint

The following methods for determining the flashpoint of flammable liquids may be used:

International standards:

ISO 1516  
ISO 1523  
ISO 2719  
ISO 13736  
ISO 3679  
ISO 3680

National standards:

American Society for Testing Materials International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, Pennsylvania, USA 19428-2959:

ASTM D3828-07a, Standard Test Methods for Flash Point by Small Scale Closed Cup Tester  
ASTM D56-05, Standard Test Method for Flash Point by Tag Closed Cup Tester  
ASTM D3278-96(2004)e, Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus  
ASTM D93-08, Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester

Association française de normalisation, AFNOR, 11, rue Francis de Pressensé, 93571 La Plaine Saint-Denis Cedex:

French Standard NF M 07-019  
French Standards NF M 07-011/NF T 30-050/NF T 66-009  
French Standard NF M 07-036

Deutsches Institut für Normung, Burggrafenstr. 6, D-10787 Berlin:

Standard DIN 51755 (flashpoints below 65°C)

State Committee of the Council of Ministers for Standardization, 113813, GSP, Moscow, M-49 Leninsky Prospect, 9:

GOST 12.1.044-84

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<b>Effective Date</b>	1/1/2020
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### 2.3.4 Determination of initial boiling point

The following methods for determining the initial boiling point of flammable liquids may be used:

International standards:

ISO 3924  
ISO 4626  
ISO 3405

National standards:

American Society for Testing Materials International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken,

Pennsylvania, USA 19428-2959:

ASTM D86-07a, Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure  
ASTM D1078-05, Standard Test Method for Distillation Range of Volatile Organic Liquids

Further acceptable methods:

Method A.2 as described in Part A of the Annex to Commission Regulation (EC) No 440/2008.\*

\* Commission Regulation (EC) No 440/2008 of 30 May 2008 laying down test methods pursuant to Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) (Official Journal of the European Union, No L 142 of 31.05.2008, pages 1–739 and No L 143 of 03.06.2008, page 55).

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### 2.3.5 Substances not accepted for transport

Chemically unstable substances of class 3 shall not be accepted for transport unless the necessary precautions have been taken to prevent the possibility of a dangerous decomposition or polymerization under normal conditions of transport. For the precautions necessary to prevent polymerization, see special provision 386 of chapter 3.3. To this end particular care shall be taken to ensure that receptacles and tanks do not contain any substances liable to promote these reactions.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.4.0
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<b>Note</b>	Incorporating Amendment 39-18

## Chapter 2.4

### Class 4 – Flammable solids; substances liable to spontaneous combustion; substances which, in contact with water, emit flammable gases

#### 2.4.0 Introductory note

Since organometallic substances can be classified in classes 4.2 or 4.3 with additional subsidiary hazards, depending on their properties, a specific classification flowchart for these substances is given in 2.4.5.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.4.1
<b>Effective Date</b>	1/1/2020
<b>Note</b>	Incorporating Amendment 39-18

#### 2.4.1 Definition and general provisions

2.4.1.1 In this Code, class 4 deals with substances, other than those classified as explosives, which, under conditions of transport, are readily combustible or may cause or contribute to a fire. Class 4 is subdivided as follows:

##### Class 4.1 – Flammable solids

Solids which, under conditions encountered in transport, are readily combustible or may cause or contribute to fire through friction; self-reactive substances (solids and liquids) and polymerizing substances which are liable to undergo a strongly exothermic reaction; solid desensitized explosives which may explode if not diluted sufficiently;

##### Class 4.2 – Substances liable to spontaneous combustion

Substances (solids and liquids) which are liable to spontaneous heating under normal conditions encountered in transport, or to heating up in contact with air, and being then liable to catch fire;

Class 4.3 – Substances which, in contact with water, emit flammable gases

Substances (solids and liquids) which, by interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities.

2.4.1.2 As referenced in this chapter, test methods and criteria, with advice on application of the tests, are given in the Manual of Tests and Criteria for the classification of following types of substances of class 4:

- .1 flammable solids (class 4.1);
- .2 self-reactive substances (class 4.1);
- .3 polymerizing substances (class 4.1);
- .4 pyrophoric solids (class 4.2);
- .5 pyrophoric liquids (class 4.2);
- .6 self-heating substances (class 4.2); and
- .7 substances which, in contact with water, emit flammable gases (class 4.3).

Test methods and criteria for self-reactive substances and polymerizing substances are given in part II of the Manual of Tests and Criteria, and test methods and criteria for the other types of substances of class 4 are given in the Manual of Tests and Criteria, part III, chapter 33.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.4.2
<b>Effective Date</b>	1/1/2020
<b>Note</b>	Incorporating Amendment 39-18

## **2.4.2 Class 4.1 - Flammable solids, self-reactive substances, solid desensitized explosives and polymerizing substances**

### 2.4.2.1 General

Class 4.1 includes the following types of substances:

- .1 flammable solids (see 2.4.2.2);
- .2 self-reactive substances (see 2.4.2.3);
- .3 solid desensitized explosives (see 2.4.2.4); and
- .4 polymerizing substances (see 2.4.2.5).

Some substances (such as celluloid) may evolve toxic and flammable gases when heated or if involved in a fire.

### 2.4.2.2 Class 4.1 Flammable solids

#### 2.4.2.2.1 Definitions and properties

2.4.2.2.1.1 For the purpose of this Code, flammable solids means readily combustible solids and solids which may cause fire through friction.

2.4.2.2.1.2 Readily combustible solids means fibres, powdered, granular, or pasty substances which are dangerous if they can be easily ignited by brief contact with an ignition source such as a burning match, and if the flame spreads rapidly. The danger may come not only from the fire but also from toxic combustion products. Metal powders are especially dangerous because of the difficulty of extinguishing a fire, since normal extinguishing agents such as carbon dioxide or water can increase the hazard.

#### 2.4.2.2.2 Classification of flammable solids

2.4.2.2.2.1 Powdered, granular or pasty substances shall be classified as readily combustible solids of class 4.1 when the time of burning of one or more of the test runs, performed in accordance with the test method described in the Manual of Tests and Criteria, part III, 33.2.1, is less than 45 s or the rate of burning is more than 2.2 mm/s. Powders of metals or metal alloys shall be classified in class 4.1 when they can be ignited and the reaction spreads over the whole length of the sample in 10 min or less.

2.4.2.2.2.2 Solids which may cause fire through friction shall be classified in class 4.1 by analogy with existing entries (such as matches) until definitive criteria are established.

#### 2.4.2.2.3 Assignment of packing groups

2.4.2.2.3.1 Packing groups are assigned on the basis of the test methods referred to in 2.4.2.2.2.1. For readily combustible solids (other than metal powders), packing group II shall be assigned if the burning time is less than 45 s and the flame passes the wetted zone. Packing group II shall be assigned to powders of metal or metal alloys if the zone of reaction spreads over the whole length of the sample in five minutes or less.

2.4.2.2.3.2 Packing groups are assigned on the basis of the test methods referred to in 2.4.2.2.2.1. For readily combustible solids (other than metal powders), packing group III shall be assigned if the burning time is less than 45 s and the wetted zone stops the flame propagation for at least four minutes. Packing group III shall be assigned to metal powders if the reaction spreads over the whole length of the sample in more than five minutes but not more than 10 min.

2.4.2.2.3.3 For solids which may cause fire through friction, the packing group shall be assigned by analogy with existing entries or in accordance with any appropriate special provision.

2.4.2.2.4 Pyrophoric metal powders, if wetted with sufficient water to suppress their pyrophoric properties, may be classified as class 4.1.

#### 2.4.2.3 Class 4.1 Self-reactive substances

##### 2.4.2.3.1 Definitions and properties

2.4.2.3.1.1 For the purposes of this Code:

Self-reactive substances are thermally unstable substances liable to undergo a strongly exothermic decomposition even without participation of oxygen (air). Substances are not considered to be self-reactive substances of class 4.1, if:

- .1 they are explosives according to the criteria of class 1;
- .2 they are oxidizing substances according to the classification procedure for class 5.1 (see 2.5.2) except that mixtures of oxidizing substances which contain 5.0% or more of combustible organic substances shall be subjected to the classification procedure defined in note 3;
- .3 they are organic peroxides according to the criteria of class 5.2;
- .4 their heat of decomposition is less than 300 J/g; or
- .5 their self-accelerating decomposition temperature (SADT) (see 2.4.2.3.4) is greater than 75°C for a 50 kg package.

Note 1: The heat of decomposition may be determined using any internationally recognized method such as differential scanning calorimetry and adiabatic calorimetry.

Note 2: Any substance which shows the properties of a self-reactive substance shall be classified as such, even if this substance gives a positive test result according to 2.4.3.2 for inclusion in class 4.2.

Note 3: Mixtures of oxidizing substances meeting the criteria of class 5.1 which contain 5.0% or more of combustible organic substances, which do not meet the criteria mentioned in .1, .3, .4 or .5 above, shall be subjected to the self-reactive substance classification procedure.

A mixture showing the properties of a self-reactive substance, types B to F, shall be classified as a self-reactive substance of class 4.1.

A mixture showing the properties of a self-reactive substance, type G, according to the principle of 2.4.2.3.3.2.7 shall be considered for classification as a substance of class 5.1 (see 2.5.2).

2.4.2.3.1.2 The decomposition of self-reactive substances can be initiated by heat, contact with catalytic impurities (such as acids, heavy-metal compounds, bases), friction or impact. The rate of decomposition increases with temperature and varies with the substance. Decomposition, particularly if no ignition occurs, may result in the evolution of toxic gases or vapours. For certain self-reactive substances, the temperature shall be controlled. Some self-reactive substances may decompose explosively, particularly if confined. This characteristic may be modified by the addition of diluents or by the use of appropriate packagings. Some self-reactive substances burn vigorously. Self-reactive substances are, for example, some compounds of the types listed below:

- .1 aliphatic azo compounds ( $-C-N=N-C-$ );
- .2 organic azides ( $-C-N_3$ );
- .3 diazonium salts ( $-CN_2^+Z^-$ );
- .4 N-nitroso compounds ( $-N-N=O$ ); and
- .5 aromatic sulphohydrazides ( $-SO_2-NH-NH_2$ ).

This list is not exhaustive and substances with other reactive groups and some mixtures of substances may have similar properties.

#### 2.4.2.3.2 Classification of self-reactive substances

2.4.2.3.2.1 Self-reactive substances are classified into seven types according to the degree of danger they present. The types of self-reactive substance range from type A, which may not be accepted for transport in the packaging in which it is tested, to type G, which is not subject to the provisions for self-reactive substances of class 4.1. The classification of types B to F is directly related to the maximum quantity allowed in one packaging.

2.4.2.3.2.2 Self-reactive substances permitted for transport in packagings are listed in 2.4.2.3.2.3, those permitted for transport in IBCs are listed in packing instruction IBC520 and those permitted for transport in portable tanks are listed in portable tank instruction T23. For each permitted substance listed, the appropriate generic entry of the Dangerous Goods List (UN 3221 to UN 3240) is assigned, and appropriate subsidiary hazards and remarks providing relevant transport information are given. The generic entries specify:

- .1 self-reactive substance type (B to F);
- .2 physical state (liquid or solid); and
- .3 temperature control, when required (2.4.2.3.4).

### 2.4.2.3.2.3 List of currently assigned self-reactive substances in packagings

In the column "Packing Method" codes "OP1" to "OP8" refer to packing methods in packing instruction P520. Self-reactive substances to be transported shall fulfil the classification and the control and emergency temperatures (derived from the SADT) as listed. For substances permitted in IBCs, see packing instruction IBC520, and for those permitted in tanks, see portable tank instruction T23. The formulations listed in packing instruction IBC520 of 4.1.4.2 and in portable tank instruction T23 of 4.2.5.2.6 may also be transported packed in accordance with packing method OP8 of packing instruction P520 of 4.1.4.1, with the same control and emergency temperatures, if applicable.

Note: The classification given in this table is based on the technically pure substance (except where a concentration of less than 100% is specified). For other concentrations, the substances may be classified differently following the procedures in 2.4.2.3.3 and 2.4.2.3.4.

UN generic entry	Self-reactive substance	Concentration (%)	Packing method	Control temperature (°C)	Emergency temperature (°C)	Remarks
3222	2-DIAZO-1-NAPHTHOL-4-SULPHONYL CHLORIDE	100	OP5			(2)
	2-DIAZO-1-NAPHTHOL-5-SULPHONYL CHLORIDE	100	OP5			(2)
3223	SELF-REACTIVE LIQUID, SAMPLE		OP2			(8)
3224	AZODICARBONAMIDE FORMULATION TYPE C	< 100	OP6			(3)
	2,2'-AZODI(ISOBUTYRONITRILE) as a water-based paste	≤ 50	OP6			
	N,N'-DINITROSO-N,N'-DIMETHYL-TEREPHTHALAMIDE, as a paste	72	OP6			
	N,N'-DINITROSOPENTAMETHYLENETETRAMINE	82	OP6			(7)
	SELF-REACTIVE SOLID, SAMPLE		OP2			(8)
3226	AZODICARBONAMIDE FORMULATION TYPE D	< 100	OP7			(5)
	1,1'-AZODI(HEXAHYDROBENZONITRILE)	100	OP7			
	BENZENE-1,3-DISULPHONYL HYDRAZIDE as a paste	52	OP7			
	BENZENESULPHONYL HYDRAZIDE	100	OP7			
	4-(BENZYL(ETHYL)AMINO)-3-ETHOXY-BENZENEDIAZONIUM ZINC CHLORIDE	100	OP7			
	3-CHLORO-4-DIETHYLAMINOBENZENE-DIAZONIUM ZINC CHLORIDE	100	OP7			
	2-DIAZO-1-NAPHTHOLSULPHONIC ACID ESTER MIXTURE TYPE D	< 100	OP7			(9)
	2,5-DIETHOXY-4-(4-MORPHOLINYL)-BENZENEDIAZONIUM SULPHATE	100	OP7			
	DIPHENYLOXIDE-4,4'-DISULPHONYL HYDRAZIDE	100	OP7			
	4-DIPROPYLAMINOBENZENEDIAZONIUM ZINC CHLORIDE	100	OP7			
	4-METHYLBENZENESULPHONYLHYDRAZIDE	100	OP7			
	SODIUM 2-DIAZO-1-NAPHTHOL-4-SULPHONATE	100	OP7			
	SODIUM 2-DIAZO-1-NAPHTHOL-5-SULPHONATE	100	OP7			
3227	PHOSPHOROTHIOIC ACID, O-[(CYANOPHENYL METHYLENE) AZANYL] O,O-DIETHYL ESTER (Z isomer)	82-91	OP8			(10)
3228	ACETONE-PYROGALLOL COPOLYMER	100	OP8			
	2-DIAZO-1-NAPHTHOL-5-SULPHONATE					
	4-(DIMETHYLAMINO)BENZENEDIAZONIUM TRICHLOROZINCATE(-1)	100	OP8			
	2,5-DIBUTOXY-4-(4-MORPHOLINYL)-BENZENEDIAZONIUM TETRACHLOROZINCATE(2:1)	100	OP8			
3232	AZODICARBONAMIDE FORMULATION TYPE B, TEMPERATURE CONTROLLED	< 100	OP5			(1) (2)

3233	SELF-REACTIVE LIQUID, SAMPLE, TEMPERATURE CONTROLLED		OP2			(8)
3234	AZODICARBONAMIDE FORMULATION TYPE C, TEMPERATURE CONTROLLED	< 100	OP6			(4)
	2,2'-AZODI(ISOBTYRONITRILE)	100	OP6	+40	+45	
	3-METHYL-4-(PYRROLIDIN-1-YL)BENZENE-DIAZONIUM TETRAFLUOROBORATE	95	OP6	+45	+50	
	SELF-REACTIVE SOLID, SAMPLE, TEMPERATURE CONTROLLED		OP2			(8)
	TETRAMINEPALLADIUM(II) NITRATE	100	OP6	+30	+35	
3235	2,2'-AZODI(ETHYL-2-METHYLPROPIONATE)	100	OP7	+20	+25	
3236	AZODICARBONAMIDE FORMULATION TYPE D, TEMPERATURE CONTROLLED	< 100	OP7			(6)
	2,2'-AZODI(2,4-DIMETHYL-4-METHOXY-VALERONITRILE)	100	OP7	-5	+5	
	2,2'-AZODI(2,4-DIMETHYLVALERONITRILE)	100	OP7	+10	+15	
	2,2'-AZODI(2-METHYLBUTYRONITRILE)	100	OP7	+35	+40	
	4-(BENZYL(METHYL)AMINO)-3-ETHOXY-BENZENEDIAZONIUM ZINC CHLORIDE	100	OP7	+40	+45	
	2,5-DIETHOXY-4-MORPHOLINO-BENZENEDIAZONIUM ZINC CHLORIDE	67-100	OP7	+35	+40	
	2,5-DIETHOXY-4-MORPHOLINO-BENZENEDIAZONIUM ZINC CHLORIDE	66	OP7	+40	+45	
	2,5-DIETHOXY-4-MORPHOLINO-BENZENE-DIAZONIUM TETRAFLUOROBORATE	100	OP7	+30	+35	
	2,5-DIETHOXY-4-(PHENYLSULPHONYL)-BENZENEDIAZONIUM ZINC CHLORIDE	67	OP7	+40	+45	
	2,5-DIMETHOXY-4-(4-METHYLPHENYL-SULPHONYL)BENZENEDIAZONIUM ZINC CHLORIDE	79	OP7	+40	+45	
	4-DIMETHYLAMINO-6-(2-DIMETHYLAMINO-ETHOXY)TOLUENE-2-DIAZONIUM ZINC CHLORIDE	100	OP7	+40	+45	
	2-(N,N-ETHOXYCARBONYLPHENYLAMINO)-3-METHOXY-4-(N-METHYL-N-CYCLOHEXYLAMINO)-BENZENEDIAZONIUM ZINC CHLORIDE	63-92	OP7	+40	+45	
	2-(N,N-ETHOXYCARBONYLPHENYLAMINO)-3-METHOXY-4-(N-METHYL-N-CYCLOHEXYLAMINO)-BENZENEDIAZONIUM ZINC CHLORIDE	62	OP7	+35	+40	
	N-FORMYL-2-(NITROMETHYLENE)-1,3-PERHYDROTHIAZINE	100	OP7	+45	+50	
	2-(2-HYDROXYETHOXY)-1-(PYRROLIDIN-1-YL)-BENZENE-4-DIAZONIUM ZINC CHLORIDE	100	OP7	+45	+50	
	3-(2-HYDROXYETHOXY)-4-(PYRROLIDIN-1-YL)-BENZENEDIAZONIUM ZINC CHLORIDE	100	OP7	+40	+45	
	2-(N,N-METHYLAMINOETHYLCARBONYL)-4-(3,4-DIMETHYLPHENYLSULPHONYL)-BENZENEDIAZONIUM HYDROGEN SULPHATE	96	OP7	+45	+50	
4-NITROSOPHENOL	100	OP7	+35	+40		
3237	DIETHYLENEGLYCOL BIS(ALLYLCARBONATE) + DI-ISOPROPYL PEROXYDICARBONATE	≥ 88 + ≤ 12	OP8	-10	0	

## Remarks

(1) Azodicarbonamide formulations which fulfil the criteria of 2.4.2.3.3.2.2. The control and emergency temperatures

shall be determined by the procedure given in 7.3.7.2.

(2) "EXPLOSIVE" subsidiary hazard label (Model No 1, see 5.2.2.2.2) required.

(3) Azodicarbonamide formulations which fulfil the criteria of 2.4.2.3.2.3.

(4) Azodicarbonamide formulations which fulfil the criteria of 2.4.2.3.2.3. The control and emergency temperatures shall be determined by the procedure given in 7.3.7.2.

(5) Azodicarbonamide formulations which fulfil the criteria of 2.4.2.3.2.4.

(6) Azodicarbonamide formulations which fulfil the criteria of 2.4.2.3.2.4. The control and emergency temperatures shall be determined by the procedure given in 7.3.7.2.

(7) With a compatible diluent having a boiling point of not less than 150°C.

(8) See 2.4.2.3.2.4.2.

(9) This entry applies to mixtures of esters of 2-diazo-1-naphthol-4-sulphonic acid and 2-diazo-1-naphthol-5-sulphonic acid meeting the criteria of 2.4.2.3.2.4.

(10) This entry applies to the technical mixture in n-butanol within the specified concentration limits of the (Z) isomer.

2.4.2.3.2.4 Classification of self-reactive substances not listed in 2.4.2.3.2.3, packing instruction IBC520 or portable tank instruction T23 and assignment to a generic entry shall be made by the competent authority of the country of origin on the basis of a test report. Principles applying to the classification of such substances are provided in 2.4.2.3.3. The applicable classification procedures, test methods and criteria, and an example of a suitable test report, are given in the Manual of Tests and Criteria, part II. The statement of approval shall contain the classification and the relevant transport conditions.

.1 Activators, such as zinc compounds, may be added to some self-reactive substances to change their reactivity. Depending on both the type and the concentration of the activator, this may result in a decrease in thermal stability and a change in explosive properties. If either of these properties is altered, the new formulation shall be assessed in accordance with this classification procedure.

.2 Samples of self-reactive substances or formulations of self-reactive substances not listed in 2.4.2.3.2.3, for which a complete set of test results is not available and which are to be transported for further testing or evaluation, may be assigned to one of the appropriate entries for self-reactive substances type C provided the following conditions are met:

.1 the available data indicate that the sample would be no more dangerous than self-reactive substances type B;

.2 the sample is packaged in accordance with packing method OP2 (see applicable packing instruction) and the quantity per cargo transport unit is limited to 10 kg; and

.3 the available data indicate that the control temperature, if any, is sufficiently low to prevent any dangerous decomposition and sufficiently high to prevent any dangerous phase separation.

#### 2.4.2.3.3 Principles for classification of self-reactive substances

Note: This section refers only to those properties of self-reactive substances which are decisive for their classification. A flow chart, presenting the classification principles in the form of a graphically arranged scheme of questions concerning the decisive properties together with the possible answers, is given in Figure 2.4.1 in chapter 2.4 of the United Nations Recommendations on the Transport of Dangerous Goods. These properties shall be determined experimentally. Suitable test methods with pertinent evaluation criteria are given in the Manual of Tests and Criteria, part II.

2.4.2.3.3.1 A self-reactive substance is regarded as possessing explosive properties when, in laboratory testing, the

formulation is liable to detonate, to deflagrate rapidly or to show a violent effect when heated under confinement.

2.4.2.3.3.2 The following principles apply to the classification of self-reactive substances not listed in 2.4.2.3.2.3:

.1 Any substance which can detonate or deflagrate rapidly, as packaged for transport, is prohibited from transport under the provisions for self-reactive substances of class 4.1 in that packaging (defined as SELF-REACTIVE SUBSTANCE TYPE A);

.2 Any substance possessing explosive properties and which, as packaged for transport, neither detonates nor deflagrates rapidly, but is liable to undergo a thermal explosion in that package, shall also bear an "EXPLOSIVE" subsidiary hazard label (Model No. 1, see 5.2.2.2.2). Such a substance may be packaged in amounts of up to 25 kg unless the maximum quantity has to be limited to a lower amount to preclude detonation or rapid deflagration in the package (defined as SELF-REACTIVE SUBSTANCE TYPE B);

.3 Any substance possessing explosive properties may be transported without an "EXPLOSIVE" subsidiary hazard label when the substance as packaged (maximum 50 kg) for transport cannot detonate or deflagrate rapidly or undergo a thermal explosion (defined as SELF-REACTIVE SUBSTANCE TYPE C);

.4 Any substance which, in laboratory testing:

.1 detonates partially, does not deflagrate rapidly and shows no violent effect when heated under confinement; or

.2 does not detonate at all, deflagrates slowly and shows no violent effect when heated under confinement; or

.3 does not detonate or deflagrate at all and shows a medium effect when heated under confinement may be accepted for transport in packages of not more than 50 kg net mass (defined as SELF-REACTIVE SUBSTANCE TYPE D);

.5 Any substance which, in laboratory testing, neither detonates nor deflagrates at all and shows low or no effect when heated under confinement may be accepted for transport in packages of not more than 400 kg/450 L (defined as SELF-REACTIVE SUBSTANCE TYPE E);

.6 Any substance which, in laboratory testing, neither detonates in the cavitated state nor deflagrates at all and shows only a low or no effect when heated under confinement as well as low or no explosive power may be considered for transport in IBCs (defined as SELF-REACTIVE SUBSTANCE TYPE F); (for additional provisions see 4.1.7.2.2);

.7 Any substance which, in laboratory testing, neither detonates in the cavitated state nor deflagrates at all and shows no effect when heated under confinement nor any explosive power shall be exempted from classification as a self-reactive substance of class 4.1 provided that the formulation is thermally stable (self-accelerating decomposition temperature 60°C to 75°C for a 50 kg package) and any diluent meets the provisions of 2.4.2.3.5 (defined as SELF-REACTIVE SUBSTANCE TYPE G). If the formulation is not thermally stable or a compatible diluent having a boiling point less than 150°C is used for desensitization, the formulation shall be defined as SELF-REACTIVE LIQUID/SOLID TYPE F.

#### 2.4.2.3.4 Temperature control provisions

2.4.2.3.4.1 Self-reactive substances are subject to temperature control in transport if their self-accelerating decomposition temperature (SADT) is less than or equal to 55°C. For currently assigned self-reactive substances, the control and emergency temperatures are shown in 2.4.2.3.2.3. Test methods for determining the SADT are given in the Manual of Tests and Criteria, part II, chapter 28. The test selected shall be conducted in a manner which is representative, both in size and material, of the package to be transported. The temperature control provisions are given in 7.3.7.

#### 2.4.2.3.5 Desensitization of self-reactive substances

2.4.2.3.5.1 In order to ensure safety during transport, self-reactive substances may be desensitized through the use of a diluent. If a diluent is used, the self-reactive substance shall be tested with the diluent present in the concentration

and form used in transport.

2.4.2.3.5.2 Diluents which may allow a self-reactive substance to concentrate to a dangerous extent in the event of leakage from a package shall not be used.

2.4.2.3.5.3 The diluent shall be compatible with the self-reactive substance. In this regard, compatible diluents are those solids or liquids which have no detrimental influence on the thermal stability and hazard type of the self-reactive substance.

2.4.2.3.5.4 Liquid diluents in liquid formulations requiring temperature control shall have a boiling point of at least 60°C and a flashpoint not less than 5°C. The boiling point of the liquid shall be at least 50°C higher than the control temperature of the self-reactive substance (see 7.3.7.2).

#### 2.4.2.4 Class 4.1 Solid desensitized explosives

##### 2.4.2.4.1 Definitions and properties

2.4.2.4.1.1 Solid desensitized explosives are explosive substances which are wetted with water or alcohols or are diluted with other substances to form a homogeneous solid mixture to suppress their explosive properties. The desensitizing agent shall be distributed uniformly throughout the substance in the state in which it is to be transported. Where transport under conditions of low temperature is anticipated for substances containing or wetted with water, a suitable and compatible solvent, such as alcohol, may have to be added to lower the freezing point of the liquid. Some of these substances, when in a dry state, are classified as explosives. Where reference is made to a substance which is wetted with water, or some other liquid, it shall be permitted for transport as a class 4.1 substance only when in the wetted condition specified. Entries in the Dangerous Goods List in chapter 3.2 for solid desensitized explosives are UN 1310, UN 1320, UN 1321, UN 1322, UN 1336, UN 1337, UN 1344, UN 1347, UN 1348, UN 1349, UN 1354, UN 1355, UN 1356, UN 1357, UN 1517, UN 1571, UN 2555, UN 2556, UN 2557, UN 2852, UN 2907, UN 3317, UN 3319, UN 3344, UN 3364, UN 3365, UN 3366, UN 3367, UN 3368, UN 3369, UN 3370, UN 3376, UN 3380 and UN 3474.

##### 2.4.2.4.2 Substances that:

.1 have been provisionally accepted into class 1 according to Test Series 1 and 2 but exempted from class 1 by Test Series 6;

.2 are not self-reactive substances of class 4.1;

.3 are not substances of class 5  
are also assigned to class 4.1. UN 2956, UN 3241, UN 3242 and UN 3251 are such entries.

#### 2.4.2.5 Class 4.1 Polymerizing substances and mixtures (stabilized)

##### 2.4.2.5.1 Definitions and properties

Polymerizing substances are substances which, without stabilization, are liable to undergo a strongly exothermic reaction resulting in the formation of larger molecules or resulting in the formation of polymers under conditions normally encountered in transport. Such substances are considered to be polymerizing substances of class 4.1 when:

.1 their self-accelerating polymerization temperature (SAPT) is 75°C or less under the conditions (with or without chemical stabilization as offered for transport) and in the packaging, IBC or portable tank in which the substance or mixture is to be transported;

.2 they exhibit a heat of reaction of more than 300 J/g; and

.3 they do not meet any other criteria for inclusion in classes 1 to 8.

A mixture meeting the criteria of a polymerizing substance shall be classified as a polymerizing substance of Class 4.1.

##### 2.4.2.5.2 Polymerizing substances are subject to temperature control in transport if their self-accelerating polymerization

temperature (SAPT) is:

- .1 when offered for transport in a packaging or IBC, 50°C or less in the packaging or IBC in which the substance is to be transported; or
- .2 when offered for transport in a portable tank, 45°C or less in the portable tank in which the substance is to be transported.

Note: Substances meeting the criteria of a polymerizing substance and also for inclusion in classes 1 to 8 are subject to the requirements of special provision 386 of chapter 3.3.

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### 2.4.3 Class 4.2 – Substances liable to spontaneous combustion

#### 2.4.3.1 Definitions and properties

##### 2.4.3.1.1 Class 4.2 comprises:

.1 Pyrophoric substances, which are substances, including mixtures and solutions (liquid or solid), which, even in small quantities, ignite within 5 minutes of coming into contact with air. These substances are the most liable to spontaneous combustion; and

.2 Self-heating substances, which are substances, other than pyrophoric substances, which, in contact with air without energy supply, are liable to self-heating. These substances will ignite only when in large amounts (kilograms) and after long periods of time (hours or days).

2.4.3.1.2 Self-heating of a substance is a process where the gradual reaction of that substance with oxygen (in air) generates heat. If the rate of heat production exceeds the rate of heat loss, then the temperature of the substance will rise which, after an induction time, may lead to self-ignition and combustion.

2.4.3.1.3 Some substances may also give off toxic gases if involved in a fire.

#### 2.4.3.2 Classification of class 4.2 substances

2.4.3.2.1 Solids are considered pyrophoric solids which shall be classified in class 4.2 if, in tests performed in accordance with the test method given in the Manual of Tests and Criteria, part III, 33.3.1.4, the sample ignites in one of the tests.

2.4.3.2.2 Liquids are considered pyrophoric liquids which shall be classified in class 4.2 if, in tests performed in accordance with the test method given in the Manual of Tests and Criteria, part III, 33.3.1.5, the liquid ignites in the first part of the test, or if it ignites or chars the filter paper.

#### 2.4.3.2.3 Self-heating substances

2.4.3.2.3.1 A substance shall be classified as a self-heating substance of class 4.2 if, in tests performed in accordance with the test method given in the Manual of Tests and Criteria, part III, 33.3.1.6:

- .1 a positive result is obtained using a 25 mm cube sample at 140°C;
- .2 a positive result is obtained in a test using a 100 mm cube sample at 140°C and a negative result is obtained in a test using a 100 mm cube sample at 120°C and the substance is to be transported in packages with a volume of more than 3 m<sup>3</sup>;

.3 a positive result is obtained in a test using a 100 mm cube sample at 140°C and a negative result is obtained in a test using a 100 mm cube sample at 100°C and the substance is to be transported in packages with a volume of more than 450 L;

.4 a positive result is obtained in a test using a 100 mm cube sample at 140°C and a positive result is obtained using a 100 mm cube sample at 100°C.

Note: Self-reactive substances, except for type G, giving also a positive result with this test method shall not be classified in class 4.2 but in class 4.1 (see 2.4.2.3.1.1).

2.4.3.2.3.2 A substance shall not be classified in class 4.2 if:

.1 a negative result is obtained in a test using a 100 mm cube sample at 140°C;

.2 a positive result is obtained in a test using a 100 mm cube sample at 140°C and a negative result is obtained in a test using a 25 mm cube sample at 140°C, a negative result is obtained in a test using a 100 mm cube sample at 120°C and the substance is to be transported in packages with a volume not more than 3 m<sup>3</sup>;

.3 a positive result is obtained in a test using a 100 mm cube sample at 140°C and a negative result is obtained in a test using a 25 mm cube sample at 140°C, a negative result is obtained in a test using a 100 mm cube sample at 100°C and the substance is to be transported in packages with a volume not more than 450 L.

#### 2.4.3.3 Assignment of packing groups

2.4.3.3.1 Packing group I shall be assigned to all pyrophoric solids and liquids.

2.4.3.3.2 Packing group II shall be assigned to self-heating substances which give a positive result in a test using a 25 mm cube sample at 140°C.

2.4.3.3.3 Packing group III shall be assigned to self-heating substances if:

.1 a positive result is obtained in a test using a 100 mm cube sample at 140°C and a negative result is obtained in a test using a 25 mm cube sample at 140°C and the substance is to be transported in packages with a volume of more than 3 m<sup>3</sup>;

.2 a positive result is obtained in a test using a 100 mm cube sample at 140°C and a negative result is obtained in a test using a 25 mm cube sample at 140°C, a positive result is obtained in a test using a 100 mm cube sample at 120°C and the substance is to be transported in packages with a volume of more than 450 L;

.3 a positive result is obtained in a test using a 100 mm cube sample at 140°C and a negative result is obtained in a test using a 25 mm cube sample at 140°C and a positive result is obtained in a test using a 100 mm cube sample at 100°C.

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#### 2.4.4 Class 4.3 – Substances which, in contact with water, emit flammable gases

##### 2.4.4.1 Definitions and properties

2.4.4.1.1 For the purpose of this Code, the substances in this class are either liquids or solids which, by interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities.

2.4.4.1.2 Certain substances, in contact with water, may emit flammable gases that can form explosive mixtures with air. Such mixtures are easily ignited by all ordinary sources of ignition, for example naked lights, sparking handtools or

unprotected lamps. The resulting blast wave and flames may endanger people and the environment. The test method referred to in 2.4.4.2 is used to determine whether the reaction of a substance with water leads to the development of a dangerous amount of gases which may be flammable. This test method shall not be applied to pyrophoric substances.

#### 2.4.4.2 Classification of class 4.3 substances

2.4.4.2.1 Substances which, in contact with water, emit flammable gases shall be classified in class 4.3 if, in tests performed in accordance with the test method given in the Manual of Tests and Criteria, part III, 33.4.1:

- .1 spontaneous ignition takes place in any step of the test procedure; or
- .2 there is an evolution of a flammable gas at a rate greater than 1 litre per kilogram of the substance per hour.

#### 2.4.4.3 Assignment of packing groups

2.4.4.3.1 Packing group I shall be assigned to any substance which reacts vigorously with water at ambient temperatures and demonstrates generally a tendency for the gas produced to ignite spontaneously, or which reacts readily with water at ambient temperatures such that the rate of evolution of flammable gas is equal to or greater than 10 litres per kilogram of substance over any one minute.

2.4.4.3.2 Packing group II shall be assigned to any substance which reacts readily with water at ambient temperatures such that the maximum rate of evolution of flammable gas is equal to or greater than 20 litres per kilogram of substance per hour, and which does not meet the criteria for packing group I.

2.4.4.3.3 Packing group III shall be assigned to any substance which reacts slowly with water at ambient temperatures such that the maximum rate of evolution of flammable gas is greater than 1 litre per kilogram of substance per hour, and which does not meet the criteria for packing groups I or II.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.4.5
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#### 2.4.5 Classification of organometallic substances

Depending on their properties, organometallic substances may be classified in classes 4.2 or 4.3, as appropriate, in accordance with the following flowchart:



<sup>1</sup> If applicable and testing is relevant, taking into account reactivity properties, class 6.1 and class 8 properties shall be considered according to the Precedence of hazards table 2.0.3.6.

<sup>2</sup> Test methods N.1 to N.5 can be found in the Manual of Tests and Criteria, part III, section 33.

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## Chapter 2.5

### Class 5 – Oxidizing substances and organic peroxides

#### 2.5.0 Introductory note

Because of the differing properties exhibited by dangerous goods within classes 5.1 and 5.2, it is impracticable to establish a single criterion for classification in either class. Tests and criteria for assignment to the two classes are addressed in this chapter.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.5.1
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#### 2.5.1 Definitions and general provisions



In this Code, class 5 is divided into two classes as follows:

#### Class 5.1 – Oxidizing substances

Substances which, while in themselves not necessarily combustible, may, generally by yielding oxygen, cause, or contribute to, the combustion of other material. Such substances may be contained in an article;

#### Class 5.2 – Organic peroxides

Organic substances which contain the bivalent –O–O– structure and may be considered derivatives of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals. Organic peroxides are thermally unstable substances which may undergo exothermic self-accelerating decomposition. In addition, they may have one or more of the following properties:

- be liable to explosive decomposition;
- burn rapidly;
- be sensitive to impact or friction;
- react dangerously with other substances;
- cause damage to the eyes.

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### 2.5.2 Class 5.1 – Oxidizing substances

**Note 1:** For the classification of oxidizing substances to class 5.1, in the event of divergence between test results and known experience, judgement based on known experience shall take precedence over test results.

**Note 2:** By exception, solid ammonium nitrate based fertilizers shall be classified in accordance with the procedure as set out in the Manual of Tests and Criteria, part III, section 39.

#### 2.5.2.1 Properties

2.5.2.1.1 Substances of class 5.1 in certain circumstances directly or indirectly evolve oxygen. For this reason, oxidizing substances increase the risk and intensity of fire in combustible material with which they come into contact.

2.5.2.1.2 Mixtures of oxidizing substances with combustible material and even with material such as sugar, flour, edible oils, mineral oils, etc., are dangerous. These mixtures are readily ignited, in some cases by friction or impact. They may burn violently and may lead to explosion.

2.5.2.1.3 There will be a violent reaction between most oxidizing substances and liquid acids, evolving toxic gases. Toxic gases may also be evolved when certain oxidizing substances are involved in a fire.

2.5.2.1.4 The above-mentioned properties are, in general, common to all substances in this class. Additionally, some substances possess specific properties, which shall be taken into account in transport. These properties are shown in the Dangerous Goods List in chapter 3.2.

#### 2.5.2.2 Oxidizing solids

##### 2.5.2.2.1 Classification of solid substances of class 5.1

2.5.2.2.1.1 Tests are performed to measure the potential for the solid substance to increase the burning rate or burning intensity of a combustible substance when the two are thoroughly mixed. The procedure is given in the

Manual of Tests and Criteria, part III, subsection 34.4.1 (test O.1) or alternatively, in subsection 34.4.3 (test O.3). Tests are conducted on the substance to be evaluated mixed with dry fibrous cellulose in mixing ratios of 1:1 and 4:1, by mass, of sample to cellulose. The burning characteristics of the mixtures are compared:

.1 in the test O.1, with the standard 3:7 mixture, by mass, of potassium bromate to cellulose. If the burning time is equal to or less than this standard mixture, the burning times shall be compared with those from the packing group I or II reference standards, 3:2 and 2:3 ratios, by mass, of potassium bromate to cellulose, respectively; or

.2 in the test O.3, with the standard 1:2 mixture, by mass, of calcium peroxide to cellulose. If the burning rate is equal to or greater than this standard mixture, the burning rates shall be compared with those from the packing group I or II reference standards, 3:1 and 1:1 ratios, by mass, of calcium peroxide to cellulose, respectively.

2.5.2.2.1.2 The classification test results are assessed on the basis of:

.1 the comparison of the mean burning time (for the test O.1) or burning rate (for the test O.3) with those of the reference mixtures; and

.2 whether the mixture of substance and cellulose ignites and burns.

2.5.2.2.1.3 A solid substance is classified in class 5.1 if the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits:

.1 in the test O.1, a mean burning time equal to or less than the mean burning time of a 3:7 mixture (by mass) of potassium bromate and cellulose; or

.2 in the test O.3, a mean burning rate equal to or greater than the mean burning rate of a 1:2 mixture (by mass) of calcium peroxide and cellulose.

2.5.2.2.2 Assignment of packing groups

Solid oxidizing substances are assigned to a packing group according to one of the test procedures in the Manual of Tests and Criteria, part III, subsection 34.4.1 (test O.1) or subsection 34.4.3 (test O.3), in accordance with the following criteria:

.1 Test O.1:

.1 Packing group I: any substance which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning time less than the mean burning time of a 3:2 mixture, by mass, of potassium bromate and cellulose;

.2 Packing group II: any substance which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning time equal to or less than the mean burning time of a 2:3 mixture (by mass) of potassium bromate and cellulose, and the criteria for packing group I are not met;

.3 Packing group III: any substance which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning time equal to or less than the mean burning time of a 3:7 mixture (by mass) of potassium bromate and cellulose, and the criteria for packing groups I and II are not met;

.4 Not class 5.1: any substance which, in both the 4:1 and 1:1 sample-to-cellulose ratio (by mass) tested, does not ignite and burn, or exhibits mean burning times greater than that of a 3:7 mixture (by mass) of potassium bromate and cellulose.

.2 Test O.3:

.1 Packing group I: any substance which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning rate greater than the mean burning rate of a 3:1 mixture (by mass) of calcium peroxide and cellulose;

.2 Packing group II: any substance which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning rate equal to or greater than the mean burning rate of a 1:1 mixture (by mass) of calcium peroxide

and cellulose, and the criteria for packing group I are not met;

.3 Packing group III: any substance which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning rate equal to or greater than the mean burning rate of a 1:2 mixture (by mass) of calcium peroxide and cellulose, and the criteria for packing groups I and II are not met;

.4 Not class 5.1: any substance which, in both the 4:1 and 1:1 sample-to-cellulose ratio (by mass) tested, does not ignite and burn, or exhibits a mean burning rate less than the mean burning rate of a 1:2 mixture (by mass) of calcium peroxide and cellulose.

### 2.5.2.3 Oxidizing liquids

#### 2.5.2.3.1 Classification of liquid substances of class 5.1

2.5.2.3.1.1 A test is performed to determine the potential for a liquid substance to increase the burning rate or burning intensity of a combustible substance or for spontaneous ignition to occur when the two are thoroughly mixed. The procedure is given in the Manual of Tests and Criteria, part III, 34.4.2 (test O.2). It measures the pressure rise time during combustion. Whether a liquid is an oxidizing substance of class 5.1 and, if so, whether packing group I, II or III shall be assigned, is decided on the basis of the test result (see also Precedence of hazard characteristics in 2.0.3).

2.5.2.3.1.2 The classification test results are assessed on the basis of:

.1 whether the mixture of substance and cellulose spontaneously ignites;

.2 the comparison of the mean time taken for the pressure to rise from 690 kPa to 2070 kPa gauge with those of the reference substances.

2.5.2.3.1.3 A liquid substance is classified in class 5.1 if the 1:1 mixture, by mass, of substance and cellulose tested exhibits a mean pressure rise time less than or equal to the mean pressure rise time of a 1:1 mixture, by mass, of 65% aqueous nitric acid and cellulose.

#### 2.5.2.3.2 Assignment of packing groups

2.5.2.3.2.1 Liquid oxidizing substances are assigned to a packing group according to the test procedure in the Manual of Tests and Criteria, part III, 34.4.2, in accordance with the following criteria:

.1 Packing group I: any substance which, in the 1:1 mixture (by mass) of substance and cellulose tested, spontaneously ignites; or the mean pressure rise time of a 1:1 mixture (by mass) of substance and cellulose is less than that of a 1:1 mixture (by mass) of 50% perchloric acid and cellulose;

.2 Packing group II: any substance which, in the 1:1 mixture (by mass) of substance and cellulose tested, exhibits a mean pressure rise time less than or equal to the mean pressure rise time of a 1:1 mixture (by mass) of 40% aqueous sodium chlorate solution and cellulose; and the criteria for packing group I are not met;

.3 Packing group III: any substance which, in the 1:1 mixture (by mass) of substance and cellulose tested, exhibits a mean pressure rise time less than or equal to the mean pressure rise time of a 1:1 mixture (by mass) of 65% aqueous nitric acid and cellulose; and the criteria for packing groups I and II are not met;

.4 Not classified as class 5.1: any substance which, in the 1:1 mixture (by mass) of substance and cellulose tested, exhibits a pressure rise of less than 2070 kPa gauge; or exhibits a mean pressure rise time greater than the mean pressure rise time of a 1:1 mixture (by mass) of 65% aqueous nitric acid and cellulose.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.5.3
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## 2.5.3 Class 5.2 - Organic peroxides

### 2.5.3.1 Properties

2.5.3.1.1 Organic peroxides are liable to exothermic decomposition at normal or elevated temperatures. The decomposition can be initiated by heat, contact with impurities (such as acids, heavy-metal compounds, amines), friction or impact. The rate of decomposition increases with temperature and varies with the organic peroxide formulation. Decomposition may result in the evolution of harmful, or flammable, gases or vapours. For certain organic peroxides the temperature shall be controlled during transport. Some organic peroxides may decompose explosively, particularly if confined. This characteristic may be modified by the addition of diluents or by the use of appropriate packagings. Many organic peroxides burn vigorously.

2.5.3.1.2 Contact of organic peroxides with the eyes is to be avoided. Some organic peroxides will cause serious injury to the cornea, even after brief contact, or will be corrosive to the skin.

### 2.5.3.2 Classification of organic peroxides

2.5.3.2.1 Any organic peroxide shall be considered for classification in class 5.2, unless the organic peroxide formulation contains:

.1 not more than 1.0% available oxygen from the organic peroxides when containing not more than 1.0% hydrogen peroxide; or

.2 not more than 0.5% available oxygen from the organic peroxides when containing more than 1.0% but not more than 7.0% hydrogen peroxide.

Note: The available oxygen content (%) of an organic peroxide formulation is given by the formula:

$$16 \times \sum(n_i \times c_i / m_i)$$

where:

$n_i$  = number of peroxygen groups per molecule of organic peroxide  $i$ ;

$c_i$  = concentration (mass %) of organic peroxide  $i$ ;

$m_i$  = molecular mass of organic peroxide  $i$ .

2.5.3.2.2 Organic peroxides are classified into seven types according to the degree of danger they present. The types of organic peroxide range from type A, which may not be accepted for transport in the packaging in which it is tested, to type G, which is not subject to the provisions for organic peroxides of class 5.2. The classification of types B to F is directly related to the maximum quantity allowed in one packaging.

2.5.3.2.3 Organic peroxides permitted for transport in packagings are listed in 2.5.3.2.4, those permitted for transport in IBCs are listed in packing instruction IBC520 and those permitted for transport in portable tanks are listed in portable tank instruction T23. For each permitted substance listed, the generic entry of the Dangerous Goods List (UN 3101 to UN 3120) is assigned, appropriate subsidiary hazards and remarks providing relevant transport information are given. The generic entries specify:

.1 organic peroxide type (B to F);

.2 physical state (liquid or solid); and

.3 temperature control, when required (see 2.5.3.4).

2.5.3.2.3.1 Mixtures of the listed formulations may be classified as the same type of organic peroxide as that of the most dangerous component and be transported under the conditions of transport given for this type. However, as two stable components can form a thermally less stable mixture, the self-accelerating decomposition temperature (SADT) of the mixture shall be determined and, if necessary, temperature control applied as required by 2.5.3.4.

### 2.5.3.2.4 List of currently assigned organic peroxides in packagings

Note: Packing Method codes "OP1" to "OP8" refer to packing methods in packing instruction P520. Peroxides to be transported shall fulfil the classification and the control and emergency temperatures (derived from the SADT) as listed. For substances permitted in IBCs, see packing instruction IBC520, and for those permitted in tanks, see portable tank instruction T23. The formulations listed in packing instruction IBC520 of 4.1.4.2 and in portable tank instruction T23 of 4.2.5.2.6 may also be transported packed in accordance with packing method OP8 of packing instruction P520 of 4.1.4.1, with the same control and emergency temperatures, if applicable.

Number (generic entry)	ORGANIC PEROXIDE	Concentration (%)	Diluent type A (%)	Diluent type B (%) (1)	Inert solid (%)	Water (%)	Packing method	Control temperature (°C)	Emergency temperature (°C)	Subsidiary hazards and remarks
3101	tert-BUTYL PEROXYACETATE	> 52 - 77	≥ 23				OP5			(3)
	1,1-DI-(tert-BUTYLPEROXY)CYCLOHEXANE	> 80 - 100					OP5			(3)
	1,1-DI-(tert-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	> 90 - 100					OP5			(3)
	METHYL ETHYL KETONE PEROXIDE(S)	see remark (8)	≥ 48				OP5			(3) (8) (13)
	2,5-DIMETHYL-2,5-DI-(tert-BUTYLPEROXY)-HEXYNE-3	> 86 - 100					OP5			(3)
3102	tert-BUTYL MONOPEROXYMALEATE	> 52 - 100					OP5			(3)
	3-CHLOROPEROXYBENZOIC ACID	> 57 - 86			≥ 14		OP1			(3)
	DIBENZOYL PEROXIDE	> 52 - 100			≤ 48		OP2			(3)
	DIBENZOYL PEROXIDE	> 77 - 94				≥ 6	OP4			(3)
	DI-4-CHLOROBENZOYL PEROXIDE	≤ 77				≥ 23	OP5			(3)
	DI-2,4-DICHLOROBENZOYL PEROXIDE	≤ 77				≥ 23	OP5			(3)
	2,2-DIHYDROPEROXYPROPANE	≤ 27			≥ 73		OP5			(3)
	2,5-DIMETHYL-2,5-DI-(BENZOYLPEROXY)HEXANE	> 82 - 100					OP5			(3)
	DI-(2-PHENOXYETHYL) PEROXYDICARBONATE	> 85 - 100					OP5			(3)
	DISUCCINIC ACID PEROXIDE	> 72 - 100					OP4			(3) (17)
3103	tert-AMYL PEROXYBENZOATE	≤ 100					OP5			
	tert-AMYLPEROXY ISOPROPYL CARBONATE	≤ 77	≥ 23				OP5			
	n-BUTYL 4,4-DI-(tert-BUTYLPEROXY)VALERATE	> 52 - 100					OP5			
	tert-BUTYL HYDROPEROXIDE	> 79 - 90				≥ 10	OP5			(13)
	tert-BUTYL HYDROPEROXIDE + DI-tert-BUTYL PEROXIDE	< 82 + > 9				≥ 7	OP5			(13)
	tert-BUTYL MONOPEROXYMALEATE	≤ 52	≥ 48				OP6			
	tert-BUTYL PEROXYACETATE	> 32 - 52	≥ 48				OP6			
	tert-BUTYL PEROXYBENZOATE	> 77 - 100					OP5			
	tert-BUTYLPEROXY ISOPROPYLCARBONATE	≤ 77	≥ 23				OP5			
	tert-BUTYLPEROXY-2-METHYLBENZOATE	≤ 100					OP5			
	1,1-DI-(tert-AMYLPEROXY)CYCLOHEXANE	≤ 82	≥ 18				OP6			
3103 (cont.)	2,2-DI-(tert-BUTYLPEROXY)BUTANE	≤ 52	≥ 48				OP6			
	1,6-DI-(tert-BUTYLPEROXYCARBONYLOXY)-HEXANE	≤ 72	≥ 28				OP5			

	1,1-DI-(tert-BUTYLPEROXY)CYCLOHEXANE	> 52 - 80	≥ 20				OP5		
	1,1-DI-(tert-BUTYLPEROXY)CYCLOHEXANE	≤ 72		≥ 28			OP5		(30)
	1,1-DI-(tert-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	> 57 - 90	≥ 10				OP5		
	1,1-DI-(tert-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	≤ 77		≥ 23			OP5		
	1,1-DI-(tert-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	≤ 90		≥ 10			OP5		(30)
	2,5-DIMETHYL-2,5-DI-(tert-BUTYLPEROXY)HEXANE	> 90 - 100					OP5		
	2,5-DIMETHYL-2,5-DI-(tert-BUTYLPEROXY)-HEXYNE-3	> 52 - 86	≥ 14				OP5		(26)
	ETHYL 3,3-DI-(tert-BUTYLPEROXY)BUTYRATE	> 77 - 100					OP5		
	ORGANIC PEROXIDE, LIQUID, SAMPLE						OP2		(11)
3104	CYCLOHEXANONE PEROXIDE(S)	≤ 91				≥ 9	OP6		(13)
	DIBENZOYL PEROXIDE	≤ 77				≥ 23	OP6		
	2,5-DIMETHYL-2,5-DI(BENZOYLPEROXY)HEXANE	≤ 82				≥ 18	OP5		
	2,5-DIMETHYL-2,5-DIHYDROPEROXYHEXANE	≤ 82				≥ 18	OP6		
	ORGANIC PEROXIDE, SOLID, SAMPLE						OP2		(11)
3105	ACETYL ACETONE PEROXIDE	≤ 42	≥ 48			≥ 8	OP7		(2)
	tert-AMYL PEROXYACETATE	≤ 62	≥ 38				OP7		
	tert-AMYL PEROXY-2-ETHYLHEXYL CARBONATE	≤ 100					OP7		
	tert-AMYL PEROXY-3,5,5-TRIMETHYLHEXANOATE	≤ 100					OP7		
	tert-BUTYL HYDROPEROXIDE	≤ 80	≥ 20				OP7		(4) (13)
	tert-BUTYL PEROXYBENZOATE	> 52 - 77	≥ 23				OP7		
	tert-BUTYL PEROXYBUTYL FUMARATE	≤ 52	≥ 48				OP7		
	tert-BUTYL PEROXYCROTONATE	≤ 77	≥ 23				OP7		
	tert-BUTYL PEROXY-2-ETHYLHEXYLCARBONATE	≤ 100					OP7		
	1-(2-tert-BUTYLPEROXY ISOPROPYL)-3-ISOPROPENYLBENZENE	≤ 77	≥ 23				OP7		
	tert-BUTYL PEROXY-3,5,5-TRIMETHYLHEXANOATE	> 37 - 100					OP7		
	CYCLOHEXANONE PEROXIDE(S)	≤ 72	≥ 28				OP7		(5)
3105 (cont.)	2,2-DI-(tert-AMYLPEROXY)BUTANE	≤ 57	≥ 43				OP7		
	DI-tert-BUTYL PEROXYAZELATE	≤ 52	≥ 48				OP7		
	1,1-DI-(tert-BUTYLPEROXY)CYCLOHEXANE	> 42 - 52	≥ 48				OP7		
	1,1-DI-(tert-BUTYLPEROXY)CYCLOHEXANE + tert-BUTYL PEROXY-2-ETHYLHEXANOATE	≤ 43 + ≤ 16	≥ 41				OP7		
	DI-(tert-BUTYLPEROXY)PHTHALATE	> 42 - 52	≥ 48				OP7		
	2,2-DI-(tert-BUTYLPEROXY)PROPANE	≤ 52	≥ 48				OP7		
	2,5-DIMETHYL-2,5-DI-(tert-BUTYLPEROXY)HEXANE	> 52 - 90	≥ 10				OP7		
	2,5-DIMETHYL-2,5-DI-(3,5,5-TRIMETHYLHEXANOYLPEROXY)HEXANE	≤ 77	≥ 23				OP7		
	ETHYL 3,3-DI-(tert-AMYLPEROXY)BUTYRATE	≤ 67	≥ 33				OP7		

	ETHYL 3,3-DI-(tert-BUTYLPEROXY)BUTYRATE	≤ 77	≥ 23				OP7		
	p-MENTHYL HYDROPEROXIDE	> 72 - 100					OP7		(13)
	METHYL ETHYL KETONE PEROXIDE(S)	see remark (9)	≥ 55				OP7		(9)
	METHYL ISOBUTYL KETONE PEROXIDE(S)	≤ 62	≥ 19				OP7		(22)
	PEROXYACETIC ACID, TYPE D, stabilized	≤ 43					OP7		(13) (14) (19)
	PINANYL HYDROPEROXIDE	> 56 - 100					OP7		(13)
	1,1,3,3-TETRAMETHYLBUTYL HYDROPEROXIDE	≤ 100					OP7		
	3,6,9-TRIETHYL-3,6,9-TRIMETHYL-1,4,7-TRIPEROXONANE	≤ 42	≥ 58				OP7		(28)
3106	ACETYL ACETONE PEROXIDE	≤ 32 as a paste					OP7		(20)
	tert-BUTYL PEROXYBENZOATE	≤ 52			≥ 48		OP7		
	tert-BUTYL PEROXY-2-ETHYLHEXANOATE + 2,2-DI-(tert-BUTYLPEROXY)BUTANE	≤ 12 + ≤ 14	≥ 14		≥ 60		OP7		
	tert-BUTYLPEROXY STEARYLCARBONATE	≤ 100					OP7		
	tert-BUTYL PEROXY-3,5,5-TRIMETHYLHEXANOATE	≤ 42			≥ 58		OP7		
	3-CHLOROPEROXYBENZOIC ACID	≤ 57			≥ 3	≥ 40	OP7		
	3-CHLOROPEROXYBENZOIC ACID	≤ 77			≥ 6	≥ 17	OP7		
	CYCLOHEXANONE PEROXIDE(S)	≤ 72 as a paste					OP7		(5) (20)
	DIBENZOYL PEROXIDE	≤ 62			≥ 28	≥ 10	OP7		
	DIBENZOYL PEROXIDE	> 52 - 62 as a paste					OP7		(20)
	DIBENZOYL PEROXIDE	> 35 - 52			≥ 48		OP7		
	1,1-DI-(tert-BUTYLPEROXY)CYCLOHEXANE	≤ 42	≥ 13		≥ 45		OP7		
	DI-(tert-BUTYLPEROXYISOPROPYL)BENZENE(S)	> 42 - 100			≤ 57		OP7		
3106 (cont.)	DI-(tert-BUTYLPEROXY)PHTHALATE	≤ 52 as a paste					OP7		(20)
	2,2-DI-(tert-BUTYLPEROXY)PROPANE	≤ 42	≥ 13		≥ 45		OP7		
	DI-4-CHLOROBENZOYL PEROXIDE	≤ 52 as a paste					OP7		(20)
	2,2-DI-(4,4-DI-(tert-BUTYLPEROXY)CYCLOHEXYL)-PROPANE	≤ 42			≥ 58		OP7		
	DI-2,4-DICHLOROBENZOYL PEROXIDE	≤ 52 as a paste with silicon oil					OP7		
	DI-(1-HYDROXYCYCLOHEXYL)PEROXIDE	≤ 100					OP7		
	DIISOPROPYLBENZENE DIHYDROPEROXIDE	≤ 82	≥ 5			≥ 5	OP7		(24)
	DILAUROYL PEROXIDE	≤ 100					OP7		
	DI-(4-METHYLBENZOYL) PEROXIDE	≤ 52 as a paste with silicon oil					OP7		
	2,5-DIMETHYL-2,5-DI-(BENZOYLPEROXY)HEXANE	≤ 82			≥ 18		OP7		
	2,5-DIMETHYL-2,5-DI-(tert-BUTYLPEROXY)-HEXYNE-3	≤ 52			≥ 48		OP7		
	DI-(2-PHENOXYETHYL)PEROXYDICARBONATE	≤ 85				≥ 15	OP7		
	ETHYL 3,3-DI-(tert-BUTYLPEROXY)BUTYRATE	≤ 52			≥ 48		OP7		

	[(3R-(3R,5aS,6S,8aS,9R,10R,12S,12aR**))- DECAHYDRO-10-METHOXY-3,6,9- TRIMETHYL-3,12-EPOXY-12H- PYRANO[4,3-j]-1,2- BENZODIOXEPIN)	≤ 100				OP7		
3107	tert-AMYL HYDROPEROXIDE	≤ 88	≥ 6		≥ 6	OP8		
	tert-BUTYL HYDROPEROXIDE	≤ 79			> 14	OP8		(13) (23)
	CUMYL HYDROPEROXIDE	> 90 - 98	≤ 10			OP8		(13)
	DI-tert-AMYL PEROXIDE	≤ 100				OP8		
	DIBENZOYL PEROXIDE	> 36 - 42	≥ 18		≤ 40	OP8		
	DI-tert-BUTYL PEROXIDE	> 52 - 100				OP8		
	1,1-DI-(tert- BUTYLPEROXY)CYCLOHEXANE	≤ 27	≥ 25			OP8		(21)
	DI-(tert-BUTYLPEROXY)PHTHALATE	≤ 42	≥ 58			OP8		
	1,1-DI-(tert-BUTYLPEROXY)-3,3,5- TRIMETHYLCYCLOHEXANE	≤ 57	≥ 43			OP8		
	1,1-DI-(tert-BUTYLPEROXY)-3,3,5- TRIMETHYLCYCLOHEXANE	≤ 32	≥ 26	≥ 42		OP8		
	2,2-DI-(4,4-DI-(tert-BUTYLPEROXY) CYCLOHEXYL)-PROPANE	≤ 22		≥ 78		OP8		
3107 (cont.)	METHYL ETHYL KETONE PEROXIDE(S)	see remark (10)	≥ 60			OP8		(10)
	3,3,5,7,7-PENTAMETHYL-1,2,4- TRIOXEPANE	≤ 100				OP8		
	PEROXYACETIC ACID, TYPE E, stabilized	≤ 43				OP8		(13) (15) (19)
	POLYETHER POLY-tert- BUTYLPEROXYCARBONATE	≤ 52		≥ 48		OP8		
3108	tert-BUTYL CUMYL PEROXIDE	≤ 52			≥ 48	OP8		
	n-BUTYL 4,4-DI-(tert- BUTYLPEROXY)VALERATE	≤ 52			≥ 48	OP8		
	tert-BUTYL MONOPEROXYMALEATE	≤ 52			≥ 48	OP8		
	tert-BUTYL MONOPEROXYMALEATE	≤ 52 as a paste				OP8		
	1-(2-tert-BUTYLPEROXYISOPROPYL)-3- ISOPROPENYLBENZENE	≤ 42			≥ 58	OP8		
	DIBENZOYL PEROXIDE	≤ 56.5 as a paste			≥ 15	OP8		
	DIBENZOYL PEROXIDE	≤ 52 as a paste				OP8		(20)
	2,5-DIMETHYL-2,5-DI-(tert- BUTYLPEROXY)HEXANE	≤ 47 as a paste				OP8		
	2,5-DIMETHYL-2,5-DI-(tert- BUTYLPEROXY)HEXANE	≤ 77			≥ 23	OP8		
3109	tert-BUTYL CUMYL PEROXIDE	> 42 - 100				OP8		
	tert-BUTYL HYDROPEROXIDE	≤ 72			≥ 28	OP8		(13)
	tert-BUTYL PEROXYACETATE	≤ 32		≥ 68		OP8		
	tert-BUTYL PEROXY-3,5,5-TRIMETHYL- HEXANOATE	≤ 37		≥ 68		OP8		
	CUMYL HYDROPEROXIDE	≤ 90	≥ 10			OP8		(13) (18)
	DIBENZOYL PEROXIDE	≤ 42 as a stable dispersion in water				OP8		
	DI-tert-BUTYL PEROXIDE	≤ 52		≥ 48		OP8		(25)
	1,1-DI-(tert- BUTYLPEROXY)CYCLOHEXANE	≤ 42	≥ 58			OP8		
	1,1-DI-(tert- BUTYLPEROXY)CYCLOHEXANE	≤ 13	≥ 13	≥ 74		OP8		
	DILAUROYL PEROXIDE	≤ 42 as a stable dispersion in water				OP8		
	2,5-DIMETHYL-2,5-DI-(tert- BUTYLPEROXY)HEXANE	≤ 52	≥ 48			OP8		
	ISOPROPYLCUMYL HYDROPEROXIDE	≤ 72	≥ 28			OP8		(13)
	p-MENTHYL HYDROPEROXIDE	≤ 72	≥ 28			OP8		(27)

	METHYL ISOPROPYL KETONE PEROXIDE(S)	See remark (31)	≥ 70				OP8			(31)
	PEROXYACETIC ACID, TYPE F, stabilized	≤ 43					OP8			(13) (16) (19)
	1-PHENYLETHYL HYDROPEROXIDE	≤ 38		≥ 62			OP8			
	PINANYL HYDROPEROXIDE	≤ 56	≥ 44				OP8			
3110	DICUMYL PEROXIDE	> 52 - 100					OP8			(12)
	1,1-DI-(tert-BUTYLPEROXY)-3,3,5-TRIMETHYLCYCLOHEXANE	≤ 57		≥ 43			OP8			
	3,6,9-TRIETHYL-3,6,9-TRIMETHYL-1,4,7-TRIPEROXONANE	≤ 17	≥ 18	≥ 65			OP8			
3111	tert-BUTYL PEROXYISOBUTYRATE	> 52 - 77		≥ 23			OP5	+15	+20	(3)
	DIISOBUTYRYL PEROXIDE	> 32 - 52		≥ 48			OP5	-20	-10	(3)
	ISOPROPYL sec-BUTYL PEROXYDICARBONATE + DI-sec-BUTYL PEROXYDICARBONATE + DIISOPROPYL PEROXYDICARBONATE	≤ 52 + ≤ 28 + ≤ 22					OP5	-20	-10	(3)
3112	ACETYL CYCLOHEXANESULPHONYL PEROXIDE	≤ 82			≥ 12		OP4	-10	0	(3)
	DICYCLOHEXYL PEROXYDICARBONATE	> 91 - 100					OP3	+10	+15	(3)
	DIISOPROPYL PEROXYDICARBONATE	> 52 - 100					OP2	-15	-5	(3)
	DI-(2-METHYLBENZOYL) PEROXIDE	≤ 87			≥ 13		OP5	+30	+35	(3)
3113	tert-AMYL PEROXYPIVALATE	≤ 77		≥ 23			OP5	+10	+15	
	tert-BUTYL PEROXYDIETHYLACETATE	≤ 100					OP5	+20	+25	
	tert-BUTYL PEROXY-2-ETHYLHEXANOATE	> 52 - 100					OP6	+20	+25	
	tert-BUTYL PEROXYPIVALATE	> 67 - 77	≥ 23				OP5	0	+10	
	DI-sec-BUTYL PEROXYDICARBONATE	> 52 - 100					OP4	-20	-10	
	DI-(2-ETHYLHEXYL)PEROXYDICARBONATE	> 77 - 100					OP5	-20	-10	
	2,5-DIMETHYL-2,5-DI-(2-ETHYLHEXANOYLPEROXY)-HEXANE	≤ 100					OP5	+20	+25	
	DI-n-PROPYL PEROXYDICARBONATE	≤ 100					OP3	-25	-15	
	DI-n-PROPYL PEROXYDICARBONATE	≤ 77	≥ 23				OP5	-20	-10	
	ORGANIC PEROXIDE, LIQUID, SAMPLE, TEMPERATURE CONTROLLED						OP2			(11)
3114	DI-(4-tert-BUTYLCYCLOHEXYL)-PEROXYDICARBONATE	≤ 100					OP6	+30	+35	
	DICYCLOHEXYL PEROXYDICARBONATE	≤ 91			≥ 9		OP5	+10	+15	
	DIDECANOYL PEROXIDE	≤ 100					OP6	+30	+35	
	DI-n-OCTANOYL PEROXIDE	≤ 100					OP5	+10	+15	
	ORGANIC PEROXIDE, SOLID, SAMPLE, TEMPERATURE CONTROLLED						OP2			(11)
3115	ACETYL CYCLOHEXANESULPHONYL PEROXIDE	≤ 32		≥ 68			OP7	-10	0	
	tert-AMYL PEROXY-2-ETHYLHEXANOATE	≤ 100					OP7	+20	+25	
	tert-AMYL PEROXYNEODECANOATE	≤ 77		≥ 23			OP7	0	+10	
	tert-BUTYL PEROXY-2-ETHYLHEXANOATE + 2,2-DI-(tert-BUTYLPEROXY)BUTANE	≤ 31 + ≤ 36		≥ 33			OP7	+35	+40	
	tert-BUTYL PEROXYISOBUTYRATE	≤ 52		≥ 48			OP7	+15	+20	
	tert-BUTYL PEROXYNEODECANOATE	> 77 - 100					OP7	-5	+5	
	tert-BUTYL PEROXYNEODECANOATE	≤ 77		≥ 23			OP7	0	+10	
	tert-BUTYL PEROXYNEOHEPTANOATE	≤ 77	≥ 23				OP7	0	+10	
	tert-BUTYL PEROXYPIVALATE	> 27 - 67		≥ 33			OP7	0	+10	

	CUMYL PEROXYNEODECANOATE	≤ 77		≥ 23			OP7	-10	0	
	CUMYL PEROXYNEODECANOATE	≤ 87	≥ 13				OP7	-10	0	
	CUMYL PEROXYNEOHEPTANOATE	≤ 77	≥ 23				OP7	-10	0	
	CUMYL PEROXYPIVALATE	≤ 77		≥ 23			OP7	-5	+5	
	DIACETONE ALCOHOL PEROXIDES	≤ 57		≥ 26		≥ 8	OP7	+40	+45	(6)
	DIACETYL PEROXIDE	≤ 27		≥ 73			OP7	+20	+25	(7)(13)
	DI-n-BUTYL PEROXYDICARBONATE	> 27 – 52		≥ 48			OP7	-15	-5	
	DI-sec-BUTYL PEROXYDICARBONATE	≤ 52		≥ 48			OP7	-15	-5	
	DI-(2-ETHOXYETHYL)PEROXYDICARBONATE	≤ 52		≥ 48			OP7	-10	0	
	DI-(2-ETHYLHEXYL)PEROXYDICARBONATE	≤ 77		≥ 23			OP7	-15	-5	
	DIISOBUTYRYL PEROXIDE	≤ 32		≥ 68			OP7	-20	-10	
	DIISOPROPYL PEROXYDICARBONATE	≤ 52		≥ 48			OP7	-20	-10	
	DIISOPROPYL PEROXYDICARBONATE	≤ 32	≥ 68				OP7	-15	-5	
	DI-(3-METHOXYBUTYL) PEROXYDICARBONATE	≤ 52		≥ 48			OP7	-5	+5	
	DI-(3-METHYLBENZOYL) PEROXIDE + BENZOYL (3-METHYLBENZOYL) PEROXIDE + DIBENZOYL PEROXIDE	≤ 20 + ≤ 18 + ≤ 4		≥ 58			OP7	+35	+40	
	DI-(2-NEODECANOYL)PEROXYISOPROPYL)-BENZENE	≤ 52	≥ 48				OP7	-10	0	
	DI-(3,5,5-TRIMETHYLHEXANOYL) PEROXIDE	> 52 – 82	≥ 18				OP7	0	+10	
	1-(2-ETHYLHEXANOYLPEROXY)-1,3-DIMETHYLBUTYL PEROXYPIVALATE	≤ 52	≥ 45	≥ 10			OP7	-20	-10	
	tert-HEXYL PEROXYNEODECANOATE	≤ 71	≥ 29				OP7	0	+10	
	tert-HEXYL PEROXYPIVALATE	≤ 72		≥ 28			OP7	+10	+15	
3115 (cont.)	3-HYDROXY-1,1-DIMETHYLBUTYL PEROXYNEODECANOATE	≤ 77	≤ 23				OP7	-5	+5	
	ISOPROPYL sec-BUTYL PEROXYDICARBONATE + DI-sec-BUTYL PEROXYDICARBONATE + DI-ISOPROPYL PEROXYDICARBONATE	≤ 32 + ≤ 15 – 18 + ≤ 12 – 15	≥ 38				OP7	-20	-10	
	METHYLCYCLOHEXANONE PEROXIDE(S)	≥ 67		≥ 33			OP7	+35	+40	
	1,1,3,3-TETRAMETHYLBUTYL PEROXY-2-ETHYLHEXANOATE	≥ 100					OP7	+15	+20	
	1,1,3,3-TETRAMETHYLBUTYL PEROXYNEODECANOATE	≥ 72		≥ 28			OP7	-5	+5	
	1,1,3,3-TETRAMETHYLBUTYL PEROXYPIVALATE	≥ 77	≥ 23				OP7	0	+10	
3116										
	DIMYRISTYL PEROXYDICARBONATE	≤ 100					OP7	+20	+25	
	DI-n-NONANOYL PEROXIDE	≤ 100					OP7	0	+10	
	DI-(4-tert-BUTYLCYCLOHEXYL) PEROXYDICARBONATE	≤ 42 (as a paste)					OP7	+35	+40	
	DISUCCINIC ACID PEROXIDE	≤ 72				≥ 28	OP7	+10	+15	
3117	tert-BUTYL PEROXY-2-ETHYLHEXANOATE	> 32 – 52		≥ 48			OP8	+30	+35	
	DI-n-BUTYL PEROXYDICARBONATE	≤ 27		≥ 73			OP8	-10	0	
	tert-BUTYL PEROXYNEOHEPTANOATE	≤ 42 as a stable dispersion in water					OP8	0	+10	
	1,1-DIMETHYL-3-HYDROXYBUTYL PEROXYNEOHEPTANOATE	≤ 52	≥ 48				OP8	0	+10	
	DIPROPIONYL PEROXIDE	≤ 27		≥ 73			OP8	+15	+20	

	3-HYDROXY-1,1-DIMETHYLBUTYL PEROXYNEODECANOATE	≤ 52	≥ 48				OP8	-5	+5	
3118	tert-BUTYL PEROXY-2-ETHYLHEXANOATE	≤ 52			≥ 48		OP8	+20	+25	
	tert-BUTYL PEROXYNEODECANOATE	≤ 42 as a stable dispersion in water (frozen)					OP8	0	+10	
	DI-n-BUTYL PEROXYDICARBONATE	≤ 42 as a stable dispersion in water (frozen)					OP8	-15	-5	
	DI-2,4-DICHLOROBENZOYL PEROXIDE	≤ 52 as a paste					OP8	+20	+25	
	PEROXYLAURIC ACID	≤ 100					OP8	+35	+40	
3119	tert-AMYL PEROXYNEODECANOATE	≤ 47	≥ 53				OP8	0	+10	
	tert-BUTYL PEROXY-2-ETHYLHEXANOATE	≤ 32			≥ 68		OP8	+40	+45	
	tert-BUTYL PEROXYNEODECANOATE	≤ 52 as a stable dispersion in water					OP8	0	+10	
3119 (cont.)	tert-BUTYL PEROXYNEODECANOATE	≤ 32	≥ 68				OP8	0	+10	
	tert-BUTYL PEROXYPIVALATE	≤ 27			≥ 73		OP8	+30	+35	
	CUMYL PEROXYNEODECANOATE	≤ 52 as a stable dispersion in water					OP8	-10	0	
	DI-(4-tert-BUTYL)CYCLOHEXYL PEROXYDICARBONATE	≤ 42 as a stable dispersion in water					OP8	+30	+35	
	DICETYL PEROXYDICARBONATE	≤ 42 as a stable dispersion in water					OP8	+30	+35	
	DICYCLOHEXYL PEROXYDICARBONATE	≤ 42 as a stable dispersion in water					OP8	+15	+20	
	DI-(2-ETHYLHEXYL) PEROXYDICARBONATE	≤ 62 as a stable dispersion in water					OP8	-15	-5	
	DIISOBUTYRYL PEROXIDE	≤ 42 (as a stable dispersion in water)					OP8	-20	-10	
	DIMYRISTYL PEROXYDICARBONATE	≤ 42 as a stable dispersion in water					OP8	+20	+25	
	DI-(3,5,5-TRIMETHYLHEXANOYL) PEROXIDE	≤ 52 as a stable dispersion in water					OP8	+10	+15	
	DI-(3,5,5-TRIMETHYLHEXANOYL) PEROXIDE	≤ 38	≥ 62				OP8	+20	+25	
	DI-(3,5,5-TRIMETHYLHEXANOYL) PEROXIDE	> 38 – 52	≥ 48				OP8	+10	+15	
	3-HYDROXY-1,1-DIMETHYLBUTYL PEROXYNEODECANOATE	≤ 52 as a stable dispersion in water					OP8	-5	+5	
	1,1,3,3-TETRAMETHYLBUTYL PEROXYNEODECANOATE	≤ 52 as a stable dispersion in water					OP8	-5	+5	
	3120	DI-(2-ETHYLHEXYL)PEROXYDICARBONATE	≤ 52 as a stable dispersion in water (frozen)					OP8	-15	-5
DICETYL PEROXYDICARBONATE		≤ 100					OP8	+30	+35	
Exempt	CYCLOHEXANONE PEROXIDE(S)	≤ 32			≥ 68					(29)
Exempt	DIBENZOYL PEROXIDE	≤ 35			≥ 65					(29)
Exempt	DI-(2-tert-BUTYLPEROXYISOPROPYL)BENZENE(S)	≤ 42			≥ 58					(29)

Exempt	DI-4-CHLOROBENZOYL PEROXIDE	≤ 32			≥ 68					(29)
Exempt	DICUMYL PEROXIDE	≤ 52			≥ 48					(29)

- (1) Diluent type B may always be replaced by diluent type A. The boiling point of diluent type B shall be at least 60°C higher than the SADT of the organic peroxide
- (2) Available oxygen ≤ 4.7%
- (3) "EXPLOSIVE" subsidiary hazard label required. (Model No. 1, see 5.2.2.2.2)
- (4) Diluent may be replaced by di-tert-butyl peroxide
- (5) Available oxygen ≤ 9%
- (6) With ≤ 9% hydrogen peroxide; available oxygen ≤ 10%
- (7) Only non-metallic packagings are allowed
- (8) Available oxygen > 10% and ≤ 10.7%, with or without water
- (9) Available oxygen ≤ 10%, with or without water
- (10) Available oxygen ≤ 8.2%, with or without water
- (11) See 2.5.3.2.5.1
- (12) Up to 2000 kg per receptacle assigned to ORGANIC PEROXIDE TYPE F on the basis of large-scale trials
- (13) "CORROSIVE" subsidiary hazard label required (Model No. 8, see 5.2.2.2.2)
- (14) Peroxyacetic acid formulations which fulfil the criteria of 2.5.3.3.2.4
- (15) Peroxyacetic acid formulations which fulfil the criteria of 2.5.3.3.2.5
- (16) Peroxyacetic acid formulations which fulfil the criteria of 2.5.3.3.2.6
- (17) Addition of water to this organic peroxide will decrease its thermal stability
- (18) No "CORROSIVE" subsidiary hazard label required for concentrations below 80%
- (19) Mixtures with hydrogen peroxide, water and acid(s)
- (20) With diluent type A, with or without water
- (21) With ≥ 25% diluent type A by mass, and in addition ethylbenzene
- (22) With ≥ 19% diluent type A by mass, and in addition methyl isobutyl ketone
- (23) With < 6% di-tert-butyl peroxide
- (24) With ≤ 8% 1-isopropylhydroperoxy-4-isopropylhydroxybenzene
- (25) Diluent type B with boiling point > 110°C

(26) With < 0.5% hydroperoxides content

(27) For concentrations more than 56%, "CORROSIVE" subsidiary hazard label required (Model No. 8, see 5.2.2.2.2)

(28) Available active oxygen  $\leq$  7.6% in diluent type A having a 95% boil-off point in the range 200–260°C

(29) Not subject to the provisions for peroxide, class 5.2

(30) Diluent type B with boiling point > 130°C

(31) Active oxygen  $\leq$  6.7%

2.5.3.2.5 Classification of organic peroxides not listed in 2.5.3.2.4, packing instruction IBC520 or portable tank instruction T23 and assignment to a generic entry shall be made by the competent authority of the country of origin on the basis of a test report. Principles applying to the classification of such substances are provided in 2.5.3.3. Test methods and criteria and an example of a report are given in the current edition of the Manual of Tests and Criteria, part II. The statement of approval shall contain the classification and the relevant transport conditions (see 5.4.4.1.3).

2.5.3.2.5.1 Samples of new organic peroxides or new formulations of currently assigned organic peroxides for which complete test data are not available and which are to be transported for further testing or evaluation may be assigned to one of the appropriate entries for ORGANIC PEROXIDE TYPE C provided the following conditions are met:

.1 the available data indicate that the sample would be no more dangerous than ORGANIC PEROXIDE TYPE B;

.2 the sample is packaged in accordance with packing method OP2 and the quantity per cargo transport unit is limited to 10 kg; and

.3 the available data indicate that the control temperature, if any, is sufficiently low to prevent any dangerous decomposition and sufficiently high to prevent any dangerous phase separation.

### 2.5.3.3 Principles for classification of organic peroxides

Note: This section refers only to those properties of organic peroxides which are decisive for their classification. A flow chart, presenting the classification principles in the form of a graphically arranged scheme of questions concerning the decisive properties together with the possible answers, is given in figure 2.5.1 in chapter 2.5 of the United Nations Recommendations on the Transport of Dangerous Goods. These properties shall be determined experimentally. Suitable test methods with pertinent evaluation criteria are given in the Manual of Tests and Criteria, part II.

2.5.3.3.1 Any organic peroxide formulation shall be regarded as possessing explosive properties when, in laboratory testing, the formulation is liable to detonate, to deflagrate rapidly or to show a violent effect when heated under confinement.

2.5.3.3.2 The following principles apply to the classification of organic peroxide formulations not listed in 2.5.3.2.4:

.1 Any organic peroxide formulation which can detonate or deflagrate rapidly, as packaged for transport, is prohibited from transport in that packaging under class 5.2 (defined as ORGANIC PEROXIDE TYPE A);

.2 Any organic peroxide formulation possessing explosive properties and which, as packaged for transport, neither detonates nor deflagrates rapidly, but is liable to undergo a thermal explosion in that package, shall bear an "EXPLOSIVE" subsidiary hazard label (Model No. 1, see 5.2.2.2.2). Such an organic peroxide may be packaged in amounts of up to 25 kg unless the maximum quantity has to be limited to a lower amount to preclude detonation or rapid deflagration in the package (defined as ORGANIC PEROXIDE TYPE B);

.3 Any organic peroxide formulation possessing explosive properties may be transported without an "EXPLOSIVE" subsidiary hazard label when the substance as packaged (maximum 50 kg) for transport cannot detonate or deflagrate rapidly or undergo a thermal explosion (defined as ORGANIC PEROXIDE TYPE C);

4 Any organic peroxide formulation which, in laboratory testing:

- .1 detonates partially, does not deflagrate rapidly and shows no violent effect when heated under confinement; or
- .2 does not detonate at all, deflagrates slowly and shows no violent effect when heated under confinement; or
- .3 does not detonate or deflagrate at all and shows a medium effect when heated under confinement is acceptable for transport in packages of not more than 50 kg net mass (defined as ORGANIC PEROXIDE TYPE D);

.5 Any organic peroxide formulation which, in laboratory testing, neither detonates nor deflagrates at all and shows low or no effect when heated under confinement is acceptable for transport in packages of not more than 400 kg/450 L (defined as ORGANIC PEROXIDE TYPE E);

.6 Any organic peroxide formulation which, in laboratory testing, neither detonates in the cavitated state nor deflagrates at all and shows only a low or no effect when heated under confinement as well as low or no explosive power may be considered for transport in IBCs or tanks (defined as ORGANIC PEROXIDE TYPE F); for additional provisions see 4.1.7 and 4.2.1.13;

.7 Any organic peroxide formulation which, in laboratory testing, neither detonates in the cavitated state nor deflagrates at all and shows no effect when heated under confinement nor any explosive power shall be exempted from class 5.2, provided that the formulation is thermally stable (self-accelerating decomposition temperature is 60°C or higher for a 50 kg package) and for liquid formulations diluent type A is used for desensitization (defined as ORGANIC PEROXIDE TYPE G). If the formulation is not thermally stable or a diluent other than type A is used for desensitization, the formulation shall be defined as ORGANIC PEROXIDE TYPE F.

#### 2.5.3.4 Temperature control provisions

2.5.3.4.0 The properties of some organic peroxides require that they be transported under temperature control. Control and emergency temperatures for currently assigned organic peroxides are shown in the list 2.5.3.2.4. The controlled temperature provisions are given in chapter 7.3.7.

2.5.3.4.1 The following organic peroxides shall be subjected to temperature control during transport:

- .1 organic peroxides type B and C with a SADT  $\leq 50^{\circ}\text{C}$ ;
- .2 organic peroxides type D showing a medium effect when heated under confinement\* with a SADT  $\leq 50^{\circ}\text{C}$  or showing a low or no effect when heated under confinement with a SADT  $\leq 45^{\circ}\text{C}$ ; and

\* As determined by test series E as prescribed in the Manual of Tests and Criteria, part II.

- .3 organic peroxides types E and F with a SADT  $\leq 45^{\circ}\text{C}$ .

2.5.3.4.2 Test methods for determining the SADT are given in the Manual of Tests and Criteria, part II, chapter 28. The test selected shall be conducted in a manner which is representative, both in size and material, of the package to be transported.

2.5.3.4.3 Test methods for determining the flammability are given in the Manual of Tests and Criteria, part III, chapter 32.4. Because organic peroxides may react vigorously when heated, it is recommended to determine their flashpoint using small sample sizes such as described in ISO 3679.

#### 2.5.3.5 Desensitization of organic peroxides

2.5.3.5.1 In order to ensure safety during transport, organic peroxides are in many cases desensitized by organic liquids or solids, inorganic solids or water. Where a percentage of a substance is stipulated, this refers to the percentage by mass, rounded to the nearest whole number. In general, desensitization shall be such that, in case of spillage or fire, the organic peroxide will not concentrate to a dangerous extent.

2.5.3.5.2 Unless otherwise stated for the individual organic peroxide formulation, the following definitions apply for

diluents used for desensitization:

.1 Diluents type A are organic liquids which are compatible with the organic peroxide and which have a boiling point of not less than 150°C. Type A diluents may be used for desensitizing all organic peroxides.

.2 Diluents type B are organic liquids which are compatible with the organic peroxide and which have a boiling point of less than 150°C but not less than 60°C and a flashpoint of not less than 5°C. Type B diluents may be used for desensitization of all organic peroxides provided that the boiling point is at least 60°C higher than the SADT in a 50 kg package.

2.5.3.5.3 Diluents, other than type A or type B, may be added to organic peroxide formulations as listed in 2.5.3.2.4 provided that they are compatible. However, replacement of all or part of a type A or type B diluent by another diluent with differing properties requires that the organic peroxide formulation be re-assessed in accordance with the normal acceptance procedure for class 5.2.

2.5.3.5.4 Water may only be used for the desensitization of organic peroxides which are shown in 2.5.3.2.4 or in the statement of approval according to 2.5.3.2.5 as being with water or as a stable dispersion in water.

2.5.3.5.5 Organic and inorganic solids may be used for desensitization of organic peroxides provided that they are compatible.

2.5.3.5.6 Compatible liquids and solids are those which have no detrimental influence on the thermal stability and hazard type of the organic peroxide formulation.

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## Chapter 2.6

### Class 6 – Toxic and infectious substances

#### 2.6.0 Introductory notes

Note 1: The word "toxic" has the same meaning as "poisonous".

Note 2: Genetically modified microorganisms which do not meet the definition of a toxic or an infectious substance shall be considered for classification in class 9 and assigned to UN 3245.

Note 3: Toxins from plant, animal or bacterial sources which do not contain any infectious substances, or toxins that are contained in substances which are not infectious substances, shall be considered for classification in class 6.1 and assigned to UN 3172.

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#### 2.6.1 Definitions

Class 6 is subdivided into two classes as follows:

Class 6.1 – Toxic substances

These are substances liable either to cause death or serious injury or to harm human health if swallowed or inhaled, or by skin contact.

## Class 6.2 – Infectious substances

These are substances known or reasonably expected to contain pathogens. Pathogens are defined as microorganisms (including bacteria, viruses, rickettsiae, parasites, fungi) and other agents such as prions, which can cause disease in humans or animals.

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### 2.6.2 Class 6.1 - Toxic substances

#### 2.6.2.1 Definitions and properties

2.6.2.1.1 LD<sub>50</sub> (median lethal dose) for acute oral toxicity is the statistically derived single dose of a substance that can be expected to cause death within 14 days in 50 per cent of young adult albino rats when administered by the oral route. The LD<sub>50</sub> value is expressed in terms of mass of test substance per mass of test animal (mg/kg).

2.6.2.1.2 LD<sub>50</sub> for acute dermal toxicity is that dose of the substance which, administered by continuous contact for 24 hours with the bare skin of the albino rabbit, is most likely to cause death within 14 days in one half of the animals tested. The number of animals tested shall be sufficient to give a statistically significant result and be in conformity with good pharmacological practices. The result is expressed in milligrams per kilogram body mass.

2.6.2.1.3 LC<sub>50</sub> for acute toxicity on inhalation is that concentration of vapour, mist or dust which, administered by continuous inhalation to both male and female young adult albino rats for one hour, is most likely to cause death within 14 days in one half of the animals tested. A solid substance shall be tested if at least 10% (by mass) of its total mass is likely to be dust in the respirable range, such as the aerodynamic diameter of that particle fraction is 10 microns or less. A liquid substance shall be tested if a mist is likely to be generated in a leakage of the transport containment. For both solid and liquid substances, more than 90% (by mass) of a specimen prepared for inhalation toxicity testing shall be in the respirable range as defined above. The result is expressed in milligrams per litre of air for dusts and mists or in millilitres per cubic metre of air (parts per million) for vapours.

#### 2.6.2.1.4 Properties

.1 The dangers of poisoning which are inherent in these substances depend upon contact with the human body, that is by inhalation of vapours by unsuspecting persons at some distance from the cargo or the immediate dangers of physical contact with the substance. These have been considered in the context of the probability of accident occurring during transport by sea.

.2 Nearly all toxic substances evolve toxic gases when involved in a fire or when heated to decomposition.

.3 A substance specified as "stabilized" shall not be transported in an unstabilized condition.

#### 2.6.2.2 Assignment of packing groups to toxic substances

2.6.2.2.1 Toxic substances have for packing purposes been apportioned among packing groups according to the degree of their toxic hazards in transport:

.1 Packing group I: substances and preparations presenting a high toxicity hazard;

.2 Packing group II: substances and preparations presenting a medium toxicity hazard;

.3 Packing group III: substances and preparations presenting a low toxicity hazard.

2.6.2.2.2 In making this grouping, account has been taken of human experience in instances of accidental poisoning, and of special properties possessed by any individual substance, such as liquid state, high volatility, any special likelihood of penetration, and special biological effects.

2.6.2.2.3 In the absence of human experience, the grouping has been based on data obtained from animal experiments. Three possible routes of administration have been examined. These routes are exposure through:

- oral ingestion;
- dermal contact; and
- inhalation of dusts, mists or vapours

2.6.2.2.3.1 For appropriate animal test data for the various routes of exposure, see 2.6.2.1. When a substance exhibits a different order of toxicity by two or more routes of administration, the highest degree of danger indicated by the tests has been used in assigning the packing group.

2.6.2.2.4 The criteria to be applied for grouping a substance according to the toxicity it exhibits by all three routes of administration are presented in the following paragraphs.

2.6.2.2.4.1 The grouping criteria for the oral and dermal routes as well as for inhalation of dusts and mists are shown in the following table:

Grouping criteria for administration through oral ingestion,  
dermal contact and inhalation of dusts and mists

Packing group	Oral toxicity LD <sub>50</sub> (mg/kg)	Dermal toxicity LD <sub>50</sub> (mg/kg)	Inhalation toxicity by dusts and mists LC <sub>50</sub> (mg/l)
I	≤ 5.0	≤ 50	≤ 0.2
II	> 5.0 and ≤ 50	> 50 and ≤ 200	> 0.2 and ≤ 2.0
III*	> 50 and ≤ 300	> 200 and ≤ 1000	> 2.0 and ≤ 4.0

\* Tear gas substances shall be included in packing group II even if their toxicity data correspond to packing group III values.

Note: Substances meeting the criteria of class 8 and with an inhalation toxicity of dusts and mists (LC<sub>50</sub>) leading to packing group I are only accepted for an allocation to class 6.1 if the toxicity through oral ingestion or dermal contact is at least in the range of packing group I or II. Otherwise an allocation to class 8 is made when appropriate (see 2.8.2.4).

2.6.2.2.4.2 The criteria for inhalation toxicity of dusts and mists in 2.6.2.2.4.1 are based on LC<sub>50</sub> data relating to one hour exposures, and where such information is available it shall be used. However, where only LC<sub>50</sub> data relating to 4-hour exposures to dusts and mists are available, such figures can be multiplied by four and the product substituted in the above criteria, i.e. LC<sub>50</sub> (4 hours) × 4 is considered the equivalent of LC<sub>50</sub> (1 hour).

2.6.2.2.4.3 Liquids having toxic vapours shall be assigned to the following packing groups, where "V" is the saturated vapour concentration in mL/m<sup>3</sup> air at 20°C and standard atmospheric pressure:

- Packing group I: if  $V \geq 10 \text{ LC}_{50}$  and  $\text{LC}_{50} \leq 1000 \text{ mL/m}^3$ .
- Packing group II: if  $V \geq \text{LC}_{50}$  and  $\text{LC}_{50} \leq 3000 \text{ mL/m}^3$ , and do not meet the criteria for packing group I.
- Packing group III: if  $V \geq \frac{1}{5} \text{ LC}_{50}$  and  $\text{LC}_{50} \leq 5000 \text{ mL/m}^3$ , and do not meet the criteria for packing groups I or II.

Note: Tear gas substances shall be included in packing group II even if their toxicity data correspond to packing group III values.

2.6.2.2.4.4 In figure 2-3 the criteria according to 2.6.2.2.4.3 are expressed in graphical form, as an aid to easy classification. Because of approximations inherent in the use of graphs, substances falling on or near packing group borderlines shall be checked using numerical criteria.

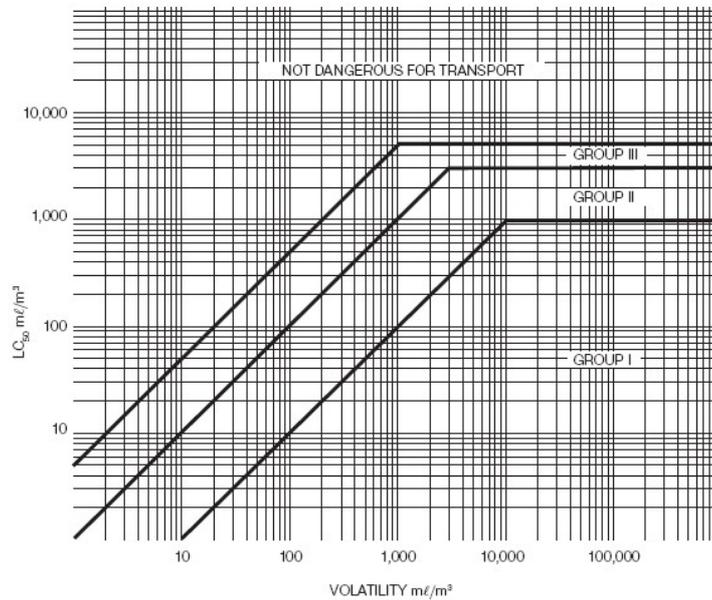


Figure 2-3 – Inhalation toxicity: packing group borderlines

2.6.2.2.4.5 The criteria for inhalation toxicity of vapours in 2.6.2.2.4.3 are based on LC<sub>50</sub> data relating to one hour exposures, and where such information is available it shall be used. However, where only LC<sub>50</sub> data relating to 4-hour exposures to the vapours are available, such figures can be multiplied by two and the product substituted in the above criteria, i.e. LC<sub>50</sub> (4 hours) × 2 is considered the equivalent of LC<sub>50</sub> (1 hour).

2.6.2.2.4.6 Mixtures of liquids that are toxic by inhalation shall be assigned to packing groups according to 2.6.2.2.4.7 or 2.6.2.2.4.8.

2.6.2.2.4.7 If LC<sub>50</sub> data are available for each of the toxic substances comprising a mixture, the packing group may be determined as follows:

.1 Estimate the LC<sub>50</sub> of the mixture using the formula:

$$LC_{50}(\text{mixture}) = \frac{1}{\sum_{i=1}^n \left( \frac{f_i}{LC_{50i}} \right)}$$

where:

$f_i$  = mole fraction of the  $i^{\text{th}}$  component substance of the mixture

$LC_{50i}$  = mean lethal concentration of the  $i^{\text{th}}$  component substance in  $\text{mℓ}/\text{m}^3$ .

.2 Estimate the volatility of each component substance comprising the mixture using the formula:

$$V_i = \left( \frac{P_i \times 10^6}{101.3} \right) \text{mℓ}/\text{m}^3$$

where:  $P_i$  = the partial pressure of the  $i^{\text{th}}$  component substance in kPa at 20°C and one atmosphere pressure.

.3 Calculate the ratio of the volatility to the LC<sub>50</sub> using the formula:

$$R = \sum_{i=1}^n \left( \frac{V_i}{LC_{50i}} \right)$$

.4 Using the calculated values of LC<sub>50</sub> (mixture) and R, the packing group for the mixture is determined:



2.6.2.2.4.8 In the absence of LC<sub>50</sub> data on the toxic constituent substances, the mixture may be assigned a packing group based on the following simplified threshold toxicity tests. When these threshold tests are used, the most restrictive packing group shall be determined and used for transporting the mixture.

.1 A mixture is assigned to packing group I only if it meets both of the following criteria:

- A sample of the liquid mixture is vaporized and diluted with air to create a test atmosphere of 1,000 mL/m<sup>3</sup> vaporized mixture in air. Ten albino rats (five male and five female) are exposed to the test atmosphere for one hour and observed for 14 days. If five or more of the animals die within the 14-day observation period, the mixture is presumed to have an LC<sub>50</sub> equal to or less than 1,000 mL/m<sup>3</sup>.
- A sample of the vapour in equilibrium with the liquid mixture at 20°C is diluted with 9 equal volumes of air to form a test atmosphere. Ten albino rats (five male and five female) are exposed to the test atmosphere for one hour and observed for 14 days. If five or more of the animals die within the 14-day observation period, the mixture is presumed to have a volatility equal to or greater than 10 times the mixture LC<sub>50</sub>.

.2 A mixture is assigned to packing group II only if it meets both of the following criteria, and the mixture does not meet the criteria for packing group I:

- A sample of the liquid mixture is vaporized and diluted with air to create a test atmosphere of 3,000 mL/m<sup>3</sup> vaporized mixture in air. Ten albino rats (five male and five female) are exposed to the test atmosphere for one hour and observed for 14 days. If five or more of the animals die within the 14-day observation period, the mixture is presumed to have an LC<sub>50</sub> equal to or less than 3,000 mL/m<sup>3</sup>.
- A sample of the vapour in equilibrium with the liquid mixture at 20°C is used to form a test atmosphere. Ten albino rats (five male and five female) are exposed to the test atmosphere for one hour and observed for 14 days. If five or more of the animals die within the 14-day observation period, the mixture is presumed to have a volatility equal to or greater than the mixture LC<sub>50</sub>.

.3 A mixture is assigned to packing group III only if it meets both of the following criteria, and the mixture does not meet the criteria for packing groups I or II:

- A sample of the liquid mixture is vaporized and diluted with air to create a test atmosphere of 5,000 mL/m<sup>3</sup> vaporized mixture in air. Ten albino rats (five male and five female) are exposed to the test atmosphere for one hour and observed for 14 days. If five or more of the animals die within the 14-day observation period, the mixture is presumed to have an LC<sub>50</sub> equal to or less than 5,000 mL/m<sup>3</sup>.



## 2.6.2.3 Methods for determining oral and dermal toxicity of mixtures

2.6.2.3.1 When classifying and assigning the appropriate packing group to mixtures in class 6.1, in accordance with the oral and dermal toxicity criteria in 2.6.2.2, it is necessary to determine the acute LD<sub>50</sub> of the mixture.

2.6.2.3.2 If a mixture contains only one active substance, and the LD<sub>50</sub> of that constituent is known, in the absence of reliable acute oral and dermal toxicity data on the actual mixture to be transported, the oral or dermal LD<sub>50</sub> may be obtained by the following method:

$$\text{LD}_{50} \text{ value of preparation} = \frac{\text{LD}_{50} \text{ value of active substance} \times 100}{\text{percentage of active substance by mass}}$$

2.6.2.3.3 If a mixture contains more than one active constituent, there are three possible approaches that may be used to determine the oral or dermal LD<sub>50</sub> of the mixture. The preferred method is to obtain reliable acute oral and dermal

toxicity data on the actual mixture to be transported. If reliable, accurate data are not available, then either of the following methods may be performed:

- .1 Classify the formulation according to the most hazardous constituent of the mixture as if that constituent were present in the same concentration as the total concentration of all active constituents; or
- .2 Apply the formula:

$$\frac{C_A}{T_A} + \frac{C_B}{T_B} + \dots + \frac{C_Z}{T_Z} = \frac{100}{T_M}$$

where: C = the % concentration of constituent A, B . . . Z in the mixture;  
T = the oral LD<sub>50</sub> value of constituent A, B . . . Z;  
T<sub>M</sub> = the oral LD<sub>50</sub> value of the mixture.

Note: This formula can also be used for dermal toxicities provided that this information is available on the same species for all constituents. The use of this formula does not take into account any potentiation or protective phenomena.

#### 2.6.2.4 Classification of pesticides

2.6.2.4.1 All active pesticide substances and their preparations for which the LC<sub>50</sub> and/or LD<sub>50</sub> values are known and which are classified in class 6.1 shall be classified under appropriate packing groups in accordance with the criteria given in 2.6.2.2. Substances and preparations which are characterized by subsidiary hazards shall be classified according to the precedence of hazard table in 2.0.3 with the assignment of appropriate packing groups.

2.6.2.4.2 If the oral or dermal LD<sub>50</sub> value for a pesticide preparation is not known, but the LD<sub>50</sub> value of its active substance(s) is known, the LD<sub>50</sub> value for the preparation may be obtained by applying the procedures in 2.6.2.3.

Note: LD<sub>50</sub> toxicity data for a number of common pesticides may be obtained from the most current edition of "The WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification", available from the International Programme on Chemical Safety, World Health Organization (WHO), 1211 Geneva 27, Switzerland. While that publication may be used as a source of LD<sub>50</sub> data for pesticides, its classification system shall not be used for purposes of transport classification of, or assignment of packing groups to, pesticides, which shall be in accordance with the provisions of this Code.

2.6.2.4.3 The proper shipping name used in the transport of the pesticide shall be selected from those referenced on the basis of the active ingredient, of the physical state of the pesticide and any subsidiary hazards which it may exhibit.

#### 2.6.2.5 Substances not accepted for transport

Chemically unstable substances of class 6.1 shall not be accepted for transport unless the necessary precautions have been taken to prevent the possibility of a dangerous decomposition or polymerization under normal conditions of transport. For the precautions necessary to prevent polymerization, see special provision 386 of chapter 3.3. To this end particular care shall be taken to ensure that receptacles and tanks do not contain any substances liable to promote these reactions.

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### 2.6.3 Class 6.2 – Infectious substances

#### 2.6.3.1 Definitions

For the purposes of this Code:

2.6.3.1.1 Infectious substances are substances which are known or are reasonably expected to contain pathogens. Pathogens are defined as micro-organisms (including bacteria, viruses, rickettsiae, parasites, fungi) and other agents such

as prions, which can cause disease in humans or animals.

2.6.3.1.2 Biological products are those products derived from living organisms which are manufactured and distributed in accordance with the requirements of appropriate national authorities, which may have special licensing requirements, and are used either for prevention, treatment, or diagnosis of disease in humans or animals, or for development, experimental or investigation purposes related thereto. They include, but are not limited to, finished or unfinished products such as vaccines.

2.6.3.1.3 Cultures are the result of a process by which pathogens are intentionally propagated. This definition does not include human or animal patient specimens as defined in 2.6.3.1.4.

2.6.3.1.4 Patient specimens are those collected directly from humans or animals, including, but not limited to, excreta, secretions, blood and its components, tissue and tissue fluid swabs, and body parts being transported for purposes such as research, diagnosis, investigational activities, disease treatment and prevention.

2.6.3.1.5 [Reserved]

2.6.3.1.6 Medical or clinical wastes are wastes derived from the medical treatment of animals or humans or from bio-research.

## 2.6.3.2 Classification of infectious substances

2.6.3.2.1 Infectious substances shall be classified in class 6.2 and assigned to UN 2814, UN 2900, UN 3291 or UN 3373, as appropriate.

2.6.3.2.2 Infectious substances are divided into the following categories:

2.6.3.2.2.1 Category A: An infectious substance which is transported in a form that, when exposure to it occurs, is capable of causing permanent disability, life-threatening or fatal disease in otherwise healthy humans or animals. Indicative examples of substances that meet these criteria are given in the table in this paragraph.

Note: An exposure occurs when an infectious substance is released outside the protective packaging, resulting in physical contact with humans or animals.

.1 Infectious substances meeting these criteria which cause disease in humans or in both humans and animals shall be assigned to UN 2814. Infectious substances which cause disease only in animals shall be assigned to UN 2900.

.2 Assignment to UN 2814 or UN 2900 shall be based on the known medical history and symptoms of the source, human or animal, endemic local conditions, or professional judgement concerning individual circumstances of the human or animal source.

Note 1: The proper shipping name for UN 2814 is INFECTIOUS SUBSTANCE, AFFECTING HUMANS. The proper shipping name for UN 2900 is INFECTIOUS SUBSTANCE, AFFECTING ANIMALS only.

Note 2: The following table is not exhaustive. Infectious substances, including new or emerging pathogens, which do not appear in the table but which meet the same criteria shall be assigned to category A. In addition, if there is doubt as to whether or not a substance meets the criteria it shall be included in category A.

Note 3: In the following table, the microorganism names written in italics are bacteria, mycoplasmas, rickettsiae or fungi.

Indicative examples of infectious substances included in category A in any form unless otherwise indicated (2.6.3.2.2.1.1)

UN number and proper shipping name	Micro-organism
UN 2814	<i>Bacillus anthracis</i> (cultures only)
Infectious substance,	<i>Brucella abortus</i> (cultures only)
	<i>Brucella melitensis</i> (cultures only)

affecting humans	<i>Brucella suis</i> (cultures only) <i>Burkholderia mallei</i> – <i>Pseudomonas mallei</i> – Glanders (cultures only) <i>Burkholderia pseudomallei</i> – <i>Pseudomonas pseudomallei</i> (cultures only) <i>Chlamydia psittaci</i> – avian strains (cultures only) <i>Clostridium botulinum</i> (cultures only) <i>Coccidioides immitis</i> (cultures only) <i>Coxiella burnetii</i> (cultures only) Crimean-Congo hemorrhagic fever virus Dengue virus (cultures only) Eastern equine encephalitis virus (cultures only) <i>Escherichia coli</i> , verotoxigenic (cultures only) Ebola virus Flexal virus <i>Francisella tularensis</i> (cultures only) Guanarito virus Hantaan virus
UN 2814 Infectious substance, affecting humans (cont.)	Hantavirus causing hemorrhagic fever with renal syndrome Hendra virus Hepatitis B virus (cultures only) Herpes B virus (cultures only) Human immunodeficiency virus (cultures only) Highly pathogenic avian influenza virus (cultures only) Japanese Encephalitis virus (cultures only) Junin virus Kysanur Forest disease virus Lassa virus Machupo virus Marburg virus Monkeypox virus <i>Mycobacterium tuberculosis</i> (cultures only) Nipah virus Omsk hemorrhagic fever virus Poliovirus (cultures only) Rabies virus (cultures only) <i>Rickettsia prowazekii</i> (cultures only) <i>Rickettsia rickettsii</i> (cultures only) Rift Valley fever virus (cultures only) Russian spring–summer encephalitis virus (cultures only) Sabia virus <i>Shigella dysenteriae</i> type 1 (cultures only) Tick-borne encephalitis virus (cultures only) Variola virus Venezuelan equine encephalitis virus (cultures only) West Nile virus (cultures only) Yellow fever virus (cultures only) <i>Yersinia pestis</i> (cultures only)
UN 2900 Infectious substance, affecting animals only	African swine fever virus (cultures only) Avian paramyxovirus Type 1 – Velogenic Newcastle disease virus (cultures only) Classical swine fever virus (cultures only) Foot and mouth disease virus (cultures only) Lumpy skin disease virus (cultures only) <i>Mycoplasma mycoides</i> – Contagious bovine pleuropneumonia (cultures only) Peste des petits ruminants virus (cultures only) Rinderpest virus (cultures only) Sheep-pox virus (cultures only) Goatpox virus (cultures only) Swine vesicular disease virus (cultures only) Vesicular stomatitis virus (cultures only)

2.6.3.2.2 Category B: An infectious substance which does not meet the criteria for inclusion in category A. Infectious substances in category B shall be assigned to UN 3373.

Note: The proper shipping name for UN 3373 is BIOLOGICAL SUBSTANCE, CATEGORY B.

### 2.6.3.2.3 Exemptions

2.6.3.2.3.1 Substances which do not contain infectious substances or substances which are unlikely to cause disease in humans or animals are not subject to the provisions of this Code, unless they meet the criteria for inclusion in another class.

2.6.3.2.3.2 Substances containing microorganisms which are non-pathogenic to humans or animals are not subject to the provisions of this Code unless they meet the criteria for inclusion in another class.

2.6.3.2.3.3 Substances in a form that any present pathogens have been neutralized or inactivated such that they no longer pose a health risk are not subject to the provisions of this Code unless they meet the criteria for inclusion in another class.

Note: Medical equipment which has been drained of free liquid is deemed to meet the requirements of this paragraph and is not subject to the provisions of this Code.

2.6.3.2.3.4 Environmental samples (including food and water samples) which are not considered to pose a significant risk of infection are not subject to the provisions of this Code unless they meet the criteria for inclusion in another class.

2.6.3.2.3.5 Dried blood spots, collected by applying a drop of blood onto absorbent material, are not subject to the provisions of this Code.

2.6.3.2.3.6 Faecal occult blood screening samples are not subject to the provisions of this Code.

2.6.3.2.3.7 Blood or blood components which have been collected for the purposes of transfusion or for the preparation of blood products to be used for transfusion or transplantation and any tissues or organs intended for use in transplantation as well as samples drawn in connection with such purposes are not subject to the provisions of this Code.

2.6.3.2.3.8 Human or animal specimens for which there is minimal likelihood that pathogens are present are not subject to the provisions of this Code if the specimen is transported in a packaging which will prevent any leakage and which is marked with the words "EXEMPT HUMAN SPECIMEN" or "EXEMPT ANIMAL SPECIMEN", as appropriate. The packaging should meet the following conditions:

.1 The packaging should consist of three components:

.1 a leak-proof primary receptacle(s);

.2 a leak-proof secondary packaging; and

.3 an outer packaging of adequate strength for its capacity, mass and intended use, and with at least one surface having minimum dimensions of 100 mm × 100 mm.

.2 For liquids, absorbent material in sufficient quantity to absorb the entire contents should be placed between the primary receptacle(s) and the secondary packaging so that, during transport, any release or leak of a liquid substance will not reach the outer packaging and will not compromise the integrity of the cushioning material.

.3 When multiple fragile primary receptacles are placed in a single secondary packaging, they should be either individually wrapped or separated to prevent contact between them.

Note: An element of professional judgement is required to determine if a substance is exempt under this paragraph. That judgement should be based on the known medical history, symptoms and individual circumstances of the source, human or animal, and endemic local conditions. Examples of specimens which may be transported under this paragraph include the blood or urine tests to monitor cholesterol levels, blood glucose levels, hormone levels, or prostate specific antibodies (PSA); those required to monitor organ function such as heart, liver or kidney function for humans or animals with non-infectious diseases, or therapeutic drug monitoring; those conducted for insurance or employment purposes and are intended to determine the presence of drugs or alcohol; pregnancy test; biopsies to detect cancer; and antibody detection in humans or animals in the absence of any concern for infection (e.g. evaluation of vaccine-induced immunity, diagnosis of autoimmune disease, etc.).

2.6.3.2.3.9 Except for:

.1 medical waste (UN 3291);

.2 medical devices or equipment contaminated with or containing infectious substances in category A (UN 2814 or UN 2900); and

.3 medical devices or equipment contaminated with or containing other dangerous goods that meet the definition of another hazard class,

medical devices or equipment potentially contaminated with or containing infectious substances which are being transported for disinfection, cleaning, sterilization, repair, or equipment evaluation are not subject to the provisions of this Code if packed in packagings designed and constructed in such a way that, under normal conditions of transport, they cannot break, be punctured or leak their contents. Packagings shall be designed to meet the construction requirements listed in 6.1.4 or 6.6.4.

These packagings shall meet the general packing requirements of 4.1.1.1 and 4.1.1.2 and be capable of retaining the medical devices and equipment when dropped from a height of 1.2 m.

The packagings shall be marked "USED MEDICAL DEVICE" or "USED MEDICAL EQUIPMENT". When using overpacks or unit loads these shall be marked in the same way, except when the inscription remains visible.

### 2.6.3.3 Biological products

2.6.3.3.1 For the purposes of this Code, biological products are divided into the following groups:

.1 those which are manufactured and packaged in accordance with the requirements of appropriate national authorities and transported for the purposes of final packaging or distribution, and use for personal health care by medical professionals or individuals. Substances in this group are not subject to the provisions of this Code;

.2 those which do not fall under .1 and are known or reasonably believed to contain infectious substances and which meet the criteria for inclusion in category A or category B. Substances in this group shall be assigned to UN 2814, UN 2900 or UN 3373, as appropriate.

Note: Some licensed biological products may present a biohazard only in certain parts of the world. Competent authorities may require that such biological products comply with local requirements for infectious substances or may impose other restrictions.

### 2.6.3.4 Genetically modified microorganisms and organisms

2.6.3.4.1 Genetically modified microorganisms not meeting the definition of infectious substance shall be classified in accordance with chapter 2.9.

### 2.6.3.5 Medical or clinical wastes

2.6.3.5.1 Medical or clinical wastes containing category A infectious substances shall be assigned to UN 2814 or UN 2900, as appropriate. Medical or clinical wastes containing infectious substances in category B shall be assigned to UN 3291.

2.6.3.5.2 Medical or clinical wastes which are reasonably believed to have a low probability of containing infectious substances shall be assigned to UN 3291. For the assignment, international, regional or national waste catalogues may be taken into account.

Note: The proper shipping name for UN 3291 is CLINICAL WASTE, UNSPECIFIED, N.O.S. or (BIO) MEDICAL WASTE, N.O.S. or REGULATED MEDICAL WASTE, N.O.S.

2.6.3.5.3 Decontaminated medical or clinical wastes which previously contained infectious substances are not subject to the provisions of this Code unless they meet the criteria for inclusion in another class.

### 2.6.3.6 Infected animals

2.6.3.6.1 Unless an infectious substance cannot be consigned by any other means, live animals shall not be used to consign such a substance. A live animal which has been intentionally infected and is known or suspected to contain an infectious substance shall only be transported under terms and conditions approved by the competent authority.

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## Chapter 2.7

### Class 7 – Radioactive material

Note: For class 7, the type of packaging may have a decisive effect on classification.

#### 2.7.1 Definitions

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 2.7.2.2.1 to 2.7.2.2.6.

##### 2.7.1.2 Contamination

Contamination means the presence of a radioactive substance on a surface in quantities in excess of 0.4 Bq/cm<sup>2</sup> for beta and gamma emitters and low-toxicity alpha emitters, or 0.04 Bq/cm<sup>2</sup> for all other alpha emitters.

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

Fixed contamination means contamination other than non-fixed contamination.

##### 2.7.1.3 Definitions of specific terms

###### A<sub>1</sub> and A<sub>2</sub>

A<sub>1</sub> means the activity value of special form radioactive material which is listed in the table in 2.7.2.2.1 or derived in 2.7.2.2.2 and is used to determine the activity limits for the provisions of this Code.

A<sub>2</sub> means the activity value of radioactive material, other than special form radioactive material, which is listed in the table in 2.7.2.2.1 or derived in 2.7.2.2.2 and is used to determine the activity limits for the provisions of this Code.

Fissile nuclides means uranium-233, uranium-235, plutonium-239 and plutonium-241. Fissile material means a material containing any of the fissile nuclides. Excluded from the definition of fissile material are the following:

- .1 natural uranium or depleted uranium which is unirradiated;
- .2 natural uranium or depleted uranium which has been irradiated in thermal reactors only;
- .3 material with fissile nuclides less than a total of 0.25 g;
- .4 any combination of .1, .2 and/or .3.

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

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.

Low specific activity (LSA) material means radioactive material which by its nature has a limited specific activity, or

radioactive material for which limits of estimated average specific activity apply. External shielding materials surrounding the LSA material shall not be considered in determining the estimated average specific activity.

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.

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

Special form radioactive material means either:

- .1 an indispersible solid radioactive material; or
- .2 a sealed capsule containing radioactive material.

Surface contaminated object (SCO) means a solid object which is not itself radioactive but which has radioactive material distributed on its surface.

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  $2 \times 10^{-3}$  Bq of plutonium per gram of uranium 235, not more than  $9 \times 10^{-6}$  Bq of fission products per gram of uranium 235 and not more than  $5 \times 10^{-3}$  g of uranium-236 per gram of uranium-235.

Uranium – natural, depleted, enriched means the following:

Natural uranium means uranium (which may be chemically separated) containing the naturally occurring distribution of uranium isotopes (approximately 99.28% uranium 238, and 0.72% uranium 235 by mass).

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.

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## 2.7.2 Classification

### 2.7.2.1 General provisions

2.7.2.1.1 Radioactive material shall be assigned to one of the UN numbers specified in table 2.7.2.1.1, in accordance with 2.7.2.4 and 2.7.2.5, taking into account the material characteristics determined in 2.7.2.3.

Table 2.7.2.1.1 - Assignment of UN Numbers

UN numbers	Proper shipping name <sup>a</sup> and description
<b>Excepted packages</b> (1.5.1.5)	
2908	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – EMPTY PACKAGING
2909	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – ARTICLES MANUFACTURED FROM NATURAL URANIUM or DEPLETED URANIUM or NATURAL THORIUM
2910	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – LIMITED QUANTITY OF MATERIAL
2911	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – INSTRUMENTS or ARTICLES
3507	URANIUM HEXAFLUORIDE, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE less than 0.1 kg per package, non-fissile or fissile-excepted <sup>b, c</sup>
<b>Low specific activity radioactive material</b> (2.7.2.3.1)	

2912	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-I), non-fissile or fissile-excepted <sup>b</sup>
3321	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), non-fissile or fissile-excepted <sup>b</sup>
3322	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-III), non-fissile or fissile-excepted <sup>b</sup>
3324	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-II), FISSILE
3325	RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-III), FISSILE
<b>Surface contaminated objects</b> (2.7.2.3.2)	
2913	RADIOACTIVE MATERIAL, SURFACE CONTAMINATED OBJECTS (SCO-I or SCO-II), non-fissile or fissile-excepted <sup>b</sup>
3326	RADIOACTIVE MATERIAL, SURFACE CONTAMINATED OBJECTS (SCO-I or SCO-II), FISSILE
<b>Type A packages</b> (2.7.2.4.4)	
2915	RADIOACTIVE MATERIAL, TYPE A PACKAGE, non-special form, non-fissile or fissile-excepted <sup>b</sup>
3327	RADIOACTIVE MATERIAL, TYPE A PACKAGE, FISSILE, non-special form
3332	RADIOACTIVE MATERIAL, TYPE A PACKAGE, SPECIAL FORM, non-fissile or fissile-excepted <sup>b</sup>
3333	RADIOACTIVE MATERIAL, TYPE A PACKAGE, SPECIAL FORM, FISSILE
<b>Type B(U) package</b> (2.7.2.4.6)	
2916	RADIOACTIVE MATERIAL, TYPE B(U) PACKAGE, non-fissile or fissile-excepted <sup>b</sup>
3328	RADIOACTIVE MATERIAL, TYPE B(U) PACKAGE, FISSILE
<b>Type B(M) package</b> (2.7.2.4.6)	
2917	RADIOACTIVE MATERIAL, TYPE B(M) PACKAGE, non-fissile or fissile-excepted <sup>b</sup>
3329	RADIOACTIVE MATERIAL, TYPE B(M) PACKAGE, FISSILE
<b>Type C package</b> (2.7.2.4.6)	
3323	RADIOACTIVE MATERIAL, TYPE C PACKAGE, non-fissile or fissile-excepted <sup>b</sup>
3330	RADIOACTIVE MATERIAL, TYPE C PACKAGE, FISSILE
<b>Special arrangement</b> (2.7.2.5)	
2919	RADIOACTIVE MATERIAL, TRANSPORTED UNDER SPECIAL ARRANGEMENT, non-fissile or fissile-excepted <sup>b</sup>
3331	RADIOACTIVE MATERIAL, TRANSPORTED UNDER SPECIAL ARRANGEMENT, FISSILE
<b>Uranium hexafluoride</b> (2.7.2.4.5)	
2977	RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, FISSILE
2978	RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, non-fissile or fissile-excepted <sup>b</sup>
3507	URANIUM HEXAFLUORIDE, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE less than 0.1 kg per package, non-fissile or fissile-excepted <sup>b, c</sup>

<sup>a</sup> The proper shipping name is found in the column "Proper shipping name and description" and is restricted to that part shown in capital letters. In the cases of UN Nos. 2909, 2911, 2913 and 3326, where alternative proper shipping names are separated by the word "or", only the relevant proper shipping name shall be used.

<sup>b</sup> The term "fissile-excepted" refers only to material excepted under 2.7.2.3.5.

<sup>c</sup> For UN 3507, see also special provision 369 in chapter 3.3.

## 2.7.2.2 Determination of activity level

2.7.2.2.1 The following basic values for individual radionuclides are given in table 2.7.2.2.1:

- .1  $A_1$  and  $A_2$  in TBq;
- .2 Activity concentration limits for exempt material in Bq/g; and
- .3 Activity limits for exempt consignments in Bq.

Table 2.7.2.2.1 – Basic radionuclides values for individual radionuclides

Radionuclide (atomic number)	A <sub>1</sub> (TBq)	A <sub>2</sub> (TBq)	Activity concentration limit for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
Actinium (89)				
Ac-225 (a)	8 x 10 <sup>-1</sup>	6 x 10 <sup>-3</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>4</sup>
Ac-227 (a)	9 x 10 <sup>-1</sup>	9 x 10 <sup>-5</sup>	1 x 10 <sup>-1</sup>	1 x 10 <sup>3</sup>
Ac-228	6 x 10 <sup>-1</sup>	5 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>
Silver (47)				
Ag-105	2 x 10 <sup>0</sup>	2 x 10 <sup>0</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>6</sup>
Ag-108m (a)	7 x 10 <sup>-1</sup>	7 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup> (b)	1 x 10 <sup>6</sup> (b)
Ag-110m (a)	4 x 10 <sup>-1</sup>	4 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>
Ag-111	2 x 10 <sup>0</sup>	6 x 10 <sup>-1</sup>	1 x 10 <sup>3</sup>	1 x 10 <sup>6</sup>
Aluminium (13)				
Al-26	1 x 10 <sup>-1</sup>	1 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>5</sup>
Americium (95)				
Am-241	1 x 10 <sup>1</sup>	1 x 10 <sup>-3</sup>	1 x 10 <sup>0</sup>	1 x 10 <sup>4</sup>
Am-242m (a)	1 x 10 <sup>1</sup>	1 x 10 <sup>-3</sup>	1 x 10 <sup>0</sup> (b)	1 x 10 <sup>4</sup> (b)
Am-243 (a)	5 x 10 <sup>0</sup>	1 x 10 <sup>-3</sup>	1 x 10 <sup>0</sup> (b)	1 x 10 <sup>3</sup> (b)
Argon (18)				
Ar-37	4 x 10 <sup>1</sup>	4 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>	1 x 10 <sup>8</sup>
Ar-39	4 x 10 <sup>1</sup>	2 x 10 <sup>1</sup>	1 x 10 <sup>7</sup>	1 x 10 <sup>4</sup>
Ar-41	3 x 10 <sup>-1</sup>	3 x 10 <sup>-1</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>9</sup>
Arsenic (33)				
As-72	3 x 10 <sup>-1</sup>	3 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>5</sup>
As-73	4 x 10 <sup>1</sup>	4 x 10 <sup>1</sup>	1 x 10 <sup>3</sup>	1 x 10 <sup>7</sup>
As-74	1 x 10 <sup>0</sup>	9 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>
As-76	3 x 10 <sup>-1</sup>	3 x 10 <sup>-1</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>5</sup>
As-77	2 x 10 <sup>1</sup>	7 x 10 <sup>-1</sup>	1 x 10 <sup>3</sup>	1 x 10 <sup>6</sup>
Astatine (85)				
At-211 (a)	2 x 10 <sup>1</sup>	5 x 10 <sup>-1</sup>	1 x 10 <sup>3</sup>	1 x 10 <sup>7</sup>
Gold (79)				
Au-193	7 x 10 <sup>0</sup>	2 x 10 <sup>0</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>7</sup>
Au-194	1 x 10 <sup>0</sup>	1 x 10 <sup>0</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>
Au-195	1 x 10 <sup>1</sup>	6 x 10 <sup>0</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>7</sup>
Au-198	1 x 10 <sup>0</sup>	6 x 10 <sup>-1</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>6</sup>
Au-199	1 x 10 <sup>1</sup>	6 x 10 <sup>-1</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>6</sup>
Barium (56)				
Ba-131 (a)	2 x 10 <sup>0</sup>	2 x 10 <sup>0</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>6</sup>
Ba-133	3 x 10 <sup>0</sup>	3 x 10 <sup>0</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>6</sup>
Ba-133m	2 x 10 <sup>1</sup>	6 x 10 <sup>-1</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>6</sup>
Ba-140 (a)	5 x 10 <sup>-1</sup>	3 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup> (b)	1 x 10 <sup>5</sup> (b)
Beryllium (4)				
Be-7	2 x 10 <sup>1</sup>	2 x 10 <sup>1</sup>	1 x 10 <sup>3</sup>	1 x 10 <sup>7</sup>

Be-10	$4 \times 10^1$	$6 \times 10^{-1}$	$1 \times 10^4$	$1 \times 10^6$
Bismuth (83)				
Bi-205	$7 \times 10^{-1}$	$7 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Bi-206	$3 \times 10^{-1}$	$3 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^5$
Bi-207	$7 \times 10^{-1}$	$7 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Bi-210	$1 \times 10^0$	$6 \times 10^{-1}$	$1 \times 10^3$	$1 \times 10^6$
Bi-210m (a)	$6 \times 10^{-1}$	$2 \times 10^{-2}$	$1 \times 10^1$	$1 \times 10^5$
Bi-212 (a)	$7 \times 10^{-1}$	$6 \times 10^{-1}$	$1 \times 10^1$ (b)	$1 \times 10^5$ (b)
Berkelium (97)				
Bk-247	$8 \times 10^0$	$8 \times 10^{-4}$	$1 \times 10^0$	$1 \times 10^4$
Bk-249 (a)	$4 \times 10^1$	$3 \times 10^{-1}$	$1 \times 10^3$	$1 \times 10^6$
Bromine (35)				
Br-76	$4 \times 10^{-1}$	$4 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^5$
Br-77	$3 \times 10^0$	$3 \times 10^0$	$1 \times 10^2$	$1 \times 10^6$
Br-82	$4 \times 10^{-1}$	$4 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Carbon (6)				
C-11	$1 \times 10^0$	$6 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
C-14	$4 \times 10^1$	$3 \times 10^0$	$1 \times 10^4$	$1 \times 10^7$
Calcium (20)				
Ca-41	Unlimited	Unlimited	$1 \times 10^5$	$1 \times 10^7$
Ca-45	$4 \times 10^1$	$1 \times 10^0$	$1 \times 10^4$	$1 \times 10^7$
Ca-47 (a)	$3 \times 10^0$	$3 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Cadmium (48)				
Cd-109	$3 \times 10^1$	$2 \times 10^0$	$1 \times 10^4$	$1 \times 10^6$
Cd-113m	$4 \times 10^1$	$5 \times 10^{-1}$	$1 \times 10^3$	$1 \times 10^6$
Cd-115 (a)	$3 \times 10^0$	$4 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^6$
Cd-115m	$5 \times 10^{-1}$	$5 \times 10^{-1}$	$1 \times 10^3$	$1 \times 10^6$
Cerium (58)				
Ce-139	$7 \times 10^0$	$2 \times 10^0$	$1 \times 10^2$	$1 \times 10^6$
Ce-141	$2 \times 10^1$	$6 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^7$
Ce-143	$9 \times 10^{-1}$	$6 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^6$
Ce-144 (a)	$2 \times 10^{-1}$	$2 \times 10^{-1}$	$1 \times 10^2$ (b)	$1 \times 10^5$ (b)
Californium (98)				
Cf-248	$4 \times 10^1$	$6 \times 10^{-3}$	$1 \times 10^1$	$1 \times 10^4$
Cf-249	$3 \times 10^0$	$8 \times 10^{-4}$	$1 \times 10^0$	$1 \times 10^3$
Cf-250	$2 \times 10^1$	$2 \times 10^{-3}$	$1 \times 10^1$	$1 \times 10^4$
Cf-251	$7 \times 10^0$	$7 \times 10^{-4}$	$1 \times 10^0$	$1 \times 10^3$
Cf-252	$1 \times 10^{-1}$	$3 \times 10^{-3}$	$1 \times 10^1$	$1 \times 10^4$
Cf-253 (a)	$4 \times 10^1$	$4 \times 10^{-2}$	$1 \times 10^2$	$1 \times 10^5$
Cf-254	$1 \times 10^{-3}$	$1 \times 10^{-3}$	$1 \times 10^0$	$1 \times 10^3$
Chlorine (17)				
Cl-36	$1 \times 10^1$	$6 \times 10^{-1}$	$1 \times 10^4$	$1 \times 10^6$
Cl-38	$2 \times 10^{-1}$	$2 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^5$
Curium (96)				
Cm-240	$4 \times 10^1$	$2 \times 10^{-2}$	$1 \times 10^2$	$1 \times 10^5$

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

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

I-132	$4 \times 10^{-1}$	$4 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^5$
I-133	$7 \times 10^{-1}$	$6 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
I-134	$3 \times 10^{-1}$	$3 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^5$
I-135 (a)	$6 \times 10^{-1}$	$6 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Indium (49)				
In-111	$3 \times 10^0$	$3 \times 10^0$	$1 \times 10^2$	$1 \times 10^6$
In-113m	$4 \times 10^0$	$2 \times 10^0$	$1 \times 10^2$	$1 \times 10^6$
In-114m (a)	$1 \times 10^1$	$5 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^6$
In-115m	$7 \times 10^0$	$1 \times 10^0$	$1 \times 10^2$	$1 \times 10^6$
Iridium (77)				
Ir-189 (a)	$1 \times 10^1$	$1 \times 10^1$	$1 \times 10^2$	$1 \times 10^7$
Ir-190	$7 \times 10^{-1}$	$7 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Ir-192	$1 \times 10^0$ (c)	$6 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^4$
Ir-194	$3 \times 10^{-1}$	$3 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^5$
Potassium (19)				
K-40	$9 \times 10^{-1}$	$9 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^6$
K-42	$2 \times 10^{-1}$	$2 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^6$
K-43	$7 \times 10^{-1}$	$6 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Krypton (36)				
Kr-79	$4 \times 10^0$	$2 \times 10^0$	$1 \times 10^3$	$1 \times 10^5$
Kr-81	$4 \times 10^1$	$4 \times 10^1$	$1 \times 10^4$	$1 \times 10^7$
Kr-85	$1 \times 10^1$	$1 \times 10^1$	$1 \times 10^5$	$1 \times 10^4$
Kr-85m	$8 \times 10^0$	$3 \times 10^0$	$1 \times 10^3$	$1 \times 10^{10}$
Kr-87	$2 \times 10^{-1}$	$2 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^9$
Lanthanum (57)				
La-137	$3 \times 10^1$	$6 \times 10^0$	$1 \times 10^3$	$1 \times 10^7$
La-140	$4 \times 10^{-1}$	$4 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^5$
Lutetium (71)				
Lu-172	$6 \times 10^{-1}$	$6 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Lu-173	$8 \times 10^0$	$8 \times 10^0$	$1 \times 10^2$	$1 \times 10^7$
Lu-174	$9 \times 10^0$	$9 \times 10^0$	$1 \times 10^2$	$1 \times 10^7$
Lu-174m	$2 \times 10^1$	$1 \times 10^1$	$1 \times 10^2$	$1 \times 10^7$
Lu-177	$3 \times 10^1$	$7 \times 10^{-1}$	$1 \times 10^3$	$1 \times 10^7$
Magnesium (12)				
Mg-28 (a)	$3 \times 10^{-1}$	$3 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^5$
Manganese (25)				
Mn-52	$3 \times 10^{-1}$	$3 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^5$
Mn-53	Unlimited	Unlimited	$1 \times 10^4$	$1 \times 10^9$
Mn-54	$1 \times 10^0$	$1 \times 10^0$	$1 \times 10^1$	$1 \times 10^6$
Mn-56	$3 \times 10^{-1}$	$3 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^5$
Molybdenum (42)				
Mo-93	$4 \times 10^1$	$2 \times 10^1$	$1 \times 10^3$	$1 \times 10^8$
Mo-99 (a)	$1 \times 10^0$	$6 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^6$
Nitrogen (7)				
N-13	$9 \times 10^{-1}$	$6 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^9$

Sodium (11)				
Na-22	$5 \times 10^{-1}$	$5 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Na-24	$2 \times 10^{-1}$	$2 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^5$
Niobium (41)				
Nb-93m	$4 \times 10^1$	$3 \times 10^1$	$1 \times 10^4$	$1 \times 10^7$
Nb-94	$7 \times 10^{-1}$	$7 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Nb-95	$1 \times 10^0$	$1 \times 10^0$	$1 \times 10^1$	$1 \times 10^6$
Nb-97	$9 \times 10^{-1}$	$6 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Neodymium (60)				
Nd-147	$6 \times 10^0$	$6 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^6$
Nd-149	$6 \times 10^{-1}$	$5 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^6$
Nickel (28)				
Ni-59	Unlimited	Unlimited	$1 \times 10^4$	$1 \times 10^8$
Ni-63	$4 \times 10^1$	$3 \times 10^1$	$1 \times 10^5$	$1 \times 10^8$
Ni-65	$4 \times 10^{-1}$	$4 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Neptunium (93)				
Np-235	$4 \times 10^1$	$4 \times 10^1$	$1 \times 10^3$	$1 \times 10^7$
Np-236(short-lived)	$2 \times 10^1$	$2 \times 10^0$	$1 \times 10^3$	$1 \times 10^7$
Np-236(long-lived)	$9 \times 10^0$	$2 \times 10^{-2}$	$1 \times 10^2$	$1 \times 10^5$
Np-237	$2 \times 10^1$	$2 \times 10^{-3}$	$1 \times 10^0$ (b)	$1 \times 10^3$ (b)
Np-239	$7 \times 10^0$	$4 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^7$
Osmium (76)				
Os-185	$1 \times 10^0$	$1 \times 10^0$	$1 \times 10^1$	$1 \times 10^6$
Os-191	$1 \times 10^1$	$2 \times 10^0$	$1 \times 10^2$	$1 \times 10^7$
Os-191m	$4 \times 10^1$	$3 \times 10^1$	$1 \times 10^3$	$1 \times 10^7$
Os-193	$2 \times 10^0$	$6 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^6$
Os-194 (a)	$3 \times 10^{-1}$	$3 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^5$
Phosphorus (15)				
P-32	$5 \times 10^{-1}$	$5 \times 10^{-1}$	$1 \times 10^3$	$1 \times 10^5$
P-33	$4 \times 10^1$	$1 \times 10^0$	$1 \times 10^5$	$1 \times 10^8$
Protactinium (91)				
Pa-230 (a)	$2 \times 10^0$	$7 \times 10^{-2}$	$1 \times 10^1$	$1 \times 10^6$
Pa-231	$4 \times 10^0$	$4 \times 10^{-4}$	$1 \times 10^0$	$1 \times 10^3$
Pa-233	$5 \times 10^0$	$7 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^7$
Lead (82)				
Pb-201	$1 \times 10^0$	$1 \times 10^0$	$1 \times 10^1$	$1 \times 10^6$
Pb-202	$4 \times 10^1$	$2 \times 10^1$	$1 \times 10^3$	$1 \times 10^6$
Pb-203	$4 \times 10^0$	$3 \times 10^0$	$1 \times 10^2$	$1 \times 10^6$
Pb-205	Unlimited	Unlimited	$1 \times 10^4$	$1 \times 10^7$
Pb-210 (a)	$1 \times 10^0$	$5 \times 10^{-2}$	$1 \times 10^1$ (b)	$1 \times 10^4$ (b)
Pb-212 (a)	$7 \times 10^{-1}$	$2 \times 10^{-1}$	$1 \times 10^1$ (b)	$1 \times 10^5$ (b)
Palladium (46)				
Pd-103 (a)	$4 \times 10^1$	$4 \times 10^1$	$1 \times 10^3$	$1 \times 10^8$
Pd-107	Unlimited	Unlimited	$1 \times 10^5$	$1 \times 10^8$

Pd-109	$2 \times 10^0$	$5 \times 10^{-1}$	$1 \times 10^3$	$1 \times 10^6$
Promethium (61)				
Pm-143	$3 \times 10^0$	$3 \times 10^0$	$1 \times 10^2$	$1 \times 10^6$
Pm-144	$7 \times 10^{-1}$	$7 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Pm-145	$3 \times 10^1$	$1 \times 10^1$	$1 \times 10^3$	$1 \times 10^7$
Pm-147	$4 \times 10^1$	$2 \times 10^0$	$1 \times 10^4$	$1 \times 10^7$
Pm-148m (a)	$8 \times 10^{-1}$	$7 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Pm-149	$2 \times 10^0$	$6 \times 10^{-1}$	$1 \times 10^3$	$1 \times 10^6$
Pm-151	$2 \times 10^0$	$6 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^6$
Polonium (84)				
Po-210	$4 \times 10^1$	$2 \times 10^{-2}$	$1 \times 10^1$	$1 \times 10^4$
Praseodymium (59)				
Pr-142	$4 \times 10^{-1}$	$4 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^5$
Pr-143	$3 \times 10^0$	$6 \times 10^{-1}$	$1 \times 10^4$	$1 \times 10^6$
Platinum (78)				
Pt-188 (a)	$1 \times 10^0$	$8 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Pt-191	$4 \times 10^0$	$3 \times 10^0$	$1 \times 10^2$	$1 \times 10^6$
Pt-193	$4 \times 10^1$	$4 \times 10^1$	$1 \times 10^4$	$1 \times 10^7$
Pt-193m	$4 \times 10^1$	$5 \times 10^{-1}$	$1 \times 10^3$	$1 \times 10^7$
Pt-195m	$1 \times 10^1$	$5 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^6$
Pt-197	$2 \times 10^1$	$6 \times 10^{-1}$	$1 \times 10^3$	$1 \times 10^6$
Pt-197m	$1 \times 10^1$	$6 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^6$
Plutonium (94)				
Pu-236	$3 \times 10^1$	$3 \times 10^{-3}$	$1 \times 10^1$	$1 \times 10^4$
Pu-237	$2 \times 10^1$	$2 \times 10^1$	$1 \times 10^3$	$1 \times 10^7$
Pu-238	$1 \times 10^1$	$1 \times 10^{-3}$	$1 \times 10^0$	$1 \times 10^4$
Pu-239	$1 \times 10^1$	$1 \times 10^{-3}$	$1 \times 10^0$	$1 \times 10^4$
Pu-240	$1 \times 10^1$	$1 \times 10^{-3}$	$1 \times 10^0$	$1 \times 10^3$
Pu-241 (a)	$4 \times 10^1$	$6 \times 10^{-2}$	$1 \times 10^2$	$1 \times 10^5$
Pu-242	$1 \times 10^1$	$1 \times 10^{-3}$	$1 \times 10^0$	$1 \times 10^4$
Pu-244 (a)	$4 \times 10^{-1}$	$1 \times 10^{-3}$	$1 \times 10^0$	$1 \times 10^4$
Radium (88)				
Ra-223 (a)	$4 \times 10^{-1}$	$7 \times 10^{-3}$	$1 \times 10^2 (b)$	$1 \times 10^5 (b)$
Ra-224 (a)	$4 \times 10^{-1}$	$2 \times 10^{-2}$	$1 \times 10^1 (b)$	$1 \times 10^5 (b)$
Ra-225 (a)	$2 \times 10^{-1}$	$4 \times 10^{-3}$	$1 \times 10^2$	$1 \times 10^5$
Ra-226 (a)	$2 \times 10^{-1}$	$3 \times 10^{-3}$	$1 \times 10^1 (b)$	$1 \times 10^4 (b)$
Ra-228 (a)	$6 \times 10^{-1}$	$2 \times 10^{-2}$	$1 \times 10^1 (b)$	$1 \times 10^5 (b)$
Rubidium (37)				
Rb-81	$2 \times 10^0$	$8 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Rb-83 (a)	$2 \times 10^0$	$2 \times 10^0$	$1 \times 10^2$	$1 \times 10^6$
Rb-84	$1 \times 10^0$	$1 \times 10^0$	$1 \times 10^1$	$1 \times 10^6$
Rb-86	$5 \times 10^{-1}$	$5 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^5$
Rb-87	Unlimited	Unlimited	$1 \times 10^4$	$1 \times 10^7$
Rb(nat)	Unlimited	Unlimited	$1 \times 10^4$	$1 \times 10^7$

Rhenium (75)				
Re-184	1 x 10 <sup>0</sup>	1 x 10 <sup>0</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>
Re-184m	3 x 10 <sup>0</sup>	1 x 10 <sup>0</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>6</sup>
Re-186	2 x 10 <sup>0</sup>	6 x 10 <sup>-1</sup>	1 x 10 <sup>3</sup>	1 x 10 <sup>6</sup>
Re-187	Unlimited	Unlimited	1 x 10 <sup>6</sup>	1 x 10 <sup>9</sup>
Re-188	4 x 10 <sup>-1</sup>	4 x 10 <sup>-1</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>5</sup>
Re-189 (a)	3 x 10 <sup>0</sup>	6 x 10 <sup>-1</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>6</sup>
Re(nat)	Unlimited	Unlimited	1 x 10 <sup>6</sup>	1 x 10 <sup>9</sup>
Rhodium (45)				
Rh-99	2 x 10 <sup>0</sup>	2 x 10 <sup>0</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>
Rh-101	4 x 10 <sup>0</sup>	3 x 10 <sup>0</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>7</sup>
Rh-102	5 x 10 <sup>-1</sup>	5 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>
Rh-102m	2 x 10 <sup>0</sup>	2 x 10 <sup>0</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>6</sup>
Rh-103m	4 x 10 <sup>1</sup>	4 x 10 <sup>1</sup>	1 x 10 <sup>4</sup>	1 x 10 <sup>8</sup>
Rh-105	1 x 10 <sup>1</sup>	8 x 10 <sup>-1</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>7</sup>
Radon (86)				
Rn-222 (a)	3 x 10 <sup>-1</sup>	4 x 10 <sup>-3</sup>	1 x 10 <sup>1</sup> (b)	1 x 10 <sup>3</sup> (b)
Ruthenium (44)				
Ru-97	5 x 10 <sup>0</sup>	5 x 10 <sup>0</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>7</sup>
Ru-103 (a)	2 x 10 <sup>0</sup>	2 x 10 <sup>0</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>6</sup>
Ru-105	1 x 10 <sup>0</sup>	6 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>
Ru-106 (a)	2 x 10 <sup>-1</sup>	2 x 10 <sup>-1</sup>	1 x 10 <sup>2</sup> (b)	1 x 10 <sup>5</sup> (b)
Sulphur (16)				
S-35	4 x 10 <sup>1</sup>	3 x 10 <sup>0</sup>	1 x 10 <sup>5</sup>	1 x 10 <sup>8</sup>
Antimony (51)				
Sb-122	4 x 10 <sup>-1</sup>	4 x 10 <sup>-1</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>4</sup>
Sb-124	6 x 10 <sup>-1</sup>	6 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>
Sb-125	2 x 10 <sup>0</sup>	1 x 10 <sup>0</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>6</sup>
Sb-126	4 x 10 <sup>-1</sup>	4 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>5</sup>
Scandium (21)				
Sc-44	5 x 10 <sup>-1</sup>	5 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>5</sup>
Sc-46	5 x 10 <sup>-1</sup>	5 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>
Sc-47	1 x 10 <sup>1</sup>	7 x 10 <sup>-1</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>6</sup>
Sc-48	3 x 10 <sup>-1</sup>	3 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>5</sup>
Selenium (34)				
Se-75	3 x 10 <sup>0</sup>	3 x 10 <sup>0</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>6</sup>
Se-79	4 x 10 <sup>1</sup>	2 x 10 <sup>0</sup>	1 x 10 <sup>4</sup>	1 x 10 <sup>7</sup>
Silicon (14)				
Si-31	6 x 10 <sup>-1</sup>	6 x 10 <sup>-1</sup>	1 x 10 <sup>3</sup>	1 x 10 <sup>6</sup>
Si-32	4 x 10 <sup>1</sup>	5 x 10 <sup>-1</sup>	1 x 10 <sup>3</sup>	1 x 10 <sup>6</sup>
Samarium (62)				
Sm-145	1 x 10 <sup>1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>7</sup>
Sm-147	Unlimited	Unlimited	1 x 10 <sup>1</sup>	1 x 10 <sup>4</sup>
Sm-151	4 x 10 <sup>1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>4</sup>	1 x 10 <sup>8</sup>
Sm-153	9 x 10 <sup>0</sup>	6 x 10 <sup>-1</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>6</sup>

Tin (50)				
Sn-113 (a)	4 x 10 <sup>0</sup>	2 x 10 <sup>0</sup>	1 x 10 <sup>3</sup>	1 x 10 <sup>7</sup>
Sn-117m	7 x 10 <sup>0</sup>	4 x 10 <sup>-1</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>6</sup>
Sn-119m	4 x 10 <sup>1</sup>	3 x 10 <sup>1</sup>	1 x 10 <sup>3</sup>	1 x 10 <sup>7</sup>
Sn-121m (a)	4 x 10 <sup>1</sup>	9 x 10 <sup>-1</sup>	1 x 10 <sup>3</sup>	1 x 10 <sup>7</sup>
Sn-123	8 x 10 <sup>-1</sup>	6 x 10 <sup>-1</sup>	1 x 10 <sup>3</sup>	1 x 10 <sup>6</sup>
Sn-125	4 x 10 <sup>-1</sup>	4 x 10 <sup>-1</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>5</sup>
Sn-126 (a)	6 x 10 <sup>-1</sup>	4 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>5</sup>
Strontium (38)				
Sr-82 (a)	2 x 10 <sup>-1</sup>	2 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>5</sup>
Sr-85	2 x 10 <sup>0</sup>	2 x 10 <sup>0</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>6</sup>
Sr-85m	5 x 10 <sup>0</sup>	5 x 10 <sup>0</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>7</sup>
Sr-87m	3 x 10 <sup>0</sup>	3 x 10 <sup>0</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>6</sup>
Sr-89	6 x 10 <sup>-1</sup>	6 x 10 <sup>-1</sup>	1 x 10 <sup>3</sup>	1 x 10 <sup>6</sup>
Sr-90 (a)	3 x 10 <sup>-1</sup>	3 x 10 <sup>-1</sup>	1 x 10 <sup>2</sup> (b)	1 x 10 <sup>4</sup> (b)
Sr-91 (a)	3 x 10 <sup>-1</sup>	3 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>5</sup>
Sr-92 (a)	1 x 10 <sup>0</sup>	3 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>
Tritium (1)				
T(H-3)	4 x 10 <sup>1</sup>	4 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>	1 x 10 <sup>9</sup>
Tantalum (73)				
Ta-178(long-lived)	1 x 10 <sup>0</sup>	8 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>
Ta-179	3 x 10 <sup>1</sup>	3 x 10 <sup>1</sup>	1 x 10 <sup>3</sup>	1 x 10 <sup>7</sup>
Ta-182	9 x 10 <sup>-1</sup>	5 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>4</sup>
Terbium (65)				
Tb-157	4 x 10 <sup>1</sup>	4 x 10 <sup>1</sup>	1 x 10 <sup>4</sup>	1 x 10 <sup>7</sup>
Tb-158	1 x 10 <sup>0</sup>	1 x 10 <sup>0</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>
Tb-160	1 x 10 <sup>0</sup>	6 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>
Technetium (43)				
Tc-95m (a)	2 x 10 <sup>0</sup>	2 x 10 <sup>0</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>
Tc-96	4 x 10 <sup>-1</sup>	4 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>
Tc-96m (a)	4 x 10 <sup>-1</sup>	4 x 10 <sup>-1</sup>	1 x 10 <sup>3</sup>	1 x 10 <sup>7</sup>
Tc-97	Unlimited	Unlimited	1 x 10 <sup>3</sup>	1 x 10 <sup>8</sup>
Tc-97m	4 x 10 <sup>1</sup>	1 x 10 <sup>0</sup>	1 x 10 <sup>3</sup>	1 x 10 <sup>7</sup>
Tc-98	8 x 10 <sup>-1</sup>	7 x 10 <sup>-1</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>
Tc-99	4 x 10 <sup>1</sup>	9 x 10 <sup>-1</sup>	1 x 10 <sup>4</sup>	1 x 10 <sup>7</sup>
Tc-99m	1 x 10 <sup>1</sup>	4 x 10 <sup>0</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>7</sup>
Tellurium (52)				
Te-121	2 x 10 <sup>0</sup>	2 x 10 <sup>0</sup>	1 x 10 <sup>1</sup>	1 x 10 <sup>6</sup>
Te-121m	5 x 10 <sup>0</sup>	3 x 10 <sup>0</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>6</sup>
Te-123m	8 x 10 <sup>0</sup>	1 x 10 <sup>0</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>7</sup>
Te-125m	2 x 10 <sup>1</sup>	9 x 10 <sup>-1</sup>	1 x 10 <sup>3</sup>	1 x 10 <sup>7</sup>
Te-127	2 x 10 <sup>1</sup>	7 x 10 <sup>-1</sup>	1 x 10 <sup>3</sup>	1 x 10 <sup>6</sup>
Te-127m (a)	2 x 10 <sup>1</sup>	5 x 10 <sup>-1</sup>	1 x 10 <sup>3</sup>	1 x 10 <sup>7</sup>
Te-129	7 x 10 <sup>-1</sup>	6 x 10 <sup>-1</sup>	1 x 10 <sup>2</sup>	1 x 10 <sup>6</sup>

Te-129m (a)	$8 \times 10^{-1}$	$4 \times 10^{-1}$	$1 \times 10^3$	$1 \times 10^6$
Te-131m (a)	$7 \times 10^{-1}$	$5 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Te-132 (a)	$5 \times 10^{-1}$	$4 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^7$
Thorium (90)				
Th-227	$1 \times 10^1$	$5 \times 10^{-3}$	$1 \times 10^1$	$1 \times 10^4$
Th-228 (a)	$5 \times 10^{-1}$	$1 \times 10^{-3}$	$1 \times 10^0$ (b)	$1 \times 10^4$ (b)
Th-229	$5 \times 10^0$	$5 \times 10^{-4}$	$1 \times 10^0$ (b)	$1 \times 10^3$ (b)
Th-230	$1 \times 10^1$	$1 \times 10^{-3}$	$1 \times 10^0$	$1 \times 10^4$
Th-231	$4 \times 10^1$	$2 \times 10^{-2}$	$1 \times 10^3$	$1 \times 10^7$
Th-232	Unlimited	Unlimited	$1 \times 10^1$	$1 \times 10^4$
Th-234 (a)	$3 \times 10^{-1}$	$3 \times 10^{-1}$	$1 \times 10^3$ (b)	$1 \times 10^5$ (b)
Th(nat)	Unlimited	Unlimited	$1 \times 10^0$ (b)	$1 \times 10^3$ (b)
Titanium (22)				
Ti-44 (a)	$5 \times 10^{-1}$	$4 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^5$
Thallium (81)				
Tl-200	$9 \times 10^{-1}$	$9 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Tl-201	$1 \times 10^1$	$4 \times 10^0$	$1 \times 10^2$	$1 \times 10^6$
Tl-202	$2 \times 10^0$	$2 \times 10^0$	$1 \times 10^2$	$1 \times 10^6$
Tl-204	$1 \times 10^1$	$7 \times 10^{-1}$	$1 \times 10^4$	$1 \times 10^4$
Thulium (69)				
Tm-167	$7 \times 10^0$	$8 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^6$
Tm-170	$3 \times 10^0$	$6 \times 10^{-1}$	$1 \times 10^3$	$1 \times 10^6$
Tm-171	$4 \times 10^1$	$4 \times 10^1$	$1 \times 10^4$	$1 \times 10^8$
Uranium (92)				
U-230 (fast lung absorption) (a)(d)	$4 \times 10^1$	$1 \times 10^{-1}$	$1 \times 10^1$ (b)	$1 \times 10^5$ (b)
U-230 (medium lung absorption) (a)(e)	$4 \times 10^1$	$4 \times 10^{-3}$	$1 \times 10^1$	$1 \times 10^4$
U-230 (slow lung absorption) (a)(f)	$3 \times 10^1$	$3 \times 10^{-3}$	$1 \times 10^1$	$1 \times 10^4$
U-232 (fast lung absorption) (d)	$4 \times 10^1$	$1 \times 10^{-2}$	$1 \times 10^0$ (b)	$1 \times 10^3$ (b)
U-232 (medium lung absorption) (e)	$4 \times 10^1$	$7 \times 10^{-3}$	$1 \times 10^1$	$1 \times 10^4$
U-232 (slow lung absorption) (f)	$1 \times 10^1$	$1 \times 10^{-3}$	$1 \times 10^1$	$1 \times 10^4$
U-233 (fast lung absorption) (d)	$4 \times 10^1$	$9 \times 10^{-2}$	$1 \times 10^1$	$1 \times 10^4$
U-233 (medium lung absorption) (e)	$4 \times 10^1$	$2 \times 10^{-2}$	$1 \times 10^2$	$1 \times 10^5$
U-233 (slow lung absorption) (f)	$4 \times 10^1$	$6 \times 10^{-3}$	$1 \times 10^1$	$1 \times 10^5$
U-234 (fast lung absorption) (d)	$4 \times 10^1$	$9 \times 10^{-2}$	$1 \times 10^1$	$1 \times 10^4$
U-234 (medium lung absorption) (e)	$4 \times 10^1$	$2 \times 10^{-2}$	$1 \times 10^2$	$1 \times 10^5$
U-234 (slow lung absorption) (f)	$4 \times 10^1$	$6 \times 10^{-3}$	$1 \times 10^1$	$1 \times 10^5$
U-235 (all lung absorption types) (a) (d) (e) (f)	Unlimited	Unlimited	$1 \times 10^1$ (b)	$1 \times 10^4$ (b)
U-236 (fast lung absorption) (d)	Unlimited	Unlimited	$1 \times 10^1$	$1 \times 10^4$
U-236 (medium lung absorption) (e)	$4 \times 10^1$	$2 \times 10^{-2}$	$1 \times 10^2$	$1 \times 10^5$
U-236 (slow lung absorption) (f)	$4 \times 10^1$	$6 \times 10^{-3}$	$1 \times 10^1$	$1 \times 10^4$
U-238 (all lung absorption types) (d) (e) (f)	Unlimited	Unlimited	$1 \times 10^1$ (b)	$1 \times 10^4$ (b)
U (nat)	Unlimited	Unlimited	$1 \times 10^0$ (b)	$1 \times 10^3$ (b)
U (enriched to 20% or less) (g)	Unlimited	Unlimited	$1 \times 10^0$	$1 \times 10^3$
U (dep)	Unlimited	Unlimited	$1 \times 10^0$	$1 \times 10^3$

Vanadium (23)				
V-48	$4 \times 10^{-1}$	$4 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^5$
V-49	$4 \times 10^1$	$4 \times 10^1$	$1 \times 10^4$	$1 \times 10^7$
Tungsten (74)				
W-178 (a)	$9 \times 10^0$	$5 \times 10^0$	$1 \times 10^1$	$1 \times 10^6$
W-181	$3 \times 10^1$	$3 \times 10^1$	$1 \times 10^3$	$1 \times 10^7$
W-185	$4 \times 10^1$	$8 \times 10^{-1}$	$1 \times 10^4$	$1 \times 10^7$
W-187	$2 \times 10^0$	$6 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^6$
W-188 (a)	$4 \times 10^{-1}$	$3 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^5$
Xenon (54)				
Xe-122 (a)	$4 \times 10^{-1}$	$4 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^9$
Xe-123	$2 \times 10^0$	$7 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^9$
Xe-127	$4 \times 10^0$	$2 \times 10^0$	$1 \times 10^3$	$1 \times 10^5$
Xe-131m	$4 \times 10^1$	$4 \times 10^1$	$1 \times 10^4$	$1 \times 10^4$
Xe-133	$2 \times 10^1$	$1 \times 10^1$	$1 \times 10^3$	$1 \times 10^4$
Xe-135	$3 \times 10^0$	$2 \times 10^0$	$1 \times 10^3$	$1 \times 10^{10}$
Yttrium (39)				
Y-87 (a)	$1 \times 10^0$	$1 \times 10^0$	$1 \times 10^1$	$1 \times 10^6$
Y-88	$4 \times 10^{-1}$	$4 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Y-90	$3 \times 10^{-1}$	$3 \times 10^{-1}$	$1 \times 10^3$	$1 \times 10^5$
Y-91	$6 \times 10^{-1}$	$6 \times 10^{-1}$	$1 \times 10^3$	$1 \times 10^6$
Y-91m	$2 \times 10^0$	$2 \times 10^0$	$1 \times 10^2$	$1 \times 10^6$
Y-92	$2 \times 10^{-1}$	$2 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^5$
Y-93	$3 \times 10^{-1}$	$3 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^5$
Ytterbium (70)				
Yb-169	$4 \times 10^0$	$1 \times 10^0$	$1 \times 10^2$	$1 \times 10^7$
Yb-175	$3 \times 10^1$	$9 \times 10^{-1}$	$1 \times 10^3$	$1 \times 10^7$
Zinc (30)				
Zn-65	$2 \times 10^0$	$2 \times 10^0$	$1 \times 10^1$	$1 \times 10^6$
Zn-69	$3 \times 10^0$	$6 \times 10^{-1}$	$1 \times 10^4$	$1 \times 10^6$
Zn-69m (a)	$3 \times 10^0$	$6 \times 10^{-1}$	$1 \times 10^2$	$1 \times 10^6$
Zirconium (40)				
Zr-88	$3 \times 10^0$	$3 \times 10^0$	$1 \times 10^2$	$1 \times 10^6$
Zr-93	Unlimited	Unlimited	$1 \times 10^3$ (b)	$1 \times 10^7$ (b)
Zr-95 (a)	$2 \times 10^0$	$8 \times 10^{-1}$	$1 \times 10^1$	$1 \times 10^6$
Zr-97 (a)	$4 \times 10^{-1}$	$4 \times 10^{-1}$	$1 \times 10^1$ (b)	$1 \times 10^5$ (b)

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

Mg-28	Al-28
Ar-42	K-42
Ca-47	Sc-47
Ti-44	Sc-44
Fe-52	Mn-52m
Fe-60	Co-60m
Zn-69m	Zn-69
Ge-68	Ga-68

Rb-83	Kr-83m
Sr-82	Rb-82
Sr-90	Y-90
Sr-91	Y-91m
Sr-92	Y-92
Y-87	Sr-87m
Zr-95	Nb-95m
Zr-97	Nb-97m, Nb-97
Mo-99	Tc-99m
Tc-95m	Tc-95
Tc-96m	Tc-96
Ru-103	Rh-103m
Ru-106	Rh-106
Pd-103	Rh-103m
Ag-108m	Ag-108
Ag-110m	Ag-110
Cd-115	In-115m
In-114m	In-114
Sn-113	In-113m
Sn-121m	Sn-121
Sn-126	Sb-126m
Te-118	Sb-118
Te-127m	Te-127
Te-129m	Te-129
Te-131m	Te-131
Te-132	I-132
I-135	Xe-135m
Xe-122	I-122
Cs-137	Ba-137m
Ba-131	Cs-131
Ba-140	La-140
Ce-144	Pr-144m, Pr-144
Pm-148m	Pm-148
Gd-146	Eu-146
Dy-166	Ho-166
Hf-172	Lu-172
W-178	Ta-178
W-188	Re-188
Re-189	Os-189m
Os-194	Ir-194
Ir-189	Os-189m
Pt-188	Ir-188
Hg-194	Au-194
Hg-195m	Hg-195
Pb-210	Bi-210
Pb-212	Bi-212, Tl-208, Po-212
Bi-210m	Tl-206
Bi-212	Tl-208, Po-212
At-211	Po-211
Rn-222	Po-218, Pb-214, At-218, Bi-214, Po-214
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Po-211, Tl-207
Ra-224	Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
Ra-225	Ac-225, Fr-221, At-217, Bi-213, Tl-209, Po-213, Pb-209
Ra-226	Rn-222, Po-218, Pb-214, At-218, Bi-214, Po-214
Ra-228	Ac-228
Ac-225	Fr-221, At-217, Bi-213, Tl-209, Po-213, Pb-209
Ac-227	Fr-223
Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
Th-234	Pa-234m, Pa-234
Pa-230	Ac-226, Th-226, Fr-222, Ra-222, Rn-218, Po-214
U-230	Th-226, Ra-222, Rn-218, Po-214
U-235	Th-231
Pu-241	U-237
Pu-244	U-240, Np-240m
Am-242m	Am-242, Np-238
Am-243	Np-239

KOREAN REGISTER

Cm-247 Pu-243  
 Bk-249 Am-245  
 Cf-253 Cm-249

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

Sr-90 Y-90  
 Zr-93 Nb-93m  
 Zr-97 Nb-97  
 Ru-106 Rh-106  
 Ag-108m Ag-108  
 Cs-137 Ba-137m  
 Ce-144 Pr-144  
 Ba-140 La-140  
 Bi-212 Tl-208 (0.36), Po-212 (0.64)  
 Pb-210 Bi-210, Po-210  
 Pb-212 Bi-212, Tl-208 (0.36), Po-212 (0.64)  
 Rn-222 Po-218, Pb-214, Bi-214, Po-214  
 Ra-223 Rn-219, Po-215, Pb-211, Bi-211, Tl-207  
 Ra-224 Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)  
 Ra-226 Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210  
 Ra-228 Ac-228  
 Th-228 Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)  
 Th-229 Ra-225, Ac-225, Fr-221, At-217, Bi-213, Po-213, Pb-209  
 Th (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  
 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 transport.

(e) These values apply only to compounds of uranium that take the chemical form of  $UO_3$ ,  $UF_4$ ,  $UCl_4$  and hexavalent compounds in both normal and accident conditions of transport.

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

(g) These values apply to unirradiated uranium only.

#### 2.7.2.2.2 For individual radionuclides:

.1 which are not listed in table 2.7.2.2.1, the determination of the basic radionuclide values referred to in 2.7.2.2.1 shall require multilateral approval. For these radionuclides, activity concentration limits for exempt material and activity limits for exempt consignments shall be calculated in accordance with the principles established in the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna (1996). It is permissible to use an  $A_2$  value calculated using a dose coefficient for the appropriate lung absorption type as recommended by the International Commission on Radiological Protection, if the chemical forms of each radionuclide under both normal and accident conditions of transport are taken into consideration. Alternatively, the radionuclide values in table 2.7.2.2.2 may be used without obtaining competent authority approval;

.2 In instruments or articles in which the radioactive material is enclosed or is included as a component part of the instrument or other manufactured article and which meet 2.7.2.4.1.3.3, alternative basic radionuclide values to those in table 2.7.2.2.1 for the activity limit for an exempt consignment are permitted and shall require multilateral approval. Such alternative activity limits for an exempt consignment shall be calculated in accordance with the principles set out in the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna (1996).

Table 2.7.2.2.2 - Basic radionuclide values for unknown radionuclides or mixtures

Radioactive contents	A1 (TBq)	A2 (TBq)	Activity concentration limit for exempt material (Bq/g)	Activity limit for exempt consignments (Bq)
Only beta or gamma emitting nuclides are known to be present	0.1	0.02	$1 \times 10^1$	$1 \times 10^4$
Alpha emitting nuclides but no neutron emitters are known to be present	0.2	$9 \times 10^{-5}$	$1 \times 10^{-1}$	$1 \times 10^3$
Neutron emitting nuclides are known to be present or no relevant data are available	0.001	$9 \times 10^{-5}$	$1 \times 10^{-1}$	$1 \times 10^3$

2.7.2.2.3 In the calculations of  $A_1$  and  $A_2$  for a radionuclide not in table 2.7.2.2.1, 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  $A_1$  or  $A_2$  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.

2.7.2.2.4 For mixtures of radionuclides, the basic radionuclide values referred to in 2.7.2.2.1 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  $A_1$  or  $A_2$ , or the activity concentration limit for exempt material or the activity limit for an exempt consignment, as appropriate, for the radionuclide i; and

$X_m$  is the derived value of  $A_1$  or  $A_2$ , or the activity concentration limit for exempt material or the activity limit for an exempt consignment in the case of a mixture.

2.7.2.2.5 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 formulae in 2.7.2.2.4 and 2.7.2.4.4. 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.

2.7.2.2.6 For individual radionuclides or for mixtures of radionuclides for which relevant data are not available, the values shown in table 2.7.2.2.2 shall be used.

### 2.7.2.3 Determination of other material characteristics

#### 2.7.2.3.1 Low specific activity (LSA) material

#### 2.7.2.3.1.1 [Reserved]

2.7.2.3.1.2 LSA material shall be in one of three groups:

##### .1 LSA-I

.1 uranium and thorium ores and concentrates of such ores, and other ores containing naturally occurring radionuclides;

.2 Natural uranium, depleted uranium, natural thorium or their compounds or mixtures, that are unirradiated and in solid or liquid form;

.3 radioactive material for which the  $A_2$  value is unlimited. Fissile material may be included only if excepted under 2.7.2.3.5; or

.4 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 2.7.2.2.1 to 2.7.2.2.6. Fissile material may be included only if excepted under 2.7.2.3.5;

##### .2 LSA-II

.1 water with tritium concentration up to 0.8 TBq/L;

.2 other material in which the activity is distributed throughout and the estimated average specific activity does not exceed  $10^{-4}A_2/g$  for solids and gases, and  $10^{-5}A_2/g$  for liquids;

.3 LSA-III – Solids (e.g. consolidated wastes, activated materials), excluding powders, that meet the requirements of 2.7.2.3.1.3, in which:

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

.2 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  $0.1A_2$ ; and

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

2.7.2.3.1.3 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 2.7.2.3.1.4, the activity in the water would not exceed  $0.1A_2$ .

2.7.2.3.1.4 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 7day test period the free volume of the unabsorbed and unreacted water remaining shall be at least 10% of the volume of the solid test sample itself. The water shall have an initial pH of 6 to 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 llday immersion of the test sample.

2.7.2.3.1.5 Demonstration of compliance with the performance standards in 2.7.2.3.1.4 shall be in accordance with 6.4.12.1 and 6.4.12.2.

#### 2.7.2.3.2 Surface contaminated object (SCO)

SCO is classified in one of two groups:

.1 SCO-I: A solid object on which:

.1 the nonfixed contamination on the accessible surface averaged over 300 cm<sup>2</sup> (or the area of the surface if less than 300 cm<sup>2</sup>) does not exceed 4 Bq/cm<sup>2</sup> for beta and gamma emitters and low-toxicity alpha emitters, or 0.4 Bq/cm<sup>2</sup> for all other alpha emitters;

.2 the fixed contamination on the accessible surface averaged over 300 cm<sup>2</sup> (or the area of the surface if less than 300 cm<sup>2</sup>) does not exceed 4 × 10<sup>4</sup> Bq/cm<sup>2</sup> for beta and gamma emitters and low-toxicity alpha emitters, or 4 × 10<sup>3</sup> Bq/cm<sup>2</sup> for all other alpha emitters; or

.3 the nonfixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm<sup>2</sup> (or the area of the surface if less than 300 cm<sup>2</sup>) does not exceed 4 × 10<sup>4</sup> Bq/cm<sup>2</sup> for beta and gamma emitters and low-toxicity alpha emitters, or 4 × 10<sup>3</sup> Bq/cm<sup>2</sup> for all other alpha emitters;

.2 SCO-II: A solid object on which either the fixed or non fixed contamination on the surface exceeds the applicable limits specified for SCO I in 2.7.2.3.2.1 above and on which:

.1 the nonfixed contamination on the accessible surface averaged over 300 cm<sup>2</sup> (or the area of the surface if less than 300 cm<sup>2</sup>) does not exceed 400 Bq/cm<sup>2</sup> for beta and gamma emitters and low-toxicity alpha emitters, or 40 Bq/cm<sup>2</sup> for all other alpha emitters;

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

.3 the nonfixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm<sup>2</sup> (or the area of the surface if less than 300 cm<sup>2</sup>) does not exceed 8 × 10<sup>5</sup> Bq/cm<sup>2</sup> for beta and gamma emitters and low-toxicity alpha emitters, or 8 × 10<sup>4</sup> Bq/cm<sup>2</sup> for all other alpha emitters.

### 2.7.2.3.3 Special form radioactive material

#### 2.7.2.3.3.1

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

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

.3 The design for special form radioactive material requires unilateral approval.

2.7.2.3.3.2 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 2.7.2.3.3.4 to 2.7.2.3.3.8, it shall meet the following requirements:

.1 It would not break or shatter under the impact, percussion and bending tests 2.7.2.3.3.5.1, 2.7.2.3.3.5.2, 2.7.2.3.3.5.3, and 2.7.2.3.3.6.1 as applicable;

.2 It would not melt or disperse in the applicable heat test 2.7.2.3.3.5.4 or 2.7.2.3.3.6.2 as applicable; and

.3 The activity in the water from the leaching tests specified in 2.7.2.3.3.7 and 2.7.2.3.3.8 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.

2.7.2.3.3.3 Demonstration of compliance with the performance standards in 2.7.2.3.3.2 shall be in accordance with 6.4.12.1 and 6.4.12.2.

2.7.2.3.3.4 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 2.7.2.3.3.5 or alternative tests as authorized in 2.7.2.3.3.6. 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 2.7.2.3.3.7 for indispersible solid material or 2.7.2.3.3.8 for encapsulated material.

2.7.2.3.3.5 The relevant test methods are:

.1 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;

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

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

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

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

.1 The tests prescribed in 2.7.2.3.3.5.1 and 2.7.2.3.3.5.2 provided that the specimens are alternatively subjected to the impact test prescribed in ISO 2919:2012, Radiation Protection – Sealed Radioactive Sources – General requirements and classification:

.1 the class 4 impact test if the mass of the special form radioactive material is less than 200 g; and

.2 the class 5 impact test if the mass of the special form radioactive material is equal to or more than 200 g but is less than 500 g.

.2 The test prescribed in 2.7.2.3.3.5.4 provided they are alternatively subjected to the class 6 temperature test specified in ISO 2919:2012, Radiation protection – Sealed radioactive sources – General requirements and classification.

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

.1 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 to 8 and a maximum conductivity of 1 mS/m at 20°C;

.2 The water with specimen shall then be heated to a temperature of  $(50 \pm 5)$ °C and maintained at this temperature for 4 hours;

.3 The activity of the water shall then be determined;

.4 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%;

.5 The specimen shall then be immersed in water of the same specification as in 2.7.2.3.3.7.1 above and the water with the specimen heated to (50 ± 5)°C and maintained at this temperature for 4 hours;

.6 The activity of the water shall then be determined.

2.7.2.3.3.8 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:

.1 The leaching assessment shall consist of the following steps:

.1 the specimen shall be immersed in water at ambient temperature. The water shall have an initial pH of 6 to 8 with a maximum conductivity of 1 mS/m at 20°C;

.2 the water and specimen shall be heated to a temperature of (50 ± 5)°C and maintained at this temperature for 4 hours;

.3 the activity of the water shall then be determined;

.4 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%;

.5 the process in .1, .2 and .3 shall be repeated.

.2 The alternative volumetric leakage assessment shall comprise any of the tests prescribed in ISO 9978:1992, Radiation protection – Sealed radioactive sources – Leakage test methods, provided that they are acceptable to the competent authority.

#### 2.7.2.3.4 Low dispersible material

2.7.2.3.4.1 The design for low dispersible radioactive material shall require multilateral approval. Low dispersible radioactive material shall be such that the total amount of this radioactive material in a package, taking into account the provisions of 6.4.8.14, shall meet the following provisions:

.1 The radiation level at 3 m from the unshielded radioactive material does not exceed 10 mSv/h;

.2 If subjected to the tests specified in 6.4.20.3 and 6.4.20.4, the airborne release in gaseous and particulate forms of up to 100 µm aerodynamic equivalent diameter would not exceed 100A<sub>2</sub>. A separate specimen may be used for each test; and

.3 If subjected to the test specified in 2.7.2.3.1.4, the activity in the water would not exceed 100A<sub>2</sub>. In the application of this test, the damaging effects of the tests specified in 2.7.2.3.4.1.2 above shall be taken into account.

2.7.2.3.4.2 Low dispersible material shall be tested as follows:

A specimen that comprises or simulates low dispersible radioactive material shall be subjected to the enhanced thermal test specified in 6.4.20.3 and the impact test specified in 6.4.20.4. A different specimen may be used for each of the tests. Following each test, the specimen shall be subjected to the leach test specified in 2.7.2.3.1.4. After each test it shall be determined if the applicable provisions of 2.7.2.3.4.1 have been met.

2.7.2.3.4.3 Demonstration of compliance with the performance standards in 2.7.2.3.4.1 and 2.7.2.3.4.2 shall be in accordance with 6.4.12.1 and 6.4.12.2.

### 2.7.2.3.5 Fissile material

Fissile material and packages containing fissile material shall be classified under the relevant entry as "FISSILE" in accordance with table 2.7.2.1.1 unless excepted by one of the provisions of subparagraphs .1 to .6 below and transported subject to the requirements of 5.1.5.5. All provisions apply only to material in packages that meets the requirements of 6.4.7.2 unless unpackaged material is specifically allowed in the provision.

.1 uranium enriched in uranium-235 to a maximum of 1% by mass, and with a total plutonium and uranium-233 content not exceeding 1% of the mass of uranium-235, provided that the fissile nuclides are distributed essentially homogeneously throughout the material. In addition, if uranium-235 is present in metallic, oxide or carbide forms, it shall not form a lattice arrangement;

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

.3 uranium with a maximum uranium enrichment of 5% by mass uranium-235 provided:

.1 there is no more than 3.5 g of uranium-235 per package;

.2 the total plutonium and uranium-233 content does not exceed 1% of the mass of uranium-235 per package;

.3 Transport of the package is subject to the consignment limit provided in 5.1.5.5.3;

.4 fissile nuclides with a total mass not greater than 2 g per package provided the package is transported subject to the consignment limit provided in 5.1.5.5.4;

.5 fissile nuclides with a total mass not greater than 45 g either packaged or unpackaged subject to limits provided in 5.1.5.5.5;

.6 a fissile material that meets the requirements of 5.1.5.5.2, 2.7.2.3.6 and 5.1.5.2.1.

2.7.2.3.6 A fissile material excepted from classification as "FISSILE" under 2.7.2.3.5.6 shall be subcritical without the need for accumulation control under the following conditions:

.1 the conditions of 6.4.11.1 (a);

.2 the conditions consistent with the assessment provisions stated in 6.4.11.12 (b) and 6.4.11.13 (b) for packages; and

.3 the conditions specified in 6.4.11.11 (a), if transported by air.

### 2.7.2.4 Classification of packages or unpacked material

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

#### 2.7.2.4.1 Classification as excepted package

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

.1 it is an empty package having contained radioactive material;

.2 it contains instruments or articles not exceeding the activity limits specified in columns (2) and (3) of table 2.7.2.4.1.2;

- .3 it contains articles manufactured of natural uranium, depleted uranium or natural thorium;
- .4 it contains radioactive material not exceeding the activity limits specified in column (4) of table 2.7.2.4.1.2; or
- .5 it contains less than 0.1 kg of uranium hexafluoride not exceeding the activity limits specified in column (4) of table 2.7.2.4.1.2.

2.7.2.4.1.2 A package containing radioactive material may be classified as an excepted package provided that the radiation level at any point on its external surface does not exceed 5 µSv/h.

Table 2.7.2.4.1.2 - Activity limits for excepted packages

Physical state of contents	Instruments or article		Materials package limits <sup>a</sup>
	Item limits <sup>a</sup>	Package limits <sup>a</sup>	
(1)	(2)	(3)	(4)
<b>Solids</b>			
special form	$10^{-2} A_1$	$A_1$	$10^{-3} A_1$
other form	$10^{-2} A_2$	$A_2$	$10^{-3} A_2$
<b>Liquids</b>	$10^{-3} A_2$	$10^{-1} A_2$	$10^{-4} A_2$
<b>Gases</b>			
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	$10^{-3} A_2$	$10^{-2} A_2$	$10^{-3} A_2$

<sup>a</sup> For mixtures of radionuclides, see 2.7.2.2.4 to 2.7.2.2.6.

2.7.2.4.1.3 Radioactive material which is enclosed in or is included as a component part of an instrument or other manufactured article may be classified under UN 2911, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – INSTRUMENTS or ARTICLES provided that:

.1 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

.2 each instrument or manufactured article bears the mark "RADIOACTIVE" on its external surface except for the following:

.1 radioluminescent time-pieces or devices;

.2 consumer products that either have received regulatory approval in accordance with 1.5.1.4.5 or do not individually exceed the activity limit for an exempt consignment in table 2.7.2.2.1 (column 5), provided such products are transported in a package that bears the mark "RADIOACTIVE" on its internal surface in such a manner that a warning of the presence of radioactive material is visible on opening the package;

.3 other instruments or articles too small to bear the mark "RADIOACTIVE", provided that they are transported in a package that bears the mark "RADIOACTIVE" on its internal surface in such a manner that a warning of the presence of radioactive material is visible on opening the package; and

.3 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); and

.4 the limits specified in columns 2 and 3 of table 2.7.2.4.1.2 are met for each individual item and each package, respectively.

2.7.2.4.1.4 Radioactive material in forms other than as specified in 2.7.2.4.1.3 and with an activity not exceeding the limits specified in column 4 of table 2.7.2.4.1.2, may be classified under UN 2910, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – LIMITED QUANTITY OF MATERIAL provided that:

.1 the package retains its radioactive contents under routine conditions of transport; and

.2 the package bears the mark "RADIOACTIVE" on either:

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

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

2.7.2.4.1.5 Uranium hexafluoride not exceeding the limits specified in column 4 of table 2.7.2.4.1.2 may be classified under UN 3507 URANIUM HEXAFLUORIDE, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, less than 0.1 kg per package, non-fissile or fissile-excepted, provided that:

.1 the mass of uranium hexafluoride in the package is less than 0.1 kg; and

.2 the conditions of 2.7.2.4.5.1 and 2.7.2.4.1.4.1 and 2.7.2.4.1.4.2 are met.

2.7.2.4.1.6 Articles manufactured of natural uranium, depleted uranium or natural thorium and articles in which the sole radioactive material is unirradiated natural uranium, unirradiated depleted uranium or unirradiated natural thorium may be classified under UN 2909, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – ARTICLES MANUFACTURED FROM NATURAL URANIUM or DEPLETED URANIUM or NATURAL THORIUM, provided that the outer surface of the uranium or thorium is enclosed in an inactive sheath made of metal or some other substantial material.

2.7.2.4.1.7 An empty packaging which had previously contained radioactive material may be classified under UN 2908, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – EMPTY PACKAGING, provided that:

.1 it is in a well-maintained condition and securely closed;

.2 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;

.3 the level of internal non fixed contamination, when averaged over any 300 cm<sup>2</sup>, does not exceed:

.1 400 Bq/cm<sup>2</sup> for beta and gamma emitters and low-toxicity alpha emitters; and

.2 40 Bq/cm<sup>2</sup> for all other alpha emitters; and

.4 any labels which may have been displayed on it in conformity with 5.2.2.1.12.1 are no longer visible.

#### 2.7.2.4.2 Classification as Low specific activity (LSA) material

Radioactive material may only be classified as LSA material if the definition of LSA in 2.7.1.3 and the conditions of 2.7.2.3.1, 4.1.9.2 and 7.1.4.5.1 are met.

#### 2.7.2.4.3 Classification as Surface contaminated object (SCO)

Radioactive material may be classified as SCO if the definition of SCO in 2.7.1.3 and the conditions of 2.7.2.3.2, 4.1.9.2 and 7.1.4.5.1 are met.

#### 2.7.2.4.4 Classification as Type A package

Packages containing radioactive material may be classified as Type A packages provided that the following conditions are met:

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

- .1 For special form radioactive material -  $A_1$ ;
- .2 For all other radioactive material -  $A_2$ .

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

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

where:

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

$A_1(i)$  is the  $A_1$  value for radionuclide  $i$ ;

$C(j)$  is the activity of radionuclide  $j$  as other than special form radioactive material;

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

#### 2.7.2.4.5 Classification of uranium hexafluoride

2.7.2.4.5.1 Uranium hexafluoride shall only be assigned to:

- .1 UN 2977, RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, FISSILE;
- .2 UN 2978, RADIOACTIVE MATERIAL, URANIUM HEXAFLUORIDE, non-fissile or fissile-excepted; or
- .3 UN 3507, URANIUM HEXAFLUORIDE, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE less than 0.1 kg per package, non-fissile or fissile-excepted.

2.7.2.4.5.2 The contents of a package containing uranium hexafluoride shall comply with the following requirements:

- .1 for UN Nos. 2977 and 2978, the mass of uranium hexafluoride shall not be different from that allowed for the package design, and for UN 3507, the mass of uranium hexafluoride shall be less than 0.1 kg;
- .2 the mass of uranium hexafluoride shall not be greater than 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; and
- .3 the uranium hexafluoride shall be in solid form and the internal pressure shall not be above atmospheric pressure when presented for transport.

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

2.7.2.4.6.1 Packages not otherwise classified in 2.7.2.4 (2.7.2.4.1 to 2.7.2.4.5) shall be classified in accordance with the competent authority certificate of approval for the package issued by the country of origin of design.

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

#### 2.7.2.5 Special arrangements

Radioactive material shall be classified as transported under special arrangement when it is intended to be transported in accordance with 1.5.4.

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## Chapter 2.8

### Class 8 – Corrosive substances

#### 2.8.1 Definition, general provisions and properties

##### 2.8.1.1 Definition

2.8.1.1.1 Corrosive substances are substances which, by chemical action, will cause irreversible damage to the skin, or, in the case of leakage, will materially damage, or even destroy, other goods or the means of transport.

2.8.1.1.2 For substances and mixtures that are corrosive to skin, general classification provisions are provided in section 2.8.2. Skin corrosion refers to the production of irreversible damage to the skin, namely, visible necrosis through the epidermis and into the dermis occurring after exposure to a substance or mixture.

2.8.1.1.3 Liquids and solids which may become liquid during transport, which are judged not to be skin corrosive shall still be considered for their potential to cause corrosion to certain metal surfaces in accordance with the criteria in 2.8.3.3.2.

##### 2.8.1.2 Properties

2.8.1.2.1 In cases where particularly severe personal damage is to be expected, a note to that effect is made in the Dangerous Goods List in chapter 3.2 in the wording "causes (severe) burns to skin, eyes and mucous membranes".

2.8.1.2.2 Many substances are sufficiently volatile to evolve vapour irritating to the nose and eyes. If so, this fact is mentioned in the Dangerous Goods List in chapter 3.2 in the wording "vapour irritates mucous membranes".

2.8.1.2.3 A few substances may produce toxic gases when decomposed by very high temperatures. In these cases the statement "when involved in a fire, evolves toxic gases" appears in the Dangerous Goods List in chapter 3.2.

2.8.1.2.4 In addition to direct destructive action in contact with skin or mucous membranes, some substances in this class are toxic or harmful. Poisoning may result if they are swallowed, or if their vapour is inhaled; some of them even may penetrate the skin. Where appropriate, a statement is made to that effect in the Dangerous Goods List in chapter 3.2.

2.8.1.2.5 All substances in this class have a more or less destructive effect on materials such as metals and textiles.

2.8.1.2.5.1 In the Dangerous Goods List, the term "corrosive to most metals" means that any metal likely to be present in a ship, or in its cargo, may be attacked by the substance or its vapour.

2.8.1.2.5.2 The term "corrosive to aluminium, zinc, and tin" implies that iron or steel is not damaged in contact with the substance.

2.8.1.2.5.3 A few substances in this class can corrode glass, earthenware and other siliceous materials. Where appropriate, this is stated in the Dangerous Goods List in chapter 3.2.

2.8.1.2.6 Many substances in this class only become corrosive after having reacted with water, or with moisture in the air. This fact is indicated in the Dangerous Goods List in chapter 3.2 by the words "in the presence of moisture...". The reaction of water with many substances is accompanied by the liberation of irritating and corrosive gases. Such gases usually become visible as fumes in the air.

2.8.1.2.7 A few substances in this class generate heat in reaction with water or organic materials, including wood, paper,

fibres, some cushioning materials and certain fats and oils. Where appropriate, this is indicated in the Dangerous Goods List in chapter 3.2.

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## 2.8.2 General classification provisions

2.8.2.1 Substances and mixtures of class 8 are divided among the three packing groups according to their degree of danger in transport:

- .1 packing group I: very dangerous substances and mixtures;
- .2 packing group II: substances and mixtures presenting medium danger; and
- .3 packing group III: substances and mixtures that present minor danger.

2.8.2.2 Allocation of substances listed in the Dangerous Goods List in chapter 3.2 to the packing groups in class 8 has been made on the basis of experience taking into account such additional factors as inhalation risk (see 2.8.2.4) and reactivity with water (including the formation of dangerous decomposition products).

2.8.2.3 New substances and mixtures can be assigned to packing groups on the basis of the length of time of contact necessary to produce irreversible damage of intact skin tissue in accordance with the criteria in 2.8.3. Alternatively, for mixtures, the criteria in 2.8.4 can be used.

2.8.2.4 A substance or mixture meeting the criteria of class 8 having an inhalation toxicity of dusts and mists (LC<sub>50</sub>) 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 (see note under 2.6.2.2.4.1).

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## 2.8.3 Packing group assignment for substances and mixtures

2.8.3.1 Existing human and animal data including information from single or repeated exposure shall be the first line of evaluation, as they give information directly relevant to effects on the skin.

2.8.3.2 In assigning the packing group in accordance with 2.8.2.3, 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 Test Guideline 404<sup>1</sup> or 435.<sup>2</sup> A substance or mixture which is determined not to be corrosive in accordance with OECD Test Guideline 430<sup>3</sup> or 431<sup>4</sup> may be considered not to be corrosive to skin for the purposes of these regulations without further testing.

<sup>1</sup> OECD Guideline for the testing of chemicals No. 404, Acute Dermal Irritation/Corrosion 2015.

<sup>2</sup> OECD Guideline for the testing of chemicals No. 435, In Vitro Membrane Barrier Test Method for Skin Corrosion 2015.

<sup>3</sup> OECD Guideline for the testing of chemicals No. 430, In Vitro Skin Corrosion: Transcutaneous Electrical Resistance Test (TER) 2015.

<sup>4</sup> OECD Guideline for the testing of chemicals No. 431, In Vitro Skin Corrosion: Human Skin Model Test 2015.

2.8.3.3 Packing groups are assigned to corrosive substances in accordance with the following criteria (see table 2.8.3.4):

.1 Packing group I is assigned to substances that cause irreversible damage of intact skin tissue within an observation period of up to 60 minutes starting after the exposure time of 3 minutes or less.

.2 Packing group II is assigned to substances that cause irreversible damage of intact skin tissue within an observation period of up to 14 days starting after the exposure time of more than 3 minutes but not more than 60 minutes.

.3 Packing group III is assigned to substances that:

.1 cause irreversible damage 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

.2 are judged not to cause irreversible damage of intact skin tissue but which exhibit a corrosion rate on either steel or aluminium surfaces exceeding 6.25 mm a year at a test temperature of 55°C when tested on both materials. 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 or Unified Numbering System (UNS) G10200 or a similar type 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. Note: Where an initial test on either steel or aluminium indicates the substance being tested is corrosive, the follow-up test on the other metal is not required.

**Table 2.8.3.4: Table summarizing the criteria in 2.8.3.3**

Packing Group	Exposure Time	Observation Period	Effect
I	≤ 3 min	≤ 60 min	Irreversible damage of intact skin
II	> 3 min ≤ 1 h	≤ 14 d	Irreversible damage of intact skin
III	> 1 h ≤ 4 h	≤ 14 d	Irreversible damage of intact skin
III	-	-	Corrosion rate on either steel or aluminium surfaces exceeding 6.25 mm a year at a test temperature of 55°C when tested on both materials

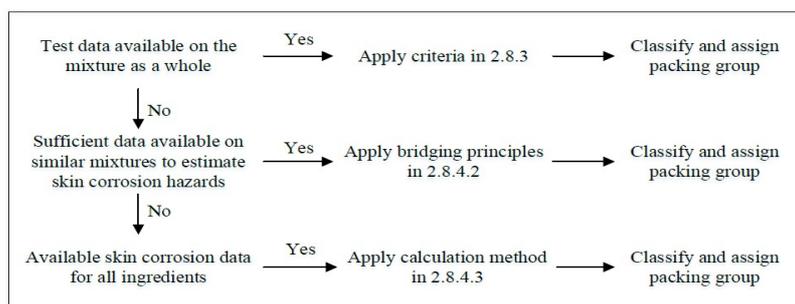
<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.8.4
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**2.8.4 Alternative packing group assignment methods for mixtures: stepwise approach**

2.8.4.1 General provisions

2.8.4.1.1 For mixtures it is necessary to obtain or derive information that allows the criteria to be applied to the mixture for the purpose of classification and assignment of packing groups. The approach to classification and assignment of packing groups is tiered, and is dependent upon the amount of information available for the mixture itself, for similar mixtures and/or for its ingredients. The flow chart of figure 2.8.4.1 below outlines the process to be followed:

**Figure 2.8.4.1: Stepwise approach to classify and assign packing group of corrosive mixtures**



## 2.8.4.2 Bridging principles

2.8.4.2.1 Where a mixture has not been tested to determine its skin corrosion potential, but there are sufficient data on both the individual ingredients and similar tested mixtures to adequately classify and assign a packing group for the mixture, these data will be used in accordance with the following bridging principles. This ensures that the classification process uses the available data to the greatest extent possible in characterizing the hazards of the mixture.

.1 Dilution: If a tested mixture is diluted with a diluent which does not meet the criteria for class 8 and does not affect the packing group of other ingredients, then the new diluted mixture may be assigned to the same packing group as the original tested mixture.

Note: in certain cases, diluting a mixture or substance may lead to an increase in the corrosive properties. If this is the case, this bridging principle cannot be used.

.2 Batching: The skin corrosion potential of a tested production batch of a mixture can be assumed to be substantially equivalent to that of another untested production batch of the same commercial product when produced by or under the control of the same manufacturer, unless there is reason to believe there is significant variation such that the skin corrosion potential of the untested batch has changed. If the latter occurs, a new classification is necessary.

.3 Concentration of mixtures of packing group I: If a tested mixture meeting the criteria for inclusion in packing group I is concentrated, the more concentrated untested mixture may be assigned to packing group I without additional testing.

.4 Interpolation within one packing group: For three mixtures (A, B and C) with identical ingredients, where mixtures A and B have been tested and are in the same skin corrosion packing group, and where untested mixture C has the same class 8 ingredients as mixtures A and B but has concentrations of class 8 ingredients intermediate to the concentrations in mixtures A and B, then mixture C is assumed to be in the same skin corrosion packing group as A and B.

.5 Substantially similar mixtures: Given the following:

.1 two mixtures: (A+B) and (C+B);

.2 the concentration of ingredient B is the same in both mixtures;

.3 the concentration of ingredient A in mixture (A+B) equals the concentration of ingredient C in mixture (C+B); and

.4 data on skin corrosion for ingredients A and C are available and substantially equivalent, i.e. they are the same skin corrosion packing group and do not affect the skin corrosion potential of B.

if mixture (A+B) or (C+B) is already classified based on test data, then the other mixture may be assigned to the same packing group.

## 2.8.4.3 Calculation method based on the classification of the substances

2.8.4.3.1 Where a mixture has not been tested to determine its skin corrosion potential, nor is sufficient data available on similar mixtures, the corrosive properties of the substances in the mixture shall be considered to classify and assign a packing group.

Applying the calculation method is only allowed if there are no synergistic effects that make the mixture more corrosive than the sum of its substances. This restriction applies only if packing group II or III would be assigned to the mixture.

2.8.4.3.2 When using the calculation method, all class 8 ingredients present at a concentration of  $\geq 1\%$  shall be taken into account, or  $< 1\%$  if these ingredients are still relevant for classifying the mixture to be corrosive to skin.

2.8.4.3.3 To determine whether a mixture containing corrosive substances shall be considered a corrosive mixture and to assign a packing group, the calculation method in the flow chart in figure 2.8.4.3 shall be applied.

2.8.4.3.4 When a specific concentration limit (SCL) is assigned to a substance following its entry in the Dangerous Goods List or in a special provision, this limit shall be used instead of the generic concentration limits (GCL). This appears where 1% is used in the first step for the assessment of the packing group I substances, and where 5% is used for the other steps respectively in figure 2.8.4.3.

2.8.4.3.5 For this purpose, the summation formula for each step of the calculation method shall be adapted. This means that, where applicable, the generic concentration limit shall be substituted by the specific concentration limit assigned to the substance(s) (SCLi), and the adapted formula is a weighted average of the different concentration limits assigned to the different substances in the mixture:

$$\frac{PGx_1}{GCL} + \frac{PGx_2}{SCL_2} + \dots + \frac{PGx_i}{SCL_i} \geq 1$$

Where:

PG<sub>x</sub>= concentration of substance 1, 2 ...i in the mixture, assigned to packing group x (I, II or III)

GCL = generic concentration limit

SCL<sub>i</sub>= specific concentration limit assigned to substance i

The criterion for a packing group is fulfilled when the result of the calculation is  $\geq 1$ . The generic concentration limits to be used for the evaluation in each step of the calculation method are those found in figure 2.8.4.3.

Examples for the application of the above formula can be found in the note below.

**Note:** Examples for the application of the above formula

Example 1: A mixture contains one corrosive substance in a concentration of 5% assigned to packing group I without a specific concentration limit:

Calculation for packing group I:  $\frac{5}{5(GCL)} = 1 \rightarrow$  assign to class 8, packing group I.

Example 2: A mixture contains three substances corrosive to skin; two of them (A and B) have specific concentration limits; for the third one (C) the generic concentration limits applies. The rest of the mixture needs not to be taken into consideration.

<b>Substance X in the mixture and its packing group assignment within class 8</b>	<b>Concentration (conc) in the mixture in %</b>	<b>Specific concentration limit (SCL) for packing group I</b>	<b>Specific concentration limit (SCL) for packing group II</b>	<b>Specific concentration limit (SCL) for packing group III</b>
A, assigned to packing group I	3	30%	none	none
B, assigned to packing group I	2	20%	10%	none
C, assigned to packing group III	10	none	none	none

Calculation for packing group I:  $\frac{3 (conc A)}{30 (SCL PGI)} + \frac{2 (conc B)}{20 (SCL PGI)} = 0,2 < 1$

The criterion for packing group I is not fulfilled.

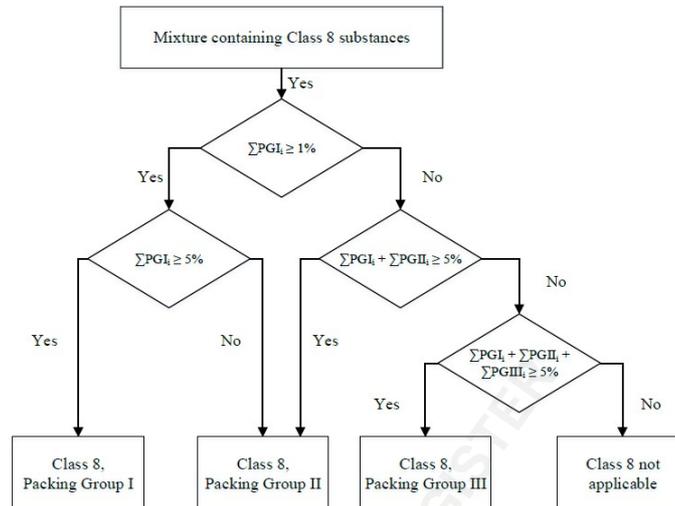
$$\text{Calculation for packing group II: } \frac{3 (\text{conc A})}{5 (\text{GCL PG II})} + \frac{2 (\text{conc B})}{10 (\text{SCL PG II})} = 0,8 < 1$$

The criterion for packing group II is not fulfilled.

$$\text{Calculation for packing group III: } \frac{3 (\text{conc A})}{5 (\text{GCL PG III})} + \frac{2 (\text{conc B})}{5 (\text{GCL PG III})} + \frac{10 (\text{conc C})}{5 (\text{GCL PG III})} = 3 \geq 1$$

The criterion for packing group III is fulfilled, the mixture shall be assigned to class 8, packing group III.

**Figure 2.8.4.3: Calculation method**



<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.8.5
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### 2.8.5 Substances not accepted for transport

Chemically unstable substances of class 8 shall not be accepted for transport unless the necessary precautions have been taken to prevent the possibility of a dangerous decomposition or polymerization under normal conditions of transport. For the precautions necessary to prevent polymerization, see special provision 386 of chapter 3.3. To this end particular care shall be taken to ensure that receptacles and tanks do not contain any substances liable to promote these reactions.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.9.1
<b>Effective Date</b>	1/1/2020
<b>Note</b>	Incorporating Amendment 39-18

## Chapter 2.9

### Miscellaneous dangerous substances and articles (Class 9) and environmentally hazardous substances

Note 1: For the purposes of this Code, the environmentally hazardous substances (aquatic environment) criteria contained in this chapter apply to the classification of marine pollutants (see 2.10).

Note 2: Although the environmentally hazardous substances (aquatic environment) criteria apply to all hazard classes, except for class 7 (see paragraphs 2.10.2.3, 2.10.2.5 and 2.10.3.2), the criteria have been included in this chapter.

#### 2.9.1 Definitions

2.9.1.1 Class 9 substances and articles (miscellaneous dangerous substances and articles) are substances and articles which, during transport, present a danger not covered by other classes.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.9.2
<b>Effective Date</b>	1/1/2020
<b>Note</b>	Incorporating Amendment 39-18

## 2.9.2 Assignment to class 9

2.9.2.1 Class 9 includes, inter alia:

.1 substances and articles not covered by other classes which experience has shown, or may show, to be of such a dangerous character that the provisions of part A of chapter VII of SOLAS, as amended, shall apply.

.2 substances not subject to the provisions of part A in chapter VII of the aforementioned Convention, but to which the provisions of Annex III of MARPOL, as amended, apply.

2.9.2.2 The substances and articles of class 9 are subdivided as follows:

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

2212 ASBESTOS, AMPHIBOLE (amosite, tremolite, actinolite, anthophyllite, crocidolite)

2590 ASBESTOS, CHRYSOTILE

### **Substances evolving flammable vapour**

2211 POLYMERIC BEADS, EXPANDABLE, evolving flammable vapour

3314 PLASTICS MOULDING COMPOUND in dough, sheet or extruded rope form evolving flammable vapour

### **Lithium batteries**

3090 LITHIUM METAL BATTERIES (including lithium alloy batteries)

3091 LITHIUM METAL BATTERIES CONTAINED IN EQUIPMENT (including lithium alloy batteries) or

3091 LITHIUM METAL BATTERIES PACKED WITH EQUIPMENT (including lithium alloy batteries)

3480 LITHIUM ION BATTERIES (including lithium ion polymer batteries)

3481 LITHIUM ION BATTERIES CONTAINED IN EQUIPMENT (including lithium ion polymer batteries) or

3481 LITHIUM ION BATTERIES PACKED WITH EQUIPMENT (including lithium ion polymer batteries)

Note: See 2.9.4.

3536 LITHIUM BATTERIES INSTALLED IN CARGO TRANSPORT UNIT

### **Capacitors**

3499 CAPACITOR, ELECTRIC DOUBLE LAYER (with an energy storage capacity greater than 0.3 Wh)

3508 CAPACITOR, ASYMMETRIC (with an energy storage capacity greater than 0.3 Wh)

### **Life-saving appliances**



2990 LIFE-SAVING APPLIANCES, SELF-INFLATING

3072 LIFE-SAVING APPLIANCES, NOT SELF-INFLATING containing dangerous goods as equipment

3268 SAFETY DEVICES, electrically initiated

#### **Substances and articles which, in the event of fire, may form dioxins**

This group of substances includes:

2315 POLYCHLORINATED BIPHENYLS, LIQUID

3432 POLYCHLORINATED BIPHENYLS, SOLID

3151 POLYHALOGENATED BIPHENYLS, LIQUID or

3151 HALOGENATED MONOMETHYLDIPHENYLMETHANES, LIQUID or

3151 POLYHALOGENATED TERPHENYLS, LIQUID

3152 POLYHALOGENATED BIPHENYLS, SOLID or

3152 HALOGENATED MONOMETHYLDIPHENYLMETHANES, SOLID or

3152 POLYHALOGENATED TERPHENYLS, SOLID

Examples of articles are transformers, condensers and apparatus containing those substances.

#### **Substances transported or offered for transport at elevated temperatures**

3257 ELEVATED TEMPERATURE LIQUID, N.O.S., at or above 100°C and below its flashpoint (including molten metal, molten salts, etc.)

3258 ELEVATED TEMPERATURE SOLID, N.O.S., at or above 240°C

#### **Environmentally hazardous substances**

3077 ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S.

3082 ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S.

These entries are used for substances and mixtures which are dangerous to the aquatic environment that do not meet the classification criteria of any other class or another substance within class 9. These entries may also be used for wastes not otherwise subject to the provisions of this Code but which are covered under the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal and for substances designated to be environmentally hazardous substances by the competent authority of the country of origin, transit or destination which do not meet the criteria for an environmentally hazardous substance according to the provisions of this Code or for any other hazard class. The criteria for substances which are hazardous to the aquatic environment are given in section 2.9.3.

#### **Genetically modified microorganisms (GMMOs) and genetically modified organisms (GMOs)**

3245 GENETICALLY MODIFIED MICROORGANISMS or

3245 GENETICALLY MODIFIED ORGANISMS

GMMOs and GMOs which do not meet the definition of toxic substances (see 2.6.2) or infectious substances (see 2.6.3)

shall be assigned to UN 3245.

GMMOs or GMOs are not subject to the provisions of this Code when authorized for use by the competent authorities of the countries of origin, transit and destination.

Genetically modified live animals shall be transported under terms and conditions of the competent authorities of the countries of origin and destination.

Ammonium nitrate based fertilizers

2071 AMMONIUM NITRATE BASED FERTILIZER

Solid ammonium nitrate based fertilizers shall be classified in accordance with the procedure as set out in the Manual of Tests and Criteria, part III, section 39.

**Other substances or articles presenting a danger during transport, but not meeting the definitions of another class:**

1841 ACETALDEHYDE AMMONIA

1845 CARBON DIOXIDE, SOLID (DRY ICE)

1931 ZINC DITHIONITE (ZINC HYDROSULPHITE)

1941 DIBROMODIFLUOROMETHANE

1990 BENZALDEHYDE

2216 FISH MEAL (FISH SCRAP), STABILIZED

2807 MAGNETIZED MATERIAL\*

2969 CASTOR BEANS or

2969 CASTOR MEAL or

2969 CASTOR POMACE or

2969 CASTOR FLAKE

3166 VEHICLE, FLAMMABLE GAS POWERED or

3166 VEHICLE, FLAMMABLE LIQUID POWERED or

3166 VEHICLE, FUEL CELL, FLAMMABLE GAS POWERED or

3166 VEHICLE, FUEL CELL, FLAMMABLE LIQUID POWERED

3171 BATTERY-POWERED VEHICLE or

3171 BATTERY-POWERED EQUIPMENT

3316 CHEMICAL KIT or

3316 FIRST AID KIT

KOREAN REGISTER

3334 AVIATION REGULATED LIQUID, N.O.S.\*

3335 AVIATION REGULATED SOLID, N.O.S.\*

3359 FUMIGATED CARGO TRANSPORT UNIT

3363 DANGEROUS GOODS IN MACHINERY or

3363 DANGEROUS GOODS IN APPARATUS

3496 BATTERIES, NICKEL-METAL HYDRIDE

3509 PACKAGINGS, DISCARDED, EMPTY, UNCLEANED†

3530 ENGINE, INTERNAL COMBUSTION or

3530 MACHINERY, INTERNAL COMBUSTION

3548 ARTICLES CONTAINING MISCELLANEOUS DANGEROUS GOODS N.O.S.

\* Not subject to the provisions of this Code but may be subject to provisions governing the transport of dangerous goods by other modes (see also special provision 960).

† This entry shall not be used for sea transport. Discarded packaging shall meet the requirements of 4.1.1.11.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.9.3
<b>Effective Date</b>	1/1/2020
<b>Note</b>	Incorporating Amendment 39-18

### 2.9.3 Environmentally hazardous substances (aquatic environment)

#### 2.9.3.1 General definitions

2.9.3.1.1 Environmentally hazardous substances include, inter alia, liquid or solid substances pollutant to the aquatic environment and solutions and mixtures of such substances (such as preparations and wastes).

For the purposes of this section,

Substance means chemical elements and their compounds in the natural state or obtained by any production process, including any additive necessary to preserve the stability of the product and any impurities deriving from the process used, but excluding any solvent which may be separated without affecting the stability of the substance or changing its composition.

2.9.3.1.2 The aquatic environment may be considered in terms of the aquatic organisms that live in the water, and the aquatic ecosystem of which they are part.\* The basis, therefore, of the identification of hazard is the aquatic toxicity of the substance or mixture, although this may be modified by further information on the degradation and bioaccumulation behaviour.

\* This does not address aquatic pollutants for which there may be a need to consider effects beyond the aquatic environment such as the impacts on human health, etc.

2.9.3.1.3 While the following classification procedure is intended to apply to all substances and mixtures, it is recognized that in some cases, e.g. metals or poorly soluble inorganic compounds, special guidance will be necessary.†

† This can be found in annex 10 of the GHS.

2.9.3.1.4 The following definitions apply for acronyms or terms used in this section:

BCF - bioconcentration factor;

BOD - biochemical oxygen demand;

COD - chemical oxygen demand;

GLP - good laboratory practices;

EC<sub>x</sub> - the concentration associated with x% response;

EC<sub>50</sub> - the effective concentration of substance that causes 50% of the maximum response;

ErC<sub>50</sub> - EC<sub>50</sub> in terms of reduction of growth;

K<sub>ow</sub> - octanol/water partition coefficient;

LC<sub>50</sub> (50% lethal concentration) - the concentration of a substance in water which causes the death of 50% (one half) in a group of test animals;

L(E)C<sub>50</sub> - LC<sub>50</sub> or EC<sub>50</sub>;

NOEC (no observed effect concentration) - the test concentration immediately below the lowest tested concentration with statistically significant adverse effect. The NOEC has no statistically significant adverse effect compared to the control;

OECD Test Guidelines - Test guidelines published by the Organization for Economic Co-operation and Development (OECD).

### 2.9.3.2 Definitions and data requirements

2.9.3.2.1 The basic elements for classification of environmentally hazardous substances (aquatic environment) are:

- .1 acute aquatic toxicity;
- .2 chronic aquatic toxicity;
- .3 potential for or actual bioaccumulation; and
- .4 degradation (biotic or abiotic) for organic chemicals;

2.9.3.2.2 While data from internationally harmonized test methods are preferred, in practice, data from national methods may also be used where they are considered as equivalent. In general, it has been agreed that freshwater and marine species toxicity data can be considered as equivalent data and are preferably to be derived using OECD Test Guidelines or equivalent according to the principles of good laboratory practices (GLP). Where such data are not available, classification shall be based on the best available data.

2.9.3.2.3 Acute aquatic toxicity means the intrinsic property of a substance to be injurious to an organism in a short-term aquatic exposure to that substance.

Acute (short-term) hazard, for classification purposes, means the hazard of a chemical caused by its acute toxicity to an organism during short-term aquatic exposure to that chemical.

Acute aquatic toxicity shall normally be determined using a fish 96 h LC<sub>50</sub> (OECD Test Guideline 203 or equivalent), a crustacea species 48 h EC<sub>50</sub> (OECD Test Guideline 202 or equivalent) and/or an algal species 72 or 96 h EC<sub>50</sub> (OECD Test Guideline 201 or equivalent). These species are considered as surrogate for all aquatic organisms and data on other species such as Lemna may also be considered if the test methodology is suitable.

2.9.3.2.4 Chronic aquatic toxicity means the intrinsic property of a substance to cause adverse effects to aquatic organisms during aquatic exposures which are determined in relation to the life cycle of the organism.

Long-term hazard, for classification purposes, means the hazard of a chemical caused by its chronic toxicity following long-term exposure in the aquatic environment.

Chronic toxicity data are less available than acute data and the range of testing procedures less standardized. Data generated according to the OECD Test Guidelines 210 (Fish Early Life Stage) or 211 (Daphnia Reproduction) and 201 (Algal Growth Inhibition) may be accepted. Other validated and internationally accepted tests may also be used. The NOECs or other equivalent EC<sub>x</sub> shall be used.

2.9.3.2.5 Bioaccumulation means net result of uptake, transformation and elimination of a substance in an organism due to all routes of exposure (i.e. air, water, sediment/soil and food).

The potential for bioaccumulation shall normally be determined by using the octanol/water partition coefficient, usually reported as a log K<sub>ow</sub> determined according to OECD Test Guidelines 107, 117 or 123. While this represents a potential to bioaccumulate, an experimentally determined bioconcentration factor (BCF) provides a better measure and shall be used in preference when available. A BCF shall be determined according to OECD Test Guideline 305.

2.9.3.2.6 Degradation means the decomposition of organic molecules to smaller molecules and eventually to carbon dioxide, water and salts.

Environmental degradation may be biotic or abiotic (e.g. hydrolysis) and the criteria used reflect this fact. Ready biodegradation is most easily defined using the biodegradability tests (A to F) of OECD Test Guidelines 301. A pass level in these tests may be considered as indicative of rapid degradation in most environments. These are freshwater tests and thus the use of the results from OECD Test Guideline 306, which is more suitable for marine environments, has also been included. Where such data are not available, a BOD(5 days)/COD ratio  $\geq 0.5$  is considered as indicative of rapid degradation. Abiotic degradation such as hydrolysis, primary degradation, both abiotic and biotic, degradation in non-aquatic media and proven rapid degradation in the environment may all be considered in defining rapid degradability.\*

\* Special guidance on data interpretation is provided in chapter 4.1 and annex 9 of the GHS.

Substances are considered rapidly degradable in the environment if the following criteria are met:

.1 In 28-day ready biodegradation studies, the following levels of degradation are achieved:

.1 tests based on dissolved organic carbon: 70%;

.2 tests based on oxygen depletion or carbon dioxide generation: 60% of theoretical maxima.

These levels of biodegradation shall be achieved within 10 days of the start of degradation which point is taken as the time when 10% of the substance has been degraded, unless the substance is identified as a complex, multi-component substance with structurally similar constituents. In this case, and where there is sufficient justification, the 10-day window condition may be waived and the pass level applied at 28 days;†

† See chapter 4.1 and annex 9, paragraph A9.4.2.2.3 of the GHS.

.2 in those cases where only BOD and COD data are available, when the ratio of BOD5/COD is  $\geq 0.5$ ; or

.3 if other convincing scientific evidence is available to demonstrate that the substance or mixture can be degraded (biotically and/or abiotically) in the aquatic environment to a level above 70% within a 28-day period.

### 2.9.3.3 Substance classification categories and criteria

2.9.3.3.1 Substances shall be classified as “environmentally hazardous substances (aquatic environment)”, if they satisfy the criteria for Acute 1, Chronic 1 or Chronic 2, according to table 2.9.1. These criteria describe in detail the classification categories. They are diagrammatically summarized in table 2.9.2.

Table 2.9.1 – Categories for substances hazardous to the aquatic environment (see note 1)

#### (a) Acute (short-term) aquatic hazard

<b>Category: Acute 1</b> (see note 2)	
96 hr LC <sub>50</sub> (for fish)	≤ 1 mg/L and/or
48 hr EC <sub>50</sub> (for crustacea)	≤ 1 mg/L and/or
72 or 96 hr ErC <sub>50</sub> (for algae or other aquatic plants)	≤ 1 mg/L (see note 3)

#### (b) Long-term aquatic hazard (see also figure 2.9.1)

##### (i) Non-rapidly degradable substances (see note 4) for which there are adequate chronic toxicity data available

<b>Category: Chronic 1</b> (see note 2)	
Chronic NOEC or EC <sub>x</sub> (for fish)	≤ 0.1 mg/L and/or
Chronic NOEC or EC <sub>x</sub> (for crustacea)	≤ 0.1 mg/L and/or
Chronic NOEC or EC <sub>x</sub> (for algae or other aquatic plants)	≤ 0.1 mg/L
<b>Category: Chronic 2</b>	
Chronic NOEC or EC <sub>x</sub> (for fish)	≤ 1 mg/L and/or
Chronic NOEC or EC <sub>x</sub> (for crustacea)	≤ 1 mg/L and/or
Chronic NOEC or EC <sub>x</sub> (for algae or other aquatic plants)	≤ 1 mg/L

##### (ii) Rapidly degradable substances for which there are adequate chronic toxicity data available

<b>Category: Chronic 1</b> (see note 2)	
Chronic NOEC or EC <sub>x</sub> (for fish)	≤ 0.01 mg/L and/or
Chronic NOEC or EC <sub>x</sub> (for crustacea)	≤ 0.01 mg/L and/or
Chronic NOEC or EC <sub>x</sub> (for algae or other aquatic plants)	≤ 0.01 mg/L
<b>Category: Chronic 2</b>	
Chronic NOEC or EC <sub>x</sub> (for fish)	≤ 0.1 mg/L and/or
Chronic NOEC or EC <sub>x</sub> (for crustacea)	≤ 0.1 mg/L and/or
Chronic NOEC or EC <sub>x</sub> (for algae or other aquatic plants)	≤ 0.1 mg/L

##### (iii) Substances for which adequate chronic toxicity data are not available

<b>Category: Chronic 1</b> (see note 2)	
96 hr LC <sub>50</sub> (for fish)	≤ 1 mg/L and/or
48 hr EC <sub>50</sub> (for crustacea)	≤ 1 mg/L and/or
72 or 96 hr ErC <sub>50</sub> (for algae or other aquatic plants)	≤ 1 mg/L(see note3)
and the substance is not rapidly degradable and/or the experimentally determined BCF is ≥ 500 (or, if absent, the log K <sub>ow</sub> ≥ 4) (see notes 4 and 5)	
<b>Category: Chronic 2</b>	
96 hr LC <sub>50</sub> (for fish)	>1 but ≤ 10 mg/L and/or
48 hr EC <sub>50</sub> (for crustacea)	>1 but ≤ 10 mg/L and/or
72 or 96 hr ErC <sub>50</sub> (for algae or other aquatic plants)	>1 but ≤ 10 mg/L(see note3)
and the substance is not rapidly degradable and/or the experimentally determined BCF is ≥ 500 (or, if absent, the log K <sub>ow</sub> ≥ 4) (see notes 4 and 5)	

Note 1: The organisms fish, crustacea and algae are tested as surrogate species covering a range of trophic levels and taxa, and the test methods are highly standardized. Data on other organisms may also be considered, however, provided they represent equivalent species and test endpoints.

Note 2: When classifying substances as Acute 1 and/or Chronic 1 it is necessary at the same time to indicate an appropriate M factor (see 2.9.3.4.6.4) to apply the summation method.

Note 3: Where the algal toxicity ErC50 (= EC<sub>50</sub> (growth rate)) falls more than 100 times below the next most sensitive species and results in a classification based solely on this effect, consideration shall be given to whether this toxicity is representative of the toxicity to aquatic plants. Where it can be shown that this is not the case, professional judgment shall be used in deciding if classification shall be applied. Classification shall be based on the ErC<sub>50</sub>. In circumstances where the basis of the EC<sub>50</sub> is not specified and no ErC<sub>50</sub> is recorded, classification shall be based on the lowest EC<sub>50</sub> available.

Note 4: Lack of rapid degradability is based on either a lack of ready biodegradability or other evidence of lack of rapid degradation. When no useful data on degradability are available, either experimentally determined or estimated data, the substance shall be regarded as not rapidly degradable.

Note 5: Potential to bioaccumulate, based on an experimentally derived BCF ≥ 500 or, if absent, a log K<sub>ow</sub> ≥ 4 provided log K<sub>ow</sub> is an appropriate descriptor for the bioaccumulation potential of the substance. Measured log K<sub>ow</sub> values take precedence over estimated values and measured BCF values take precedence over log K<sub>ow</sub> values.

Figure 2.9.1 – Categories for substances long-term hazardous to the aquatic environment

2.9.3.3.2 The classification scheme in table 2.9.2 below summarizes the classification criteria for substances.

Table 2.9.2 – Classification scheme for substances hazardous to the aquatic environment

Classification categories			
Acute hazard (see note 1)	Long-term hazard (see note 2)		
	Adequate chronic toxicity data available		Adequate chronic toxicity data not available (see note 1)
	Non-rapidly degradable substances (see note 3)	Rapidly degradable substances (see note 3)	
<b>Category: Acute 1</b>	<b>Category: Chronic 1</b>	<b>Category: Chronic 1</b>	<b>Category: Chronic 1</b>
L(E)C <sub>50</sub> ≤ 1.00	NOEC or EC <sub>x</sub> ≤ 0.1	NOEC or EC <sub>x</sub> ≤ 0.01	L(E)C <sub>50</sub> ≤ 1.00 and lack of rapid degradability and/or BCF ≥ 500 or, if absent, log K <sub>ow</sub> ≥ 4
	<b>Category: Chronic 2</b>	<b>Category: Chronic 2</b>	Category: Chronic 2
	0.1 < NOEC or EC <sub>x</sub> ≤ 1	0.01 < NOEC or EC <sub>x</sub> ≤ 0.1	1.00 < L(E)C <sub>50</sub> ≤ 10.0 and lack of rapid degradability and/or BCF ≥ 500 or, if absent, log K <sub>ow</sub> ≥ 4

Note 1: Acute toxicity band based on L(E)C<sub>50</sub> values in mg/L for fish, crustacea and/or algae or other aquatic plants (or Quantitative Structure Activity Relationships (QSAR) estimation if no experimental data).\*

\* Special guidance is provided in chapter 4.1, paragraph 4.1.2.13 and annex 9, section A9.6 of the GHS.

Note 2: Substances are classified in the various chronic categories unless there are adequate chronic toxicity data available for all three trophic levels above the water solubility or above 1 mg/L. ("Adequate" means that the data sufficiently cover the endpoint of concern. Generally this would mean measured test data, but in order to avoid unnecessary testing it can on a case by case basis also be estimated data, e.g. (Q)SAR, or for obvious cases expert judgment).

Note 3: Chronic toxicity band based on NOEC or equivalent EC<sub>x</sub> values in mg/L for fish or crustacea or other recognized measures for chronic toxicity.

### 2.9.3.4 Mixtures classification categories and criteria



2.9.3.4.1 The classification system for mixtures covers the classification categories which are used for substances, meaning categories Acute 1 and Chronic 1 and 2. In order to make use of all available data for purposes of classifying the aquatic environmental hazards of the mixture, the following assumption is made and is applied where appropriate:

The "relevant ingredients" of a mixture are those which are present in a concentration equal to or greater than 0.1% (by mass) for ingredients classified as Acute and/or Chronic 1 and equal to or greater than 1% for other ingredients, unless there is a presumption (e.g. in the case of highly toxic ingredients) that an ingredient present at less than 0.1% can still be relevant for classifying the mixture for aquatic environmental hazards.

2.9.3.4.2 The approach for classification of aquatic environmental hazards is tiered, and is dependent upon the type of information available for the mixture itself and for its ingredients. Elements of the tiered approach include:

- .1 classification based on tested mixtures;
- .2 classification based on bridging principles;
- .3 the use of "summation of classified ingredients" and/or an "additivity formula".

Figure 2.9.2 outlines the process to be followed.



Figure 2.9.2 – Tiered approach to classification of mixtures for acute and long-term aquatic environmental hazards

2.9.3.4.3 Classification of mixtures when toxicity data are available for the complete mixture

2.9.3.4.3.1 When the mixture as a whole has been tested to determine its aquatic toxicity, this information shall be used for classifying the mixture according to the criteria that have been agreed for substances. The classification is normally based on the data for fish, crustacea and algae/plants (see 2.9.3.2.3 and 2.9.3.2.4). When adequate acute or chronic data for the mixture as a whole are lacking, "bridging principles" or "summation method" shall be applied (see 2.9.3.4.4 to 2.9.3.4.6).

2.9.3.4.3.2 The long-term hazard classification of mixtures requires additional information on degradability and in certain cases bioaccumulation. There are no degradability and bioaccumulation data for mixtures as a whole. Degradability and bioaccumulation tests for mixtures are not used as they are usually difficult to interpret, and such tests may be meaningful only for single substances.

#### 2.9.3.4.3.3 Classification for category Acute 1

(a) When there are adequate acute toxicity test data ( $LC_{50}$  or  $EC_{50}$ ) available for the mixture as a whole showing  $L(E)C_{50} \leq 1$  mg/L:

Classify the mixture as Acute 1 in accordance with table 2.9.1 (a);

(b) When there are acute toxicity test data ( $LC_{50(s)}$  or  $EC_{50(s)}$ ) available for the mixture as a whole showing  $L(E)C_{50(s)} > 1$  mg/L, or above the water solubility:

No need to classify for acute hazard under these Regulations.

#### 2.9.3.4.3.4 Classification for categories Chronic 1 and 2

(a) When there are adequate chronic toxicity data ( $EC_x$  or NOEC) available for the mixture as a whole showing  $EC_x$  or NOEC of the tested mixture  $\leq 1$  mg/L:

(i) classify the mixture as Chronic 1 or 2 in accordance with table 2.9.1 (b)(ii) (rapidly degradable) if the available information allows the conclusion that all relevant ingredients of the mixture are rapidly degradable;

(ii) classify the mixture as Chronic 1 or 2 in all other cases in accordance with table 2.9.1 (b)(i) (non-rapidly degradable);

(b) When there are adequate chronic toxicity data ( $EC_x$  or NOEC) available for the mixture as a whole showing  $EC_x(s)$  or NOEC(s) of the tested mixture  $> 1$  mg/L or above the water solubility:

No need to classify for long-term hazard under these Regulations.

#### 2.9.3.4.4 Classification of mixtures when toxicity data are not available for the complete mixture: bridging principles

2.9.3.4.4.1 Where the mixture itself has not been tested to determine its aquatic environmental hazard, but there are sufficient data on the individual ingredients and similar tested mixtures to adequately characterize the hazards of the mixture, these data shall be used in accordance with the following agreed bridging rules. This ensures that the classification process uses the available data to the greatest extent possible in characterizing the hazards of the mixture without the necessity for additional testing in animals.

#### 2.9.3.4.4.2 Dilution

2.9.3.4.4.2.1 Where a new mixture is formed by diluting a tested mixture or a substance with a diluent which has an equivalent or lower aquatic hazard classification than the least toxic original ingredient and which is not expected to affect the aquatic hazards of other ingredients, then the resulting mixture shall be classified as equivalent to the original tested mixture or substance. Alternatively, the method explained in 2.9.3.4.5 may be applied.

2.9.3.4.4.2.2 If a mixture is formed by diluting another classified mixture or a substance with water or other totally non-toxic material, the toxicity of the mixture shall be calculated from the original mixture or substance.

#### 2.9.3.4.4.3 Batching

2.9.3.4.4.3.1 The aquatic hazard classification of a tested production batch of a mixture shall be assumed to be substantially equivalent to that of another untested production batch of the same commercial product when produced by or under the control of the same manufacturer, unless there is reason to believe there is significant

variation such that the aquatic hazard classification of the untested batch has changed. If the latter occurs, new classification is necessary.

#### 2.9.3.4.4.4 Concentration of mixtures which are classified with the most severe classification categories (Chronic 1 and Acute 1)

2.9.3.4.4.4.1 If a tested mixture is classified as Chronic 1 and/or Acute 1, and the ingredients of the mixture which are classified as Chronic 1 and/or Acute 1 are further concentrated, the more concentrated untested mixture shall be classified with the same classification category as the original tested mixture without additional testing.

#### 2.9.3.4.4.5 Interpolation within one toxicity category

2.9.3.4.4.5.1 For three mixtures (A, B and C) with identical ingredients, where mixtures A and B have been tested and are in the same toxicity category, and where untested mixture C has the same toxicologically active ingredients as mixtures A and B but has concentrations of toxicologically active ingredients intermediate to the concentrations in mixtures A and B, then mixture C is assumed to be in the same category as A and B.

#### 2.9.3.4.4.6 Substantially similar mixtures

2.9.3.4.4.6.1 Given the following:

(a) Two mixtures:

(i) A + B

(ii) C + B

(b) The concentration of ingredient B is essentially the same in both mixtures;

(c) The concentration of ingredient A in mixture (i) equals that of ingredient C in mixture (ii);

(d) Data on aquatic hazards for A and C are available and are substantially equivalent, i.e. they are in the same hazard category and are not expected to affect the aquatic toxicity of B.

If mixture (i) or (ii) is already classified based on test data, then the other mixture can be assigned the same hazard category.

#### 2.9.3.4.5 Classification of mixtures when toxicity data are available for all ingredients or only for some ingredients of the mixture

2.9.3.4.5.1 The classification of a mixture shall be based on summation of the concentrations of its classified ingredients. The percentage of ingredients classified as Acute or Chronic will feed straight into the summation method. Details of the summation method are described in 2.9.3.4.6.1 to 2.9.3.4.6.4.1.

2.9.3.4.5.2 Mixtures may be made of a combination of both ingredients that are classified (as Acute 1 and/or Chronic 1, 2) and those for which adequate toxicity test data are available. When adequate toxicity data are available for more than one ingredient in the mixture, the combined toxicity of those ingredients shall be calculated using the following additivity formulas (a) or (b), depending on the nature of the toxicity data:

(a) Based on acute aquatic toxicity:

$$\frac{\sum c_i}{L(E)C_{50m}} = \sum_{i=1}^n \frac{c_i}{L(E)C_{50i}}$$

where:

$C_i$  = concentration of ingredient  $i$  (mass percentage);

$L(E)C_{50i}$  =  $LC_{50}$  or  $EC_{50}$  for ingredient  $i$  (mg/l);

$n$  = number of ingredients, and  $i$  is running from 1 to  $n$ ; and

$L(E)C_{50m}$  =  $L(E)C_{50}$  of the part of the mixture with test data

The calculated toxicity shall be used to assign that portion of the mixture an acute hazard category which is then subsequently used in applying the summation method;

(b) Based on chronic aquatic toxicity:

$$\frac{\sum C_i + \sum C_j}{EqNOEC_m} = \sum \frac{C_i}{NOEC_i} + \sum \frac{C_j}{0.1 \times NOEC_j}$$

where:

$C_i$  = concentration of ingredient  $i$  (mass percentage) covering the rapidly degradable ingredients;

$C_j$  = concentration of ingredient  $j$  (mass percentage) covering the non-rapidly degradable ingredients;

$NOEC_i$  = NOEC (or other recognized measures for chronic toxicity) for ingredient  $i$  covering the rapidly degradable ingredients, in mg/l;

$NOEC_j$  = NOEC (or other recognized measures for chronic toxicity) for ingredient  $j$  covering the non-rapidly degradable ingredients, in mg/l;

$n$  = number of ingredients, and  $i$  and  $j$  are running from 1 to  $n$ ;

$EqNOEC_m$  = equivalent NOEC of the part of the mixture with test data;

The equivalent toxicity thus reflects the fact that non-rapidly degrading substances are classified one hazard category level more "severe" than rapidly degrading substances.

The calculated equivalent toxicity shall be used to assign that portion of the mixture a long-term hazard category, in accordance with the criteria for rapidly degradable substances (table 2.9.1 (b)(ii)), which is then subsequently used in applying the summation method.

2.9.3.4.5.3 When applying the additivity formula for part of the mixture, it is preferable to calculate the toxicity of this part of the mixture using for each ingredient toxicity values that relate to the same taxonomic group (i.e. fish, crustacea or algae) and then to use the highest toxicity (lowest value) obtained (i.e. use the most sensitive of the three groups). However, when toxicity data for each ingredient are not available in the same taxonomic group, the toxicity value of each ingredient shall be selected in the same manner that toxicity values are selected for the classification of substances, i.e. the higher toxicity (from the most sensitive test organism) is used. The calculated acute and chronic toxicity shall then be used to classify this part of the mixture as Acute 1 and/or Chronic 1 or 2 using the same criteria described for substances.

2.9.3.4.5.4 If a mixture is classified in more than one way, the method yielding the more conservative result shall be used.

#### 2.9.3.4.6 Summation method

##### 2.9.3.4.6.1 Classification procedure

2.9.3.4.6.1.1 In general a more severe classification for mixtures overrides a less severe classification, e.g. a classification with Chronic 1 overrides a classification with Chronic 2. As a consequence the classification procedure is already completed if the results of the classification is Chronic 1. A more severe classification than Chronic 1 is not possible; therefore, it is not necessary to pursue the classification procedure further.

#### 2.9.3.4.6.2 Classification for the category Acute 1

2.9.3.4.6.2.1 First, all ingredients classified as Acute 1 are considered. If the sum of the concentrations (in %) of these ingredients is greater than or equal to 25% the whole mixture shall be classified as Acute 1. If the result of the calculation is a classification of the mixture as Acute 1, the classification process is completed.

2.9.3.4.6.2.2 The classification of mixtures for acute hazards based on this summation of the concentrations of classified ingredients is summarized in table 2.9.3 below.

Table 2.9.3 – Classification of a mixture for acute hazards based on summation of the concentrations of classified ingredients

Sum of the concentrations (in %) of ingredients classified as:	Mixture is classified as:
Acute 1 x $M^*$ $\geq$ 25%	Acute 1

\* For explanation of the M factor, see 2.9.3.4.6.4.

#### 2.9.3.4.6.3 Classification for categories Chronic 1 and 2

2.9.3.4.6.3.1 First, all ingredients classified as Chronic 1 are considered. If the sum of the concentrations (in %) of these ingredients is greater than or equal to 25% the mixture shall be classified as Chronic 1. If the result of the calculation is a classification of the mixture as Chronic 1 the classification procedure is completed

2.9.3.4.6.3.2 In cases where the mixture is not classified as Chronic 1, classification of the mixture as Chronic 2 is considered. A mixture shall be classified as Chronic 2 if 10 times the sum of the concentrations (in %) of all ingredients classified as Chronic 1 plus the sum of the concentrations (in %) of all ingredients classified as Chronic 2 is greater than or equal to 25%. If the result of the calculation is classification of the mixture as Chronic 2, the classification process is completed.

2.9.3.4.6.3.3 The classification of mixtures for long-term hazards based on this summation of the concentrations of classified ingredients is summarized in table 2.9.4 below.

Table 2.9.4 – Classification of a mixture for long-term hazards based on summation of the concentrations of classified ingredients

Sum of the concentrations (in %) of ingredients classified as:	Mixture classified as:
Chronic 1 x $M^*$ $\geq$ 25%	Chronic 1
$(M \times 10 \times \text{Chronic 1}) + \text{Chronic 2} \geq 25\%$	Chronic 2

\* For explanation of the M factor, see 2.9.3.4.6.4.

#### 2.9.3.4.6.4 Mixtures with highly toxic ingredients

2.9.3.4.6.4.1 Acute 1 or Chronic 1 ingredients with acute toxicities well below 1 mg/L and/or chronic toxicities well below 0.1 mg/L (if non-rapidly degradable) and 0.01 mg/L (if rapidly degradable) may influence the toxicity of the mixture and are given increased weight in applying the summation method. When a mixture contains ingredients classified as Acute 1 or Chronic 1, the tiered approach described in 2.9.3.4.6.2 and 2.9.3.4.6.3 shall be applied using a weighted sum by multiplying the concentrations of Acute 1 and Chronic 1 ingredients by a factor, instead of merely adding up the percentages. This means that the concentration of Acute 1 in the left column of table 2.9.3 and the concentration of Chronic 1 in the left column of table 2.9.4 are multiplied by the appropriate multiplying factor. The multiplying factors to be applied to these ingredients are defined using the toxicity value, as summarized in table

2.9.5 below. Therefore, in order to classify a mixture containing Acute 1 and/or Chronic 1 ingredients, the classifier needs to be informed of the value of the M factor in order to apply the summation method. Alternatively, the additivity formula (2.9.3.4.5.2) may be used when toxicity data are available for all highly toxic ingredients in the mixture and there is convincing evidence that all other ingredients, including those for which specific acute and/or chronic toxicity data are not available, are of low or no toxicity and do not significantly contribute to the environmental hazard of the mixture.

Table 2.9.5 – Multiplying factors for highly toxic ingredients of mixtures

Acute toxicity L(E)C <sub>50</sub> value	M factor	Chronic toxicity NOEC value	M factor	
			NRD* ingredients	RD† ingredients
0.1 < L(E)C <sub>50</sub> ≤ 1	1	0.01 < NOEC ≤ 0.1	1	-
0.01 < L(E)C <sub>50</sub> ≤ 0.1	10	0.001 < NOEC ≤ 0.01	10	1
0.001 < L(E)C <sub>50</sub> ≤ 0.01	100	0.0001 < NOEC ≤ 0.001	100	10
0.0001 < L(E)C <sub>50</sub> ≤ 0.001	1,000	0.00001 < NOEC ≤ 0.0001	1,000	100
0.00001 < L(E)C <sub>50</sub> ≤ 0.0001	10,000	0.000001 < NOEC ≤ 0.00001	10,000	1,000
(continue in factor 10 intervals)		(continue in factor 10 intervals)		

\* Non-rapidly degradable.

† Rapidly degradable.

#### 2.9.3.4.6.5 Classification of mixtures with ingredients without any useable information

2.9.3.4.6.5.1 In the event that no useable information on acute and/or chronic aquatic toxicity is available for one or more relevant ingredients, it is concluded that the mixture cannot be attributed (a) definitive hazard category(ies). In this situation the mixture shall be classified based on the known ingredients only.

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<b>Note</b>	Incorporating Amendment 39-18

#### 2.9.4 Lithium batteries

Cells and batteries, cells and batteries contained in equipment, or cells and batteries packed with equipment, containing lithium in any form shall be assigned to UN Nos. 3090, 3091, 3480 or 3481 as appropriate. They may be transported under these entries if they meet the following provisions:

.1 Each cell or battery is of the type proved to meet the requirements of each test of the Manual of Tests and Criteria, part III, subsection 38.3. Cells and batteries manufactured according to a type meeting the requirements of subsection 38.3 of the Manual of Tests and Criteria, revision 3, amendment 1 or any subsequent revision and amendment applicable at the date of the type testing may continue to be transported, unless otherwise provided in this Code.

Cell and battery types only meeting the requirements of the Manual of Tests and Criteria, revision 3, are no longer valid. However, cells and batteries manufactured in conformity with such types before 1 July 2003 may continue to be transported if all other applicable requirements are fulfilled.

Note: Batteries shall be of a type proved to meet the testing requirements of the Manual of Tests and Criteria, part III, subsection 38.3, irrespective of whether the cells of which they are composed are of a tested type.

.2 Each cell and battery incorporates a safety venting device or is designed to preclude a violent rupture under conditions normally incident to transport.

.3 Each cell and battery is equipped with an effective means of preventing external short circuits.

.4 Each battery containing cells or series of cells connected in parallel is equipped with effective means as necessary to prevent dangerous reverse current flow (e.g. diodes, fuses, etc.).

.5 Cells and batteries shall be manufactured under a quality management programme that includes:

- .1 a description of the organizational structure and responsibilities of personnel with regard to design and product quality;
- .2 the relevant inspection and test, quality control, quality assurance, and process operation instructions that will be used;
- .3 process controls that should include relevant activities to prevent and detect internal short circuit failure during manufacture of cells;
- .4 quality records, such as inspection reports, test data, calibration data and certificates. Test data shall be kept and made available to the competent authority upon request;
- .5 management reviews to ensure the effective operation of the quality management programme;
- .6 a process for control of documents and their revision;
- .7 a means for control of cells or batteries that are not conforming to the type tested as mentioned in 2.9.4.1 above;
- .8 training programmes and qualification procedures for relevant personnel; and
- .9 procedures to ensure that there is no damage to the final product.

Note: In-house quality management programmes may be accepted. Third party certification is not required, but the procedures listed in .1 to .9 above shall be properly recorded and traceable. A copy of the quality management programme shall be made available to the competent authority upon request.

.6 Lithium batteries, containing both primary lithium metal cells and rechargeable lithium ion cells, that are not designed to be externally charged (see special provision 387 of chapter 3.3) shall meet the following conditions:

- .1 the rechargeable lithium ion cells can only be charged from the primary lithium metal cells;
  - .2 overcharge of the rechargeable lithium ion cells is precluded by design;
  - .3 the battery has been tested as a lithium primary battery; and
  - .4 component cells of the battery shall be of a type proved to meet the respective testing requirements of the Manual of Tests and Criteria, part III, subsection 38.3.
- .7 Manufacturers and subsequent distributors of cells or batteries shall make available the test summary as specified in the Manual of Tests and Criteria, part III, subsection 38.3, paragraph 38.3.5.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.10.1
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## Chapter 2.10

### Marine pollutants

#### 2.10.1 Definition

Marine pollutants means substances which are subject to the provisions of Annex III of MARPOL, as amended.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.10.2
<b>Effective Date</b>	1/1/2020
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### 2.10.2 General provisions

2.10.2.1 Marine pollutants shall be transported under the provisions of Annex III of MARPOL, as amended.

2.10.2.2 The Index indicates by the symbol P in the column headed **MP** those substances, materials and articles that are identified as marine pollutants.

2.10.2.3 Marine pollutants shall be transported under the appropriate entry according to their properties if they fall within the criteria of any of the classes 1 to 8. If they do not fall within the criteria of any of these classes, they shall be transported under the entry: ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S., UN 3077 or ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S., UN 3082, as appropriate, unless there is a specific entry in class 9.

2.10.2.4 Column 4 of the Dangerous Goods List also provides information on marine pollutants using the symbol **P** for single entries. The absence of the symbol P or the presence of a “–” in that column does not preclude the application of 2.10.3.

2.10.2.5 When a substance, material or article possesses properties that meet the criteria of a marine pollutant but is not identified in this Code, such substance, material or article shall be transported as a marine pollutant in accordance with the Code.

2.10.2.6 With the approval of the competent authority (see 7.9.2), substances, materials or articles that are identified as marine pollutants in this Code but which no longer meet the criteria as a marine pollutant need not be transported in accordance with the provisions of this Code applicable to marine pollutants.

2.10.2.7 Marine pollutants packaged in single or combination packagings containing a net quantity per single or inner packaging of 5 L or less for liquids or having a net mass per single or inner packaging of 5 kg or less for solids are not subject to any other provisions of this Code relevant to marine pollutants provided the packagings meet the general provisions of 4.1.1.1, 4.1.1.2 and 4.1.1.4 to 4.1.1.8. In the case of marine pollutants also meeting the criteria for inclusion in another hazard class, all provisions of this Code relevant to any additional hazards continue to apply.

<b>Title</b>	IMDG Code 2018 (39-18) / PART 2 / 2.10.3
<b>Effective Date</b>	1/1/2020
<b>Note</b>	Incorporating Amendment 39-18

### 2.10.3 Classification

2.10.3.1 Marine pollutants shall be classified in accordance with chapter 2.9.3.

2.10.3.2 The classification criteria of 2.9.3 are not applicable to substances or materials of class 7.

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