COMMITTEE OF EXPERTS ON THE TRANSPORT OF
DANGEROUS GOODS AND ON THE GLOBALLY
HARMONIZED SYSTEM OF CLASSIFICATION
AND LABELLING OF CHEMICALS

Sub-Committee of Experts on the
Globally Harmonized System of Classification
and Labelling of Chemicals
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GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION
AND LABELLING OF CHEMICALS (GHS)

Submitted by the GHS Editorial Group

Part 2

PHYSICAL HAZARDS
CHAPTER 2.1

EXPLOSIVES

2.1.1 Definitions and general considerations

2.1.1.1 An explosive substance (or mixture) is a solid or liquid substance (or 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.

A pyrotechnic substance (or mixture) is a substance or 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.

An explosive article is an article containing one or more explosive substances or mixtures.

A pyrotechnic article is an article containing one or more pyrotechnic substances or mixtures.

2.1.1.2 The class of explosives comprises:

(a) Explosive substances and mixtures;

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

(c) Substances, mixtures and articles not mentioned under (a) and (b) above which are manufactured with the view to producing a practical, explosive or pyrotechnic effect.

2.1.2 Classification criteria

2.1.2.1 Substances, mixtures and articles of this class are assigned to one of the following six divisions depending on the type of hazard they present:

(a) Division 1.1 Substances, mixtures and articles which have a mass explosion hazard (a mass explosion is one which affects almost the entire load virtually instantaneously);

(b) Division 1.2 Substances, mixtures and articles which have a projection hazard but not a mass explosion hazard;

(c) Division 1.3 Substances, mixtures 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:

(i) combustion of which gives rise to considerable radiant heat; or
(ii) which burn one after another, producing minor blast or projection effects or both;

(d) Division 1.4 Substances, mixtures and articles which present no significant hazard: substances, mixtures and articles which present only a small hazard in the event of ignition or initiation. 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 shall not cause virtually instantaneous explosion of almost the entire contents of the package;

(e) Division 1.5 Very insensitive substances or mixtures which have a mass explosion hazard: substances and mixtures 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;

(f) Division 1.6 Extremely insensitive articles which do not have a mass explosion hazard: articles which contain only extremely insensitive detonating substances or mixtures and which demonstrate a negligible probability of accidental initiation or propagation.

2.1.2.2 Explosives are classified in one of the six divisions above based on Test Series 2 to 7 in Part I of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria according to the following table:

**Table 2.1.1: Criteria for explosives**

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
</tr>
</thead>
</table>
| Unstable explosives or explosives of Division 1.1 to 1.6 | For explosives of Divisions 1.1 to 1.6, the following are the core set of tests that need to be performed:  
Explosibility: according to UN Test series 2 (Section 12 of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria). Intentional explosives \(^b\) are not subject to UN Test series 2  
Sensitiveness: according to UN Test series 3 (Section 13 of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria)  
Thermal stability: according to UN Test 3(c) (Sub-section 13.6.1 of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria)  
Further tests are necessary to allocate the correct Division |

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\(^a\) Unstable explosives are those which are thermally unstable and/or too sensitive for normal handling and use. Special precautions are necessary.

\(^b\) This comprises substances, mixtures and articles which are manufactured with a view to producing a practical, explosive or pyrotechnic effect.
NOTE 1: Explosive substances or mixtures in packaged form and articles may be classified under divisions 1.1 to 1.6 and, for some regulatory purposes, are further subdivided into compatibility groups A to S to distinguish technical requirements (see UN Recommendations on the Transport of Dangerous Goods, Model Regulations, Chapter 2.1).

NOTE 2: Some explosive substances and mixtures are wetted with water or alcohols or diluted with other substances to suppress their explosives properties. They may be treated differently from explosive substances and mixtures (as desensitised explosives) for some regulatory purposes (e.g. transport).

NOTE 3: For classification tests on solid substances or mixtures, the tests should be performed on the substance or mixture as presented. If for example, for the purposes of supply or transport, the same chemical is to be presented in a physical form different from that which was tested and which is considered likely to materially alter its performance in a classification test, the substance or mixture must also be tested in the new form.

2.1.3 Hazard communication

General and specific considerations concerning labelling requirements are provided in Hazard Communication: Labelling (Chapter 1.4). Annex 2 contains summary tables about classification and labelling. Annex 3 contains examples of precautionary statements and pictograms which can be used where allowed by the competent authority.

<table>
<thead>
<tr>
<th></th>
<th>Division 1.1</th>
<th>Division 1.2</th>
<th>Division 1.3</th>
<th>Division 1.4</th>
<th>Division 1.5</th>
<th>Division 1.6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symbol</strong></td>
<td>Exploding bomb</td>
<td>Exploding bomb</td>
<td>Exploding bomb</td>
<td>1.4 on orange background a</td>
<td>1.5 on orange background a</td>
<td>1.6 on orange background a</td>
</tr>
<tr>
<td><strong>Signal word</strong></td>
<td>Danger</td>
<td>Danger</td>
<td>Danger</td>
<td>Warning</td>
<td>Warning</td>
<td>No signal word</td>
</tr>
<tr>
<td><strong>Hazard statement</strong></td>
<td>Explosive; mass explosion hazard</td>
<td>Explosive; severe projection hazard</td>
<td>Explosive; fire, blast or projection hazard</td>
<td>Fire or projection hazard</td>
<td>May explode in fire</td>
<td>No hazard statement</td>
</tr>
</tbody>
</table>

*a* Applies to substances, mixtures and articles subject to some regulatory purposes (e.g. transport).
2.1.4 Decision logic and guidance

2.1.4.1 The decision logic and guidance, which follow, are not part of the harmonized classification system, but have been provided here as additional guidance. It is strongly recommended that the person responsible for classification studies the criteria before and during use of the decision logic.

2.1.4.1 Decision logic

The classification of substances, mixtures and articles in the class of explosives and further allocation to a division is a very complex, three step procedure. Reference to Part I of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, is necessary. The first step is to ascertain whether the substance or mixture has explosive effects (Test Series 1). The second step is the acceptance procedure (Test Series 2 to 4) and the third step is the assignment to a hazard division (Test Series 5 to 7). The classification procedure is according to the following decision logic (see Figures 2.1.1 to 2.1.3).
Figure 2.1.1: Overall scheme of the procedure for classifying a substance, mixture or article

SUBSTANCE, MIXTURE OR ARTICLE FOR CLASSIFICATION

ACCEPTANCE PROCEDURE

REJECT Unstable explosive

REJECT Not an explosive

ACCEPT

HAZARDOUS DIVISION ASSIGNMENT

DIVISION 1.1, 1.2, 1.3, 1.4, 1.5 or 1.6

COMPATIBILITY GROUP ASSIGNMENT

COMPATIBILITY GROUP A, B, C, D, E, F G, H, J, K, L, N or S

CLASSIFICATION CODE
Figure 2.1.2: Procedure for provisional acceptance of a substance, mixture or article in the class of explosives

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* For classification purposes, start with series 2.
Figure 2.1.3: Procedure for assignment to a division

ARTICLE OR SUBSTANCE/MIXTURE
PROVISIONALLY ACCEPTED IN THIS CLASS
(from figure 2)

Is the article a candidate for Division 1.6? No
Yes
TEST SERIES 7

Is it an extremely insensitive t il? No
Yes
TEST SERIES 6

Is the substance/mixture a candidate for Division 1.5? No
Yes
TEST SERIES 5

Is it a very insensitive explosive substance/mixture with a mass explosion hazard? No
Yes

Is the result a mass explosion? No
Yes

Is the major hazard that from dangerous projections? No
Yes

Is the major hazard radiant heat and/or violent burning but with no dangerous blast or projection hazard? No
Yes

Is there a small hazard in the event of ignition or initiation? No
Yes

Is the substance/mixture or article manufactured with the view to producing a practical explosive or pyrotechnic effect? No
Yes

Would the hazard hinder firefighting in the immediate vicinity? No
Yes

Is the product an article excluded by definition? No
Yes

NOT AN EXPLOSIVE
DIVISION 1.6
DIVISION 1.5
DIVISION 1.4 Compatibility group S
DIVISION 1.4 Compatibility groups other than S
DIVISION 1.3
DIVISION 1.2
DIVISION 1.1
2.1.4 Guidance

2.1.4.2.1 Explosive properties are associated with the presence of certain chemical groups in a molecule which can react to produce very rapid increases in temperature or pressure. The screening procedure is aimed at identifying the presence of such reactive groups and the potential for rapid energy release. If the screening procedure identifies the substance or mixture to be a potential explosive, the acceptance procedure (see section 10.3 of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria) has to be performed.

NOTE: Neither a Series 1 type (a) propagation of detonation test nor a Series 2 type (a) test of sensitivity to detonative shock is required if the exothermic decomposition energy of organic materials is less than 800 J/g.

2.1.4.2.2 A substance or mixture is not classified as explosive if:

(a) There are no chemical groups associated with explosive properties present in the molecule. Examples of groups which may indicate explosive properties are given in Table A6.1 in Appendix 6 of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria; or

(b) The substance contains chemical groups associated with explosive properties which include oxygen and the calculated oxygen balance is less than -200.

The oxygen balance is calculated for the chemical reaction:

\[ \text{C}_x\text{H}_y\text{O}_z + [x + (y/4)-(z/2)].\text{O}_2 \rightarrow x.\text{CO}_2 + (y/2).\text{H}_2\text{O} \]

using the formula:

\[ \text{oxygen balance} = -1600.[2.x +(y/2) -z]/\text{molecular weight}; \]

(c) When the organic substance or a homogenous mixture of organic substances contain chemical groups associated with explosive properties but the exothermic decomposition energy is less than 500 J/g and the onset of exothermic decomposition is below 500 °C. (The temperature limit is to prevent the procedure being applied to a large number of organic materials which are not explosive but which will decompose slowly above 500 °C to release more than 500 J/g.) The exothermic decomposition energy may be determined using a suitable calorimetric technique; or

(d) For mixtures of inorganic oxidizing substances with organic material(s), the concentration of the inorganic oxidizing substance is:

- less than 15 %, by mass, if the oxidizing substance is assigned to category 1 or 2;
- less than 30 %, by mass, if the oxidizing substance is assigned to category 3.

2.1.4.2.3 In the case of mixtures containing any known explosives, the acceptance procedure has to be performed.
CHAPTER 2.2

FLAMMABLE GASES

2.2.1 Definition

A flammable gas is a gas having a flammable range with air at 20 °C and a standard pressure of 101.3 kPa.

2.2.2 Classification criteria

A flammable gas is classified in one of the two categories for this class according to the following table:

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
</tr>
</thead>
</table>
| 1 | Gases, which at 20 °C and a standard pressure of 101.3 kPa:  
   (a) are ignitable when in a mixture of 13% or less by volume in air; or  
   (b) have a flammable range with air of at least 12 percentage points regardless of the lower flammable limit. |
| 2 | Gases, other than those of category 1, which, at 20 °C and a standard pressure of 101.3 kPa, have a flammable range while mixed in air. |

NOTE 1: Ammonia and methyl bromide may be regarded as special cases for some regulatory purposes.

NOTE 2: For the classification of aerosols, see Chapter 2.3.

2.2.3 Hazard communication

General and specific considerations concerning labelling requirements are provided in Hazard Communication : Labelling (Chapter 1.4). Annex 2 contains summary tables about classification and labelling. Annex 3 contains examples of precautionary statements and pictograms which can be used where allowed by the competent authority.

Table 2.2.2: Label elements for flammable gases

<table>
<thead>
<tr>
<th></th>
<th>Category 1</th>
<th>Category 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbol</td>
<td>Flame</td>
<td>No symbol used</td>
</tr>
<tr>
<td>Signal word</td>
<td>Danger</td>
<td>Warning</td>
</tr>
<tr>
<td>Hazard statement</td>
<td>Extremely flammable gas</td>
<td>Flammable gas</td>
</tr>
</tbody>
</table>
2.2.4 Decision logic and guidance

The decision logic and guidance, which follow, are not part of the harmonized classification system, but have been provided here as additional guidance. It is strongly recommended that the person responsible for classification studies the criteria before and during use of the decision logic.

2.2.4.1 Decision logic

To classify a flammable gas, data on its flammability are required. The classification is according to the following decision logic.

**Decision logic 2.2 for flammable gas**

Gaseous substance or mixture of gases

Does it have a flammable range with air at 20 °C and a standard pressure of 101.3 kPa?

Yes

At 20 °C and a standard pressure of 101.3 kPa, does it:

(a) ignite when in a mixture of 13% or less by volume in air?; or
(b) have a flammable range with air of at least 12 percentage points regardless of the lower flammable limit?

Yes

Category 1
Danger

No

Not classified

No

Category 2
Warning
2.2.4.2 **Guidance**

Flammability should be determined by tests or by calculation in accordance with methods adopted by ISO (see ISO 10156:1996 Gases and gas mixtures – Determination of fire potential and oxidizing ability for the selection of cylinder valve outlets). Where insufficient data are available to use these methods, tests by a comparable method recognized by the competent authority may be used.

2.2.5 **Example: Classification of a flammable gas mixture by calculation according to ISO 10156:1996**

**Formula**

\[
\sum_{i}^{n} \frac{V_{i} \%}{T_{ci}}
\]

Where:
- \(V_{i} \%\) is the equivalent flammable gas content
- \(T_{ci}\) is the maximum concentration of a flammable gas in nitrogen at which the mixture is still not flammable in air
- \(i\) is the first gas in the mixture
- \(n\) is the \(n^{th}\) gas in the mixture
- \(K_i\) is the equivalency factor for an inert gas versus nitrogen

Where a gas mixture contains an inert diluent other than nitrogen, the volume of this diluent is adjusted to the equivalent volume of nitrogen using the equivalency factor for the inert gas \((K_i)\).

**Criterion:**

\[
\sum_{i}^{n} \frac{V_{i} \%}{T_{ci}} > 1
\]

**Gas mixture**

For the purpose of this example the following is the gas mixture to be used

\[2\%(H_2) + 6\%(CH_4) + 27\%(Ar) + 65\%(He)\]

**Calculation**

1. **Ascertain the equivalency factors \((K_i)\) for the inert gases versus nitrogen**
   - \(K_i\) (Ar) = 0.5
   - \(K_i\) (He) = 0.5

2. **Calculate the equivalent mixture with nitrogen as balance gas using the \(K_i\) figures for the inert gases.**
   - \(2\%(H_2) + 6\%(CH_4) + [27\% \times 0.5 + 65\% \times 0.5](N_2) = 2\%(H_2) + 6\%(CH_4) + 46\%(N_2) = 54\%\)
3. Adjust the sum of the contents to 100%

\[
\frac{100}{54} \times [2\%(H_2) + 6\%(CH_4) + 46\%(N_2)] = 3.7\%(H_2) + 11.1\%(CH_4) + 85.2\%(N_2)
\]

4. Ascertain the Tci coefficients for the flammable gases

Tci H_2 = 5.7%
Tci CH_4 = 14.3%

5. Calculate the flammability of the equivalent mixture using the formula

\[
\sum_{i} V_i \frac{T_{ci}}{5.7 + 14.3} = \frac{3.7}{5.7} + \frac{11.1}{14.3} = 1.42
\]

1.42 > 1, Therefore the mixture is flammable in air.
CHAPTER 2.3

FLAMMABLE AEROSOLS

2.3.1 Definition

Aerosols, this means aerosol dispensers, are any non-refillable receptacles made of metal, glass or plastics and containing a gas compressed, liquefied or dissolved under pressure, with or without a liquid, paste or powder, and fitted with a release device allowing the contents to be ejected as solid or liquid particles in suspension in a gas, as a foam, paste or powder or in a liquid state or in a gaseous state.

2.3.2 Classification criteria

2.3.2.1 Aerosols should be considered for classification as flammable if they contain any component which is classified as flammable according to the GHS criteria, i.e.:

- flammable liquids (see Chapter 2.6);
- flammable gases (see Chapter 2.2);
- flammable solids (see Chapter 2.7).

**NOTE:** Flammable components do not cover pyrophoric, self-heating or water-reactive substances because such components are never used as aerosol contents.

2.3.2.2 A flammable aerosol is classified in one of the two categories for this Class on the basis of its components, of its chemical heat of combustion and, if applicable, of the results of the foam test (for foam aerosols) and of the ignition distance test and enclosed space test (for spray aerosols). See decision logic in 2.3.4.1.

2.3.3 Hazard communication

General and specific considerations concerning labelling requirements are provided in *Hazard Communication : Labelling* (Chapter 1.4). Annex 2 contains summary tables about classification and labelling. Annex 3 contains examples of precautionary statements and pictograms which can be used where allowed by the competent authority.
Table 2.3.1: Label elements for flammable aerosols

<table>
<thead>
<tr>
<th></th>
<th>Category 1</th>
<th>Category 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symbol</strong></td>
<td>Flame</td>
<td>Flame</td>
</tr>
<tr>
<td><strong>Signal word</strong></td>
<td>Danger</td>
<td>Warning</td>
</tr>
<tr>
<td><strong>Hazard statement</strong></td>
<td>Extremely flammable aerosol</td>
<td>Flammable aerosol</td>
</tr>
</tbody>
</table>

2.3.4 Decision logic and guidance

The decision logic and guidance, which follow, are not part of the harmonized classification system, but have been provided here as additional guidance. It is strongly recommended that the person responsible for classification studies the criteria before and during use of the decision logic.

**2.3.4.1 Decision logic**

To classify a flammable aerosol, data on its flammable components, on its chemical heat of combustion and, if applicable, the results of the foam test (for foam aerosols) and of the ignition distance test and enclosed space test (for spray aerosols) are required. Classification should be made according to the following decision logics.

**Decision logic 2.3 (a) for flammable aerosols**

1. **Aerosol**
2. **Does it contain ≤ 1% flammable components and does it have a heat of combustion < 20 kJ/g?**
   - **Yes**  
     - **Not classified**
   - **No**
     - **Does it contain ≥ 85% flammable components and does it have a heat of combustion ≥ 30 kJ/g?**
       - **Yes**  
         - **Category 1**  
           - **Danger**
       - **No**

For spray aerosols, go to decision logic 2.3. (b)  
For foam aerosols, go to decision logic 2.3. (c)
**Decision logic 2.3 (b) for spray aerosols**

Spray aerosol

In the ignition distance test, does ignition occur at a distance ≥ 75 cm?

- Yes → Category 1 Danger
- No

Does it have a heat of combustion < 20 kJ/g?

- No → Category 2 Warning
- Yes

In the ignition distance test, does ignition occur at a distance ≥ 15 cm?

- Yes → Category 2 Warning
- No

In the enclosed space ignition test, is the

- (a) time equivalent ≤ 300 s/m³, or
- (b) deflagration density ≤ 300 g/m³?

- Yes → Category 2 Warning
- No → Not classified
**Decision logic 2.3 (c) for foam aerosols**

In the foam test, is the
(a) flame height $\geq 20$ cm and the flame duration $\geq 2$ s; or
(b) flame height $\geq 4$ cm and the flame duration $\geq 7$ s?

- **Yes**
  - Category 1
    - Danger

- **No**
  - In the foam test, is the flame height $\geq 4$ cm and the flame duration $\geq 2$ s?
    - **Yes**
      - Category 2
        - Warning
    - **No**
      - Not classified
2.3.4.2 Guidance

2.3.4.2.1 The chemical heat of combustion (\(\Delta H_c\)), in kilojoules per gram (kJ/g), is the product of the theoretical heat of combustion (\(\Delta H_{\text{comb}}\)), and a combustion efficiency, usually less than 1.0 (a typical combustion efficiency is 0.95 or 95\%).

For a composite aerosol formulation, the chemical heat of combustion is the summation of the weighted heats of combustion for the individual components, as follows:

\[
\Delta H_c (\text{product}) = \sum_{i}^{n} \left[ w_i \% \times \Delta H_{c(i)} \right]
\]

where:
- \(\Delta H_c\) = chemical heat of combustion (kJ/g)
- \(w_i\%\) = mass fraction of component i in the product
- \(\Delta H_{c(i)}\) = specific heat of combustion (kJ/g) of component i in the product.

The chemical heats of combustion can be found in literature, calculated or determined by tests (see ASTM D 240, ISO/FDIS 13943:1999 (E/F) 86.1 to 86.3 and NFPA 30B).

2.3.4.2.2 See sub-sections 31.4, 31.5, and 31.6 of the of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, for Ignition Distance Test, Enclosed Space Ignition Test and Aerosol Foam Flammability Test.
CHAPTER 2.4

OXIDIZING GASES

2.4.1 Definition

An oxidizing gas is any gas which may, generally by providing oxygen, cause or contribute to the combustion of other material more than air does.

2.4.2 Classification criteria

An oxidizing gas is classified in a single category for this class according to the following table:

Table 2.4.1: Criteria for oxidizing gases

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Any gas which may, generally by providing oxygen, cause or contribute to the combustion of other material more than air does.</td>
</tr>
</tbody>
</table>

NOTE: Artificial air containing up to 23.5% vol % oxygen may be regarded as not oxidizing for some regulatory purposes (e.g. transport).

2.4.3 Hazard communication

General and specific considerations concerning labelling requirements are provided in Hazard Communication : Labelling (Chapter 1.4). Annex 2 contains summary tables about classification and labelling. Annex 3 contains examples of precautionary statements and pictograms which can be used where allowed by the competent authority.

Table 2.4.2: Label elements for oxidizing gases

<table>
<thead>
<tr>
<th>Category 1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbol</td>
<td>Flame over circle</td>
</tr>
<tr>
<td>Signal word</td>
<td>Danger</td>
</tr>
<tr>
<td>Hazard statement</td>
<td>May cause or intensify fire; oxidizer</td>
</tr>
</tbody>
</table>
2.4.4 Decision logic and guidance

The decision logic and guidance, which follow, are not part of the harmonized classification system, but have been provided here as additional guidance. It is strongly recommended that the person responsible for classification studies the criteria before and during use of the decision logic.

2.4.4.1 Decision logic

To classify an oxidizing gas tests or calculation methods as described in ISO 10156:1996 Gases and gas mixtures – Determination of fire potential and oxidizing ability for the selection of cylinder valve outlet - should be performed.

Decision logic 2.4 for oxidizing gases

Gaseous substance or mixture of gases

Does the gas contribute to the combustion of other material more than air does?

Yes

Category 1
Danger

No

Not classified
2.4.4.2 Example of the classification of an oxidizing gas mixture by calculation according to ISO-10156

Formula

\[ \sum_{i} V_{i}\% \times C_i \]

Where:
- \( V_{i}\% \) is the volume percentage of a gas
- \( C_i \) is the coefficient of oxygen equivalency
- \( i \) is the first gas in the mixture
- \( n \) is the \( n^{th} \) gas in the mixture

**NOTE:** Balance gas is not taken into consideration.

Criterion:

\[ \sum_{i} V_{i}\% \times C_i \geq 21 \]

Gas mixture

For the purpose of this example the following is the gas mixture to be used:

\[ 9\%(O_2) + 16\%(N_2O) + 75\%(N_2) \]

Calculation

1. Ascertain the coefficient of oxygen equivalency (\( C_i \)) for the oxidizing gases in the mixture

- \( C_i (N_2O) \) = 0.6 (nitrous oxide)
- \( C_i (O) \) = 1 (oxygen)
- \( C_i \) (all other oxidizing gases) = 40

2. Calculate if the gas mixture is oxidizing using the coefficient of oxygen equivalency figures for the oxidizing gases

\[ 9\%(O_2) + 16\%(N_2O) + 75\%(N_2) = (9 \times 1) + (16 \times 0.6) \]

\[ 18.6 < 21 \]

Therefore the mixture is considered less oxidizing than air.

If the gas mixture had been 0.6 % \( F_2 \) in Nitrogen, the equivalent calculation would have been

\[ 0.6\%(F_2) + 99.4\%(N_2) \]

The coefficient of oxygen equivalency (\( C_i \)) for \( F_2 = 40 \)

\[ 40 \times 0.6 = 24 > 21 \]

Therefore the mixture is considered more oxidizing than air.
CHAPTER 2.5

GASES UNDER PRESSURE

2.5.1 Definition

Gases under pressure are gases which are contained in a receptacle at a pressure not less than 280 kPa at 20 °C or as a refrigerated liquid.

They comprise compressed gases; liquefied gases; dissolved gases; refrigerated liquefied gases.

2.5.2 Classification criteria

Gases are classified, according to their physical state when packaged, in one of four groups in the following table:

Table 2.5.1: Criteria for gases under pressure

<table>
<thead>
<tr>
<th>Group</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressed gas</td>
<td>A gas which when packaged under pressure is entirely gaseous at -50 °C; including all gases with a critical temperature ≤ -50 °C.</td>
</tr>
<tr>
<td>Liquefied gas</td>
<td>as which when packaged under pressure, is partially liquid at temperatures above -50 °C. A distinction is made between: (a) High pressure liquefied gas: a gas with a critical temperature between -50°C and +65°C; and (b) Low pressure liquefied gas: a gas with a critical temperature above +65°C.</td>
</tr>
<tr>
<td>Refrigerated liquefied gas</td>
<td>A gas which when packaged is made partially liquid because of its low temperature.</td>
</tr>
<tr>
<td>Dissolved gas</td>
<td>A gas which when packaged under pressure is dissolved in a liquid phase solvent.</td>
</tr>
</tbody>
</table>

The critical temperature is the temperature above which a pure gas cannot be liquefied, regardless of the degree of compression.

2.5.3 Hazard communication

General and specific considerations concerning labelling requirements are provided in Hazard Communication: Labelling (Chapter 1.4). Annex 2 contains summary tables about classification and labelling. Annex 3 contains examples of precautionary statements and pictograms which can be used where allowed by the competent authority.
Table 2.5.2: Label elements for gases under pressure

<table>
<thead>
<tr>
<th></th>
<th>Compressed gas</th>
<th>Liquefied gas</th>
<th>Refrigerated liquefied gas</th>
<th>Dissolved gas</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symbol</strong></td>
<td>Gas cylinder</td>
<td>Gas cylinder</td>
<td>Gas cylinder</td>
<td>Gas cylinder</td>
</tr>
<tr>
<td><strong>Signal word</strong></td>
<td>Warning</td>
<td>Warning</td>
<td>Warning</td>
<td>Warning</td>
</tr>
<tr>
<td><strong>Hazard statement</strong></td>
<td>Contains gas under pressure; may explode if heated</td>
<td>Contains gas under pressure; may explode if heated</td>
<td>Contains refrigerated gas; may cause cryogenic burns or injury</td>
<td>Contains gas under pressure; may explode if heated</td>
</tr>
</tbody>
</table>
2.5.4 Decision logic and guidance

The decision logic and guidance, which follow, are not part of the harmonized classification system, but have been provided here as additional guidance. It is strongly recommended that the person responsible for classification studies the criteria before and during use of the decision logic.

2.5.4.1 Decision logic

Classification can be made according to the following decision logic.

**Decision logic 2.5 for gases under pressure**

1. Substance or mixture
2. Is (a) the vapour pressure at 50 °C greater than 3 bar?; or (b) the substance or mixture completely gaseous at 20°C
   - No: Not classified
   - Yes: Dissolved gas
3. Is the gas dissolved in a liquid solvent under pressure?
   - No: Liquefied gas
   - Yes: Refrigerated liquefied gas
4. Is the critical temperature above +65 °C?
   - No: Compressed gas
   - Yes: Liquefied gas
5. Is the critical temperature between −50 °C and +65 °C?
   - No: Compressed gas
   - Yes: Liquefied gas
6. Is the gas made partially liquid because of its low temperature?
   - No: Compressed gas
   - Yes: Refrigerated liquefied gas
7. Is the gas entirely in gaseous state at −50 °C?
   - No: Compressed gas
   - Yes: Compressed gas
2.5.4.2 Guidance

For this group of gases, the following information is required to be known:

- The vapour pressure at 50 °C;
- The physical state at 20 °C at standard ambient pressure;
- The critical temperature.

In order to classify a gas, the above data are needed. Data can be found in literature, calculated or determined by testing. Most pure gases are already classified in the *UN Recommendations on the Transport of Dangerous Goods, Model Regulations*. Most one off mixtures require additional calculations that can be very complex.
CHAPTER 2.6

FLAMMABLE LIQUIDS

2.6.1 Definition

A flammable liquid means a liquid having a flash point of not more than 93 °C.

2.6.2 Classification criteria

A flammable liquid is classified in one of the four categories for this class according to the following table:

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Flash point $&lt; 23$ °C and initial boiling point $\leq 35$ °C</td>
</tr>
<tr>
<td>2</td>
<td>Flash point $&lt; 23$ °C and initial boiling point $&gt; 35$ °C</td>
</tr>
<tr>
<td>3</td>
<td>Flash point $\geq 23$ °C and $\leq 60$ °C</td>
</tr>
<tr>
<td>4</td>
<td>Flash point $&gt; 60$ °C and $\leq 93$ °C</td>
</tr>
</tbody>
</table>

**NOTE 1:** Gas oils, diesel and light heating oils in the flash point range of 55 °C to 75 °C may be regarded as a special group for some regulatory purposes.

**NOTE 2:** Liquids with a flash point of more than 35 °C may be regarded as non-flammable liquids for some regulatory purposes (e.g. transport) if negative results have been obtained in the sustained combustibility test L.2 of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria.

**NOTE 3:** Viscous flammable liquids such as paints, enamels, lacquers, varnishes, adhesives and polishes may be regarded as a special group for some regulatory purposes (e.g. transport). The classification or the decision to consider these liquids as non-flammable may be determined by the pertinent regulation or competent authority.

2.6.3 Hazard communication

General and specific considerations concerning labelling requirements are provided in *Hazard Communication: Labelling* (Chapter 1.4). Annex 2 contains summary tables about classification and labelling. Annex 3 contains examples of precautionary statements and pictograms which can be used where allowed by the competent authority.
Table 2.6.2: Label elements for flammable liquids

<table>
<thead>
<tr>
<th></th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
<th>Category 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symbol</strong></td>
<td>Flame</td>
<td>Flame</td>
<td>Flame</td>
<td>No symbol used</td>
</tr>
<tr>
<td><strong>Signal word</strong></td>
<td>Danger</td>
<td>Danger</td>
<td>Warning</td>
<td>Warning</td>
</tr>
<tr>
<td><strong>Hazard statement</strong></td>
<td>Extremely flammable liquid and vapour</td>
<td>Highly flammable liquid and vapour</td>
<td>Flammable liquid and vapour</td>
<td>Combustible liquid</td>
</tr>
</tbody>
</table>
2.6.4 Decision logic and guidance

The decision logic and guidance, which follow, are not part of the harmonized classification system, but have been provided here as additional guidance. It is strongly recommended that the person responsible for classification studies the criteria before and during use of the decision logic.

2.6.4.1 Decision logic

Once flash point and initial boiling point are known, the classification of the substance or mixture and the relevant harmonized label information can be obtained with the following decision tree:

**Decision logic 2.6 for flammable liquids**

1. If the substance/mixture is a liquid:
   - **Does it have a flash point ≤ 93 °C?**
     - **No** → Not classified
     - **Yes** → **Does it have a flash point > 60°C?**
       - **Yes** → Category 4 (No symbol, Warning)
       - **No** → Category 3 (Warning)
   - **Does it have a flash point ≥ 23°C?**
     - **No** → Category 2 (Danger)
     - **Yes** → **Does it have an initial boiling point > 35°C?**
       - **Yes** → Category 1 (Danger)
       - **No** → Not classified

---

*a* Gas oils, diesel and light heating oils in the flash point range of 55 °C to 75 °C may be regarded as a special group for some regulatory purposes as these hydrocarbons mixtures have varying flash point in that range. Thus classification in category 3 or 4 of these products may be determined by the pertinent regulation or competent authority.

*b* Liquids with a flash point of more than 35 °C may be regarded as non-flammable liquids for some regulatory purposes (e.g. transport) if negative results have been obtained in the sustained combustibility test L.2 of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria.
2.6.4.2 **Guidance**

2.6.4.2.1 In order to classify a flammable liquid, data on its flash point and initial boiling point are needed. Data can be determined by testing, found in literature or calculated.

2.6.4.2.2 In the case of mixtures\(^1\) containing known flammable liquids in defined concentrations, although they may contain non-volatile components e.g. polymers, additives, the flash point need not be determined experimentally if the calculated flash point of the mixture, using the method given in 2.6.4.2.3 below, is at least 5 °C greater than the relevant classification criterion and provided that

(a) The composition of the mixture is accurately known (if the material has a specified range of composition, the composition with the lowest calculated flash point should be selected for assessment);

(b) The flash point (closed cup as given in 2.6.4.2.5 below) of each component is known (an appropriate correlation has to be applied when these data are extrapolated to other temperatures than test conditions);

(c) The activity coefficient is known for each component as present in the mixture including the temperature dependence;

(d) The liquid phase is homogeneous.

2.6.4.2.3 A suitable method is described in Gmehling and Rasmussen (Ind. Eng. Chem. Fundament, 21, 186, (1982)). For a mixture containing non-volatile components, e.g. polymers or additives, the flash point is calculated from the volatile components. It is considered that a non-volatile component only slightly decreases the partial pressure of the solvents and the calculated flash point is only slightly below the measured value.

2.6.4.2.4 If data are not available, the flash point and the initial boiling point shall be determined through testing. The flash point shall be determined by closed-cup test method. Open-cup tests are acceptable only in special cases.

---

\(^1\) Screening procedures are well established for ideal mixture of solvents, i.e. mainly hydrocarbures.
2.6.4.2.5 The following is a list of documents describing methods for determining the flash point of flammable liquids

**International standards:**

- ISO 1516
- ISO 1523
- ISO 3679
- ISO 3680

**National standards:**

*American Society for Testing Materials, 1916 Race Street, Philadelphia, Penna 19103:*
- ASTM D 3828-93, Standard Test Methods for Flash Point by Small Scale Closed Tester
- ASTM D 56-93, Standard Test Method for Flash Point by Tag Closed Tester
- ASTM D 3278-96, Standard Test Methods for Flash Point of Liquids by Setalflash Closed-Cup Apparatus
- ASTM D 0093-96, Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester

*Association française de normalisation, AFNOR, Tour Europe, 92049 Paris La Défense:*
- 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

*British Standards Institution, Linford Wood, Milton Keynes, MK14 6LE:*
- British Standard BS EN 22719
- British Standard BS 2000 Part 170

*Deutscher Normenausschuss:*
- Standard DIN 51755 (flash points below 65 °C)
- Standard DIN 51758 (flash points 65 °C to 165 °C)
- Standard DIN 53213 (for varnishes, lacquers and similar viscous liquids with flash points 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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CHAPTER 2.7

FLAMMABLE SOLIDS

2.7.1 Definitions

A flammable solid is a solid which is readily combustible, or may cause or contribute to fire through friction.

Readily combustible solids are 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.

2.7.2 Classification criteria

2.7.2.1 Powdered, granular or pasty substances or mixtures shall be classified as readily combustible solids when the time of burning of one or more of the test runs, performed in accordance with the test method described in the *UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria*, Part III, sub-section 33.2.1, is less than 45 seconds or the rate of burning is more than 2.2 mm/s.

2.7.2.2 Powders of metals or metal alloys shall be classified as flammable solids when they can be ignited and the reaction spreads over the whole length of the sample in 10 minutes or less.

2.7.2.3 Solids which may cause fire through friction shall be classified in this class by analogy with existing entries (e.g. matches) until definitive criteria are established.

2.7.2.4 A flammable solid is classified in one of the two categories for this class using Method N.1 as described in 33.2.1 of the *UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria*, according to the following table:
Table 2.7.1: Criteria for flammable solids

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
</tr>
</thead>
</table>
| 1        | Burning rate test:  
Substances or mixtures other than metal powders:  
  (a) wetted zone does not stop fire and  
  (b) burning time < 45 seconds or burning rate > 2.2 mm/second  
Metal powders:  
  - burning time ≤ 5 minutes |
| 2        | Burning rate test:  
Substances or mixtures other than metal powders:  
  (a) wetted zone stops the fire for at least 4 minutes and  
  (b) burning time < 45 seconds or burning rate > 2.2 mm/second  
Metal powders:  
  - burning time > 5 minutes and ≤ 10 minutes |

**NOTE:** For classification tests on solid substances or mixtures, the tests should be performed on the substance or mixture as presented. If for example, for the purposes of supply or transport, the same chemical is to be presented in a physical form different from that which was tested and which is considered likely to materially alter its performance in a classification test, the substance must also be tested in the new form.

2.7.3 Hazard communication

General and specific considerations concerning labelling requirements are provided in *Hazard Communication: Labelling* (Chapter 1.4). Annex 2 contains summary tables about classification and labelling. Annex 3 contains examples of precautionary statements and pictograms which can be used where allowed by the competent authority.

Table 2.7.2: Label elements for flammable solids

<table>
<thead>
<tr>
<th></th>
<th>Category 1</th>
<th>Category 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbol</td>
<td>Flame</td>
<td>Flame</td>
</tr>
<tr>
<td>Signal word</td>
<td>Danger</td>
<td>Warning</td>
</tr>
<tr>
<td>Hazard statement</td>
<td>Flammable solid</td>
<td>Flammable solid</td>
</tr>
</tbody>
</table>

2.7.4 Decision logic

The decision logic, which follows, is not part of the harmonized classification system, but has been provided here as additional guidance. It is strongly recommended that the person responsible for classification studies the criteria before and during use of the decision logic.

To classify a flammable solid, the test method N.1 as described in 33.2.1 of the *UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria*, should be performed. The procedure consists of two tests: a preliminary screening test and a burning rate test. Classification is according to the following decision tree.
**Decision logic 2.7 for flammable solids**

The substance/mixture is a solid

---

**Screening Test**

Positive

- **Burning rate test**
  - For substances or mixtures other than metal powders: Burning time < 45 s or burning rate > 2.2 mm/s?
  - Metal powders: Burning time ≤10 min?

  - Yes
    - For substances or mixtures other than metal powders: Does the wetted zone stop propagation of the flame?
    - Metal powders: Burning time > 5 min?

  - No
    - Not classified

---

Negative

- Not classified

---

Positive

- Category 1
  - Danger

---

Yes

- Category 2
  - Warning
CHAPTER 2.8

SELF-REACTIVE SUBSTANCES

2.8.1 Definition

2.8.1.1 Self-reactive substances or mixtures are thermally unstable liquid or solid substances or mixtures liable to undergo a strongly exothermic decomposition even without participation of oxygen (air). This definition excludes substances and mixtures classified under the GHS as explosives, organic peroxides or as oxidizing.

2.8.1.2 A self-reactive substance or mixture 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.

2.8.2 Classification criteria

2.8.2.1 Any self-reactive substance or mixture should be considered for classification in this class unless:

(a) They are explosives, according to the GHS criteria of Chapter 2.1;

(b) They are oxidizing liquids or solids, according to the GHS criteria of Chapters 2.13 or 2.14;

(c) They are organic peroxides, according to the GHS criteria of Chapter 2.15;

(d) Their heat of decomposition is less than 300 J/g; or

(e) Their self-accelerating decomposition temperature (SADT) is greater than 75 °C for a 50 kg package.

2.8.2.2 Self-reactive substances and mixtures are classified in one of the seven categories of "types A to G" for this class, according to the following principles:

(a) Any self-reactive substance or mixture which can detonate or deflagrate rapidly, as packaged, will be defined as self-reactive substance TYPE A;

(b) Any self-reactive substance or mixture possessing explosive properties and which, as packaged, neither detonates nor deflagrates rapidly, but is liable to undergo a thermal explosion in that package will be defined as self-reactive substance TYPE B;

(c) Any self-reactive substance or mixture possessing explosive properties when the substance or mixture as packaged cannot detonate or deflagrate rapidly or undergo a thermal explosion will be defined as self-reactive substance TYPE C;

(d) Any self-reactive substance or mixture which in laboratory testing:

(i) detonates partially, does not deflagrate rapidly and shows no violent effect when heated under confinement; or

(ii) does not detonate at all, deflagrates slowly and shows no violent effect when heated under confinement; or
(iii) does not detonate or deflagrate at all and shows a medium effect when heated under confinement;
will be defined as **self-reactive substance TYPE D**;

(e) Any self-reactive substance or mixture which, in laboratory testing, neither detonates nor deflagrates at all and shows low or no effect when heated under confinement will be defined as **self-reactive substance TYPE E**;

(f) Any self-reactive substance or mixture 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 will be defined as **self-reactive substance TYPE F**;

(g) Any self-reactive substance or mixture 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, provided that it is thermally stable (self-accelerating decomposition temperature is 60 °C to 75 °C for a 50 kg package), and, for liquid mixtures, a diluent having a boiling point not less than 150 °C is used for desensitisation will be defined as **self-reactive substance TYPE G**. If the mixture is not thermally stable or a diluent having a boiling point less than 150 °C is used for desensitisation, the mixture shall be defined as **self-reactive substance TYPE F**.

**NOTE 1:** Type **G** has no hazard communication elements assigned but should be considered for properties belonging to other hazard classes.

**NOTE 2:** Types **A** to **G** may not be necessary for all systems.

### 2.8.3 Hazard communication

General and specific considerations concerning labelling requirements are provided in *Hazard Communication : Labelling* (Chapter 1.4). Annex 2 contains summary tables about classification and labelling. Annex 3 contains examples of precautionary statements and pictograms which can be used where allowed by the competent authority.

**Table 2.8.1: Label elements for self-reactive substances and mixtures**

<table>
<thead>
<tr>
<th></th>
<th>Type A</th>
<th>Type B</th>
<th>Type C and D</th>
<th>Type E and F</th>
<th>Type G a</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symbol</strong></td>
<td>Exploding bomb</td>
<td>Exploding bomb and flame</td>
<td>Flame</td>
<td>Flame</td>
<td>There are no label elements allocated to this hazard category</td>
</tr>
<tr>
<td><strong>Signal word</strong></td>
<td>Danger</td>
<td>Danger</td>
<td>Danger</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td><strong>Hazard statement</strong></td>
<td>Heating may cause an explosion</td>
<td>Heating may cause a fire or explosion</td>
<td>Heating may cause a fire</td>
<td>Heating may cause a fire</td>
<td></td>
</tr>
</tbody>
</table>

*Type **G** has no hazard communication elements assigned but should be considered for properties belonging to other hazard classes.*
2.8.4 Decision logic and guidance

The decision logic and guidance, which follow, are not part of the harmonized classification system, but have been provided here as additional guidance. It is strongly recommended that the person responsible for classification studies the criteria before and during use of the decision logic.

2.8.4.1 Decision logic

To classify a self-reactive substance or mixture test series A to H as described in Part II of the *UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria* should be performed. Classification is according to the following decision logic.

The properties of self-reactive substances or mixtures which are decisive for their classification should be determined experimentally. Test methods with pertinent evaluation criteria are given in the *UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria*, Part II (test series A to H).

2.8.4.2 Guidance

The classification procedures for self-reactive substances and mixtures need not be applied if:

(a) There are no chemical groups present in the molecule associated with explosive or self-reactive properties; examples of such groups are given in Tables A6.1 and A6.2 in the *UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria*, Appendix 6; or

(b) For a single organic substance or a homogeneous mixture of organic substances, the estimated SADT is greater than 75 °C or the exothermic decomposition energy is less than 300J/g. The onset temperature and decomposition energy may be estimated using a suitable calorimetric technique (see 20.3.3.3 of the *UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria*).
Decision logic 2.8 for self-reactive substances and mixtures

Substance/Mixture

1.1 Yes
1.3 No
2.2 No
1.2 Partial
2.1 Yes
3.2 Yes, slowly
4.1 Yes, rapidly
3.3 No
4.2 Yes, slowly
4.3 No
5.1 Yes, rapidly
5.2 Yes, slowly
5.3 No
6.1 Yes
6.2 No
7.2 Medium
7.3 Low
7.4 No
8.1 Violent
8.2 Medium
8.3 Low
8.4 No
9.1 Violent
9.2 Medium
9.3 Low
9.4 No
10.1 Yes
10.2 No
11.1 Yes
11.2 No
12.1 Not low
12.2 Low
13.1 Low
13.2 None
12.3 None

Box 1 - Test A
Does it propagate a detonation?

Box 2 - Test B
Can it detonate as packaged?

Box 3 - Test C
Can it propagate a deflagration?

Box 4 - Test C
Can it propagate a deflagration?

Box 5 - Test C
Can it propagate a deflagration?

Box 6 - Test D
Does it deflagrate rapidly in package?

Box 7 - Test E
What is effect of heating under confinement?

Box 8 - Test E
What is effect of heating under confinement?

Box 9 - Test E
What is effect of heating under confinement?

Box 10 - Test G
Can it explode as packaged?

Box 11
Packaged in packages of more than 400 kg / 450 l or to be considered for exemption?

Box 12 - Test F
What is its explosive power?

Box 13 - Test E
What is the effect of heating under confinement?
CHAPTER 2.9
PYROPHORIC LIQUIDS

2.9.1 Definition

A pyrophoric liquid is a liquid which, even in small quantities, is liable to ignite within five minutes after coming into contact with air.

2.9.2 Classification criteria

A pyrophoric liquid is classified in a single category for this class using test N.3 in 33.3.1.5 of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, according to the following table:

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The liquid ignites within 5 min when added to an inert carrier and exposed to air, or it ignites or chars a filter paper on contact with air within 5 min.</td>
</tr>
</tbody>
</table>

2.9.3 Hazard communication

General and specific considerations concerning labelling requirements are provided in Hazard Communication: Labelling (Chapter 1.4). Annex 2 contains summary tables about classification and labelling, Annex 3 contains examples of precautionary statements and pictograms which can be used where allowed by the competent authority.

Table 2.9.2: Label elements for pyrophoric liquids

<table>
<thead>
<tr>
<th>Category 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbol</td>
</tr>
<tr>
<td>Signal word</td>
</tr>
<tr>
<td>Hazard statement</td>
</tr>
<tr>
<td>Flame</td>
</tr>
<tr>
<td>Danger</td>
</tr>
<tr>
<td>Catches fire spontaneously if exposed to air</td>
</tr>
</tbody>
</table>
2.9.4 Decision logic and guidance

The decision logic and guidance, which follow, are not part of the harmonized classification system, but have been provided here as additional guidance. It is strongly recommended that the person responsible for classification studies the criteria before and during use of the decision logic.

2.9.4.1 Decision logic

To classify a pyrophoric liquid, the test method N.3 as described in 33.3.1.5 of the *UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria*, should be performed. The procedure consists of two steps. Classification is according to the following decision logic.

**Decision logic 2.9 for pyrophoric liquids**

The substance/mixture is a liquid

Does it ignite within 5 minutes when poured into a porcelain cup filled with diatomaceous earth or silica gel?

Yes → Category 1 Danger

No → Does it ignite or char filter paper within 5 minutes?

Yes → Category 1 Danger

No → Not classified

2.9.4.2 Guidance

The classification procedure for pyrophoric liquids need not be applied when experience in production or handling shows that the substance or mixture does not ignite spontaneously on coming into contact with air at normal temperatures (i.e. the substance is known to be stable at room temperature for prolonged periods of time (days)).
CHAPTER 2.10
PYROPHORIC SOLIDS

2.10.1 Definition

A pyrophoric solid is a solid which, even in small quantities, is liable to ignite within five minutes after coming into contact with air.

2.10.2 Classification criteria

A pyrophoric solid is classified in a single category for this class using test N.2 in 33.3.1.4 of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria according to the following table:

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The solid ignites within 5 minutes of coming into contact with air.</td>
</tr>
</tbody>
</table>

**NOTE:** For classification tests on solid substances or mixtures, the tests should be performed on the substance or mixture as presented. If, for example, for the purposes of supply or transport, the same chemical is to be presented in a physical form different from that which was tested and which is considered likely to materially alter its performance in a classification test, the substance or mixture must also be tested in the new form.

2.10.3 Hazard communication

General and specific considerations concerning labelling requirements are provided in Hazard Communication : Labelling (Chapter 1.4). Annex 2 contains summary tables about classification and labelling. Annex 3 contains examples of precautionary statements and pictograms which can be used where allowed by the competent authority.

<table>
<thead>
<tr>
<th>Category 1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbol</td>
<td>Flame</td>
</tr>
<tr>
<td>Signal word</td>
<td>Danger</td>
</tr>
<tr>
<td>Hazard statement</td>
<td>Catches fire spontaneously if exposed to air</td>
</tr>
</tbody>
</table>
2.10.4 Decision logic and guidance

The decision logic and guidance, which follow, are not part of the harmonized classification system, but have been provided here as additional guidance. It is strongly recommended that the person responsible for classification studies the criteria before and during use of the decision logic.

2.10.4.1 Decision logic

To classify a pyrophoric solid, the test method n.2 as described in 33.3.1.4 of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria should be performed. Classification is according to the following decision logic.

**Decision logic 2.10 for pyrophoric solids**

1. The substance/mixture is a solid
2. Does it ignite within 5 minutes after exposure to air?
   - Yes: Category 1 – Danger
   - No: Not classified

2.10.4.2 Guidance

The classification procedure for pyrophoric solids need not be applied when experience in production or handling shows that the substance or mixture does not ignite spontaneously on coming into contact with air at normal temperatures (i.e. the substance or mixture is known to be stable at room temperature for prolonged periods of time (days)).
CHAPTER 2.11

SELF-HEATING SUBSTANCES

2.11.1 Definition

A self-heating substance or mixture is a solid substance or mixture, other than a pyrophoric liquid or solid, which, by reaction with air and without energy supply, is liable to self-heat; this substance or mixture differs from a pyrophoric liquid or solid in that it will ignite only when in large amounts (kilograms) and after long periods of time (hours or days).

**NOTE:** Self-heating of substances or mixtures, leading to spontaneous combustion, is caused by reaction of the substance or mixture with oxygen (in the air) and the heat developed not being conducted away rapidly enough to the surroundings. Spontaneous combustion occurs when the rate of heat production exceeds the rate of heat loss and the auto-ignition temperature is reached.

2.11.2 Classification criteria

2.11.2.1 A substance or mixture shall be classified as a self-heating substance of this class, if in tests performed in accordance with the test method given in the *UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria*, Part III, sub-section 33.3.1.6:

(a) A positive result is obtained using a 25 mm cube sample at 140 °C;

(b) A positive result is obtained in a test using a 100 mm sample cube at 140 °C and a negative result is obtained in a test using a 100 mm cube sample at 120 °C and the substance or mixture is to be packed in packages with a volume of more than 3 m³;

(c) A positive result is obtained in a test using a 100 mm sample cube at 140 °C and a negative result is obtained in a test using a 100 mm cube sample at 100 °C and the substance or mixture is to be packed in packages with a volume of more than 450 litres;

(d) A positive result is obtained in a test using a 100 mm sample cube at 140 °C and a positive result is obtained using a 100 mm cube sample at 100 °C.

2.11.2.2 A self-heating substance or mixture is classified in one of the two categories for this class if, in test performed in accordance with test method N. 4 in 33.3.1.6 of the *UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria*, the result meets the criteria shown in Table 2.11.1.
Table 2.11.1: Criteria for self-heating substances and mixtures

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A positive result is obtained in a test using a 25 mm sample cube at 140 °C</td>
</tr>
<tr>
<td>2</td>
<td>(a) A positive result is obtained in a test using a 100 mm sample cube at 140 °C and a negative result is obtained in a test using a 25 mm cube sample at 140 °C and the substance or mixture is to be packed in packages with a volume of more than 3 m³; or (b) A positive result is obtained in a test using a 100 mm sample cube 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 or mixture is to be packed in packages with a volume of more than 450 litres; or (c) A positive result is obtained in a test using a 100 mm sample cube 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.</td>
</tr>
</tbody>
</table>

NOTE 1: For classification tests on solid substances or mixtures, the tests should be performed on the substance or mixture as presented. If for example, for the purposes of supply or transport, the same chemical is to be presented in a physical form different from that which was tested and which is considered likely to materially alter its performance in a classification test, the substance or mixture must also be tested in the new form.

NOTE 2: The criteria are based on the self-ignition temperature of charcoal, which is 50°C for a sample cube of 27 m³. Substances and mixtures with a temperature of spontaneous combustion higher than 50°C for a volume of 27 m³ should not be assigned to this hazard class. Substances and mixtures with a spontaneous ignition temperature higher than 50°C for a volume of 450 litres should not be assigned to hazard category 1 of this hazard class.

2.11.3 Hazard communication

General and specific considerations concerning labelling requirements are provided in Hazard Communication : Labelling (Chapter 1.4). Annex 2 contains summary tables about classification and labelling. Annex 3 contains examples of precautionary statements and pictograms which can be used where allowed by the competent authority.

Table 2.11.2: Label elements for self-heating substances and mixtures

<table>
<thead>
<tr>
<th></th>
<th>Category 1</th>
<th>Category 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbol</td>
<td>Flame</td>
<td>Flame</td>
</tr>
<tr>
<td>Signal word</td>
<td>Danger</td>
<td>Warning</td>
</tr>
<tr>
<td>Hazard statement</td>
<td>Self-heating; may catch fire</td>
<td>Self-heating in large quantities; may catch fire</td>
</tr>
</tbody>
</table>
2.11.4 Decision logic and guidance

The decision logic and guidance, which follow, are not part of the harmonized classification system, but have been provided here as additional guidance. It is strongly recommended that the person responsible for classification studies the criteria before and during use of the decision logic.

2.11.4.1 Decision logic

To classify a self-heating substance, test method N.4, as described in 33.3.1.6 of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, should be performed. Classification is according to decision logic 2.11.

2.11.4.2 Guidance

The classification procedure for self-heating substances need not be applied if the results of a screening test can be adequately correlated with the classification test and an appropriate safety margin is applied. Examples of screening tests are:

(a) The Grewer Oven test (VDI guideline 2263, part 1, 1990, Test methods for the Determination of the Safety Characteristics of Dusts) with an onset temperature 80 K above the reference temperature for a volume of 1 l;

(b) The Bulk Powder Screening Test (Gibson, N. Harper, D. J. Rogers, R. Evaluation of the fire and explosion risks in drying powders, Plant Operations Progress, 4 (3), 181 - 189, 1985) with an onset temperature 60 K above the reference temperature for a volume of 1 l.
**Decision logic 2.11 for self-heating substances**

1. **Substance/mixture**
   - Does it undergo dangerous self-heating when tested in a 100 mm sample cube at 140 °C?
     - Yes: Category 1
       - Danger
     - No: Not classified
   - Yes: Category 1
     - Danger
   - No: Not classified

2. **Substance/mixture**
   - Is it packaged in more than 3 m³?
     - Yes: Category 2
       - Warning
     - No: Not classified
   - Yes: Category 2
     - Warning
   - No: Not classified

3. **Substance/mixture**
   - Does it undergo dangerous self-heating when tested in a 100 mm sample cube at 120 °C?
     - Yes: Category 2
       - Warning
     - No: Not classified
   - Yes: Category 2
     - Warning
   - No: Not classified

4. **Substance/mixture**
   - Is it packaged in more than 450 litres volume?
     - Yes: Category 2
       - Warning
     - No: Not classified
   - Yes: Category 2
     - Warning
   - No: Not classified

5. **Substance/mixture**
   - Does it undergo dangerous self-heating when tested in a 100 mm sample cube at 100 °C?
     - Yes: Category 2
       - Warning
     - No: Not classified
   - Yes: Category 2
     - Warning
   - No: Not classified

6. **Substance/mixture**
   - Does it undergo dangerous self-heating when tested in a 25 mm sample cube at 140 °C?
     - Yes: Category 1
       - Danger
     - No: Not classified
   - Yes: Category 1
     - Danger
   - No: Not classified
CHAPTER 2.12

SUBSTANCES WHICH, IN CONTACT WITH WATER, EMIT FLAMMABLE GASES

2.12.1 Definition

Substances or mixtures which, in contact with water, emit flammable gases are solid or liquid substances or mixtures which, by interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities.

2.12.2 Classification criteria

A substance or mixture which, in contact with water, emit flammable gases is classified in one of the three categories for this class, using test N.5 in 33.4.1.4 of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, according to the following table:

Table 2.12.1: Criteria for substances and mixtures which, in contact with water, emit flammable gases

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Any substance or mixture 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.</td>
</tr>
<tr>
<td>2</td>
<td>Any substance or mixture 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 category 1.</td>
</tr>
<tr>
<td>3</td>
<td>Any substance or mixture which reacts slowly with water at ambient temperatures such that the maximum rate of evolution of flammable gas is equal to or greater than 1 litre per kilogram of substance per hour, and which does not meet the criteria for categories 1 and 2.</td>
</tr>
</tbody>
</table>

NOTE 1: A substance or mixture is classified as a substance which, in contact with water, emits flammable gases if spontaneous ignition takes place in any step of the test procedure.

NOTE 2: For classification tests on solid substances or mixtures, the tests should be performed on the substance or mixture as presented. If for example, for the purposes of supply or transport, the same chemical is to be presented in a physical form different from that which was tested and which is considered likely to materially alter its performance in a classification test, the substance or mixture must also be tested in the new form.
2.12.3 Hazard communication

General and specific considerations concerning labelling requirements are provided in *Hazard Communication: Labelling* (Chapter 1.4). Annex 2 contains summary tables about classification and labelling. Annex 3 contains examples of precautionary statements and pictograms which can be used where allowed by the competent authority.

**Table 2.12.2: Label elements for substances and mixtures, which in contact with water, emit flammable gases**

<table>
<thead>
<tr>
<th></th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbol</td>
<td>Flame</td>
<td>Flame</td>
<td>Flame</td>
</tr>
<tr>
<td>Signal word</td>
<td>Danger</td>
<td>Danger</td>
<td>Warning</td>
</tr>
<tr>
<td>Hazard statement</td>
<td>In contact with water releases flammable gases which may ignite spontaneously</td>
<td>In contact with water releases flammable gases</td>
<td>In contact with water releases flammable gases</td>
</tr>
</tbody>
</table>

2.12.4 Decision logic and guidance

The decision logic and guidance, which follow, are not part of the harmonized classification system, but have been provided here as additional guidance. It is strongly recommended that the person responsible for classification studies the criteria before and during use of the decision logic.

2.12.4.1 Decision logic

To classify a substance or mixture which, in contact with water emits flammable gases, test N.5 as described in 33.4.1.4 of the *UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria*, should be performed. Classification is according to the following decision logic.
Decision logic 2.12 for substances and mixtures which, in contact with water, emit flammable gases

Substance/mixture

In contact with water, does it react slowly at ambient temperatures such that the maximum rate of evolution of flammable gas is equal to or greater than 1 litre per kilogram of substance per hour?

No → Not classified

Yes →

In contact with water, does the substance react vigorously with water at ambient temperatures and demonstrate generally a tendency for the gas produced to ignite spontaneously, or does it react 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?

Yes → Category 1 Danger

No →

In contact with water, does it react 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?

Yes → Category 2 Danger

No → Category 3 Warning
2.12.4.2  **Guidance**

The classification procedure for this class need not be applied if:

(a) The chemical structure of the substance or mixture does not contain metals or metalloids;

(b) Experience in production or handling shows that the substance or mixture does not react with water, e.g. the substance is manufactured with water or washed with water; or

(c) The substance or mixture is known to be soluble in water to form a stable mixture.
CHAPTER 2.13

OXIDIZING LIQUIDS

2.13.1 Definition

An oxidizing liquid is a liquid which, while in itself not necessarily combustible, may, generally by yielding oxygen, cause, or contribute to, the combustion of other material.

2.13.2 Classification criteria

An oxidizing liquid is classified in one of the three categories for this class using test O.2 in 34.4.2 of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, according to the following table:

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Any substance or mixture which, in the 1:1 mixture, by mass, of substance (or mixture) 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</td>
</tr>
<tr>
<td>2</td>
<td>Any substance or mixture which, in the 1:1 mixture, by mass, of substance (or mixture) 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 category 1 are not met</td>
</tr>
<tr>
<td>3</td>
<td>Any substance or mixture which, in the 1:1 mixture, by mass, of substance (or mixture) 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 category 1 and 2 are not met</td>
</tr>
</tbody>
</table>

2.13.3 Hazard communication

General and specific considerations concerning labelling requirements are provided in Hazard Communication: Labelling (Chapter 1.4). Annex 2 contains summary tables about classification and labelling. Annex 3 contains examples of precautionary statements and pictograms which can be used where allowed by the competent authority.
Table 2.13.2: Label elements for oxidizing liquids

<table>
<thead>
<tr>
<th></th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symbol</strong></td>
<td>Flame over circle</td>
<td>Flame over circle</td>
<td>Flame over circle</td>
</tr>
<tr>
<td><strong>Signal word</strong></td>
<td>Danger</td>
<td>Danger</td>
<td>Warning</td>
</tr>
<tr>
<td><strong>Hazard statement</strong></td>
<td>May cause fire or explosion; strong oxidizer</td>
<td>May intensify fire; oxidizer</td>
<td>May intensify fire; oxidizer</td>
</tr>
</tbody>
</table>

2.13.4 Decision logic and guidance

The decision logic and guidance, which follow, are not part of the harmonized classification system, but have been provided here as additional guidance. It is strongly recommended that the person responsible for classification studies the criteria before and during use of the decision logic.

2.13.4.1 Decision logic

To classify an oxidizing liquid test method O.2 as described in 34.4.2 of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria should be performed. Classification is according to the following decision logic.

2.13.4.2 Guidance

2.13.4.2.1 Experience in the handling and use of substances or mixtures which shows them to be oxidizing is an important additional factor in considering classification in this class. In the event of divergence between tests results and known experience, judgement based on known experience should take precedence over test results.

2.13.4.2.2 In some cases, substances or mixtures may generate a pressure rise (too high or too low), caused by chemical reactions not characterising the oxidizing properties of the substance or mixture. In these cases, it may be necessary to repeat the test described in 34.4.2 of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria with an inert substance, e.g. diatomite (kieselguhr), in place of the cellulose in order to clarify the nature of the reaction.

2.13.4.2.3 For organic substances or mixtures the classification procedure for this class need not be applied if:

   (a) The substance or mixture does not contain oxygen, fluorine or chlorine; or

   (b) The substance or mixture contains oxygen, fluorine or chlorine and these elements are chemically bonded only to carbon or hydrogen.

2.13.4.2.4 For inorganic substances or mixtures, the classification procedure for this class need not be applied if they do not contain oxygen or halogen atoms.
Decision logic 2.13 for oxidizing liquids

The substance/mixture is a liquid

Does it, in the 1:1 mixture, by mass, of substance (or mixture) and cellulose tested, exhibit a pressure rise of at least 2070 kPa gauge?

No → Not classified

Yes

Does it, in the 1:1 mixture, by mass, of substance (or mixture) and cellulose tested, exhibit 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?

No → Not classified

Yes

Does it, in the 1:1 mixture, by mass, of substance (or mixture) and cellulose tested, exhibit 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 and cellulose?

No → Category 3

Warning

Yes

Does it, in the 1:1 mixture, by mass, of substance (or mixture) and cellulose tested, spontaneously ignite or exhibit a mean pressure rise time less than that of a 1:1 mixture, by mass, of 50% perchloric acid and cellulose?

No → Category 2

Danger

Yes

Category 1

Danger
CHAPTER 2.14

OXIDIZING SOLIDS

2.14.1 Definition

An oxidizing solid is a solid which, while in itself is not necessarily combustible, may, generally by yielding oxygen, cause, or contribute to, the combustion of other material.

2.14.2 Classification criteria

An oxidizing solid is classified in one of the three categories for this class using test O.1 in 34.4.1 of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, according to the following table:

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Any substance or mixture 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.</td>
</tr>
<tr>
<td>2</td>
<td>Any substance or mixture 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 category 1 are not met.</td>
</tr>
<tr>
<td>3</td>
<td>Any substance or mixture 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 categories 1 and 2 are not met.</td>
</tr>
</tbody>
</table>

NOTE: For classification tests on solid substances or mixtures, the tests should be performed on the substance or mixture as presented. If for example, for the purposes of supply or transport, the same chemical is to be presented in a physical form different from that which was tested and which is considered likely to materially alter its performance in a classification test, the substance or mixture must also be tested in the new form.

2.14.3 Hazard communication

General and specific considerations concerning labelling requirements are provided in Hazard Communication: Labelling (Chapter 1.4). Annex 2 contains summary tables about classification and labelling. Annex 3 contains examples of precautionary statements and pictograms which can be used where allowed by the competent authority.
Table 2.14.2: Label elements for oxidizing solids

<table>
<thead>
<tr>
<th></th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symbol</strong></td>
<td>Flame over circle</td>
<td>Flame over circle</td>
<td>Flame over circle</td>
</tr>
<tr>
<td><strong>Signal word</strong></td>
<td>Danger</td>
<td>Danger</td>
<td>Warning</td>
</tr>
<tr>
<td><strong>Hazard statement</strong></td>
<td>May cause fire or explosion; strong oxidizer</td>
<td>May intensify fire; oxidizer</td>
<td>May intensify fire; oxidizer</td>
</tr>
</tbody>
</table>

2.14.4 Decision logic and guidance

The decision logic and guidance, which follow, are not part of the harmonized classification system, but have been provided here as additional guidance. It is strongly recommended that the person responsible for classification studies the criteria before and during use of the decision logic.

2.14.4.1 Decision logic

To classify an oxidizing solid test method O.1 as described in 34.4.1 of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, should be performed. Classification is according to the following decision logic.

2.14.4.2 Guidance

2.14.4.2.1 Experience in the handling and use of substances or mixtures which shows them to be oxidizing is an important additional factor in considering classification in this class. In the event of divergence between tests results and known experience, judgement based on known experience should take precedence over test results.

2.14.4.2.2 The classification procedure for this class need not be applied to organic substances or mixtures if:

(a) The substance or mixture does not contain oxygen, fluorine or chlorine; or

(b) The substance or mixture contains oxygen, fluorine or chlorine and these elements are chemically bonded only to carbon or hydrogen.

2.14.4.2.3 The classification procedure for this class need not be applied to inorganic substances or mixtures if they do not contain oxygen or halogen atoms.
**Decision logic 2.14 for oxidizing solids**

The substance/mixture is a solid

Does it, in the 4:1 or 1:1 sample-to-cellulose ratio, by mass, tested ignite or burn?

**No**

Not classified

**Yes**

Does it, in the 4:1 or 1:1 sample-to-cellulose ratio, by mass, tested, exhibit a mean burning time less than or equal to the mean burning time of a 3:7 mixture, by mass, of potassium bromate and cellulose?

**No**

Not classified

**Yes**

Does it, in the 4:1 or 1:1 sample-to-cellulose ratio, by mass, tested, exhibit a mean burning time less than or equal to the mean burning time of a 2:3 mixture, by mass, of potassium bromate and cellulose?

**No**

**Yes**

Does it, in the 4:1 or 1:1 sample-to-cellulose ratio, by mass, tested, exhibit a mean burning time less than the mean burning time of a 3:2 mixture, by mass, of potassium bromate and cellulose?

**No**

**Yes**

Does it, in the 4:1 or 1:1 sample-to-cellulose ratio, by mass, tested, exhibit a mean burning time less than the mean burning time of a 3:2 mixture, by mass, of potassium bromate and cellulose?

**Category 1**

Danger

**Category 2**

Danger

**Category 3**

Warning

No
CHAPTER 2.15

ORGANIC PEROXIDES

2.15.1 Definition

2.15.1.1 Organic peroxides are liquid or solid 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. The term also includes organic peroxide formulations (mixtures). Organic peroxides are thermally unstable substances or mixtures, which may undergo exothermic self-accelerating decomposition. In addition, they may have one or more of the following properties:

(a) be liable to explosive decomposition;
(b) burn rapidly;
(c) be sensitive to impact or friction;
(d) react dangerously with other substances.

2.15.1.2 An organic peroxide 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.

2.15.2 Classification criteria

2.15.2.1 Any organic peroxide shall be considered for classification in this class, unless it contains:

(a) Not more than 1.0% available oxygen from the organic peroxides when containing not more than 1.0% hydrogen peroxide; or
(b) 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 mixture is given by the formula:

\[ 16 \times \sum_{i} \left( \frac{n_{i} \times c_{i}}{m_{i}} \right) \]

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 \( i \).

2.15.2.2 Organic peroxides are classified in one of the seven categories of "Types A to G" for this class, according to the following principles:

(a) Any organic peroxide which, as packaged, can detonate or deflagrate rapidly will be defined as organic peroxide TYPE A;
(b) Any organic peroxide possessing explosive properties and which, as packaged, neither
detonates nor deflagrates rapidly, but is liable to undergo a thermal explosion in that
package will be defined as organic peroxide TYPE B;

(c) Any organic peroxide possessing explosive properties when the substance or mixture
as packaged cannot detonate or deflagrate rapidly or undergo a thermal explosion will
be defined as organic peroxide TYPE C;

(d) Any organic peroxide which in laboratory testing:

(i) detonates partially, does not deflagrate rapidly and shows no violent effect
when heated under confinement; or

(ii) does not detonate at all, deflagrates slowly and shows no violent effect when
heated under confinement; or

(iii) does not detonate or deflagrate at all and shows a medium effect when heated
under confinement;

will be defined as organic peroxide TYPE D;

(e) Any organic peroxide which, in laboratory testing, neither detonates nor deflagrates at
all and shows low or no effect when heated under confinement will be defined as
organic peroxide TYPE E;

(f) Any organic peroxide 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 will be defined as organic
peroxide TYPE F;

(g) Any organic peroxide 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, provided that it is thermally stable (self-accelerating
decomposition temperature is 60°C or higher for a 50 kg package), and, for liquid
mixtures, a diluent having a boiling point of not less than 150 °C is used for
desensitisation, will be defined as organic peroxide TYPE G. If the organic peroxide
is not thermally stable or a diluent having a boiling point less than 150 °C is used for
desensitization, it shall be defined as organic peroxide TYPE F.

**NOTE 1:** Type G has no hazard communication elements assigned but should be considered for
properties belonging to other hazard classes.

**NOTE 2:** Types A to G may not be necessary for all systems.

### 2.15.3 Hazard communication

General and specific considerations concerning labelling requirements are provided in
Hazard Communication: Labelling (Chapter 1.4). Annex 2 contains summary tables about classification
and labelling. Annex 3 contains examples of precautionary statements and pictograms which can be used
where allowed by the competent authority.
Table 2.15.1: Label elements for organic peroxides

<table>
<thead>
<tr>
<th></th>
<th>Type A</th>
<th>Type B</th>
<th>Type C and D</th>
<th>Type E and F</th>
<th>Type G a</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symbol</strong></td>
<td>Exploding bomb and flame over circle</td>
<td>Exploding bomb and flame over circle</td>
<td>Flame over circle</td>
<td>Flame over circle</td>
<td></td>
</tr>
<tr>
<td><strong>Signal word</strong></td>
<td>Danger</td>
<td>Danger</td>
<td>Danger</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td><strong>Hazard statement</strong></td>
<td>Heating may cause an explosion</td>
<td>Heating may cause a fire or explosion</td>
<td>Heating may cause a fire</td>
<td>Heating may cause a fire</td>
<td></td>
</tr>
</tbody>
</table>

* Type G has no hazard communication elements assigned but should be considered for properties belonging to other hazard classes.

2.15.4 Decision logic and guidance

The decision logic and guidance, which follow, are not part of the harmonized classification system, but have been provided here as additional guidance. It is strongly recommended that the person responsible for classification studies the criteria before and during use of the decision logic.

2.15.4.1 Decision logic

To classify an organic peroxide test series A to H as described in Part II of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, should be performed. Classification is according to the following decision logic:
**Decision logic 2.15 for organic peroxides**

1. **Test A**
   - Does it propagate a detonation?
   - 1.1 Yes
   - 1.2 Partial
   - 1.3 No

2. **Test B**
   - Can it detonate as packaged?
   - 2.1 Yes
   - 2.2 No

3. **Test C**
   - Can it propagate a deflagration?
   - 3.1 Yes, rapidly
   - 3.2 Yes, slowly
   - 3.3 No

4. **Test D**
   - Does it deflagrate rapidly in package?
   - 4.1 Yes, rapidly
   - 4.2 Yes, slowly
   - 4.3 No

5. **Test E**
   - What is the effect of heating under confinement?
   - 5.1 Yes, rapidly
   - 5.2 Yes, slowly
   - 5.3 No

6. **Test F**
   - What is its explosive power?
   - 6.1 Violent
   - 6.2 Medium
   - 6.3 Low
   - 6.4 No

7. **Test G**
   - Can it explode as packaged?
   - 7.1 Violent
   - 7.2 Medium
   - 7.3 Low
   - 7.4 No

8. **Test H**
   - Packaged in packages of more than 400 kg / 450 l or to be considered for exemption?
   - 8.1 Violent
   - 8.2 Medium
   - 8.3 Low
   - 8.4 No

9. **Test I**
   - What is the effect of heating under confinement?
   - 9.1 Violent
   - 9.2 Medium
   - 9.3 Low
   - 9.4 No

10. **Test J**
    - What is the explosive power?
    - 10.1 Yes
    - 10.2 No

11. **Test K**
    - Packaged in packages of more than 400 kg / 450 l or to be considered for exemption?
    - 11.1 Yes
    - 11.2 No

12. **Test L**
    - What is the effect of heating under confinement?
    - 12.1 Not low
    - 12.2 Low
    - 13.1 Low

13. **Test M**
    - What is the explosive power?
    - 13.2 None
2.15.4.2  Guidance

2.15.4.2.1 Organic peroxides are classified by definition based on their chemical structure and on the available oxygen and hydrogen peroxide contents of the mixture (see 2.15.2.1).

2.15.4.2.2 The properties of organic peroxides which are decisive for their classification should be determined experimentally. Test methods with pertinent evaluation criteria are given in the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, Part II (test series A to H).

2.15.4.2.3 Mixtures of organic peroxides may be classified as the same type of organic peroxide as that of the most dangerous component. However, as two stable components can form a thermally less stable mixture, the self-accelerating decomposition temperature (SADT) of the mixture shall be determined.
CHAPTER 2.16
CORROSIVE TO METALS

2.16.1 Definition

A substance or a mixture that is corrosive to metal is a substance or a mixture which by chemical action will materially damage, or even destroy, metals.

2.16.2 Classification criteria

A substance or a mixture which is corrosive to metal is classified in a single category for this class according to the following table

Table 2.16.1: Criteria for substances and mixtures corrosive to metal

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Corrosion rate on steel or aluminium surfaces exceeding 6.25 mm per year at a test temperature of 55 °C.</td>
</tr>
</tbody>
</table>

2.16.3 Hazard communication

General and specific considerations concerning labelling requirements are provided in Hazard Communication: Labelling (Chapter 1.4). Annex 2 contains summary tables about classification and labelling. Annex 3 contains examples of precautionary statements and pictograms which can be used where allowed by the competent authority.

Table 2.16.2: Label elements for substances and mixtures corrosive to metals

<table>
<thead>
<tr>
<th>Category 1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbol</td>
<td>Corrosive</td>
</tr>
<tr>
<td>Signal word</td>
<td>Warning</td>
</tr>
<tr>
<td>Hazard statement</td>
<td>May be corrosive to metals</td>
</tr>
</tbody>
</table>

2.16.4 Decision logic and guidance

The decision logic and guidance, which follow, are not part of the harmonized classification system but have been provided here as additional guidance. It is strongly recommended that the person responsible for classification studies the criteria before and during use of the decision logic.
2.16.4.1 Decision logic

**Decision Logic 2.16 for substances and mixtures corrosive to metals**

Does it corrode on steel or aluminium surfaces at a rate exceeding 6.25 mm/year?

- Yes: Category 1
- No: Not classified

2.16.4.2 Guidance

The corrosion rate can be measured with the following tests methods:

- for the purposes of testing steel, type P235 (ISO 9328-2:1991 - Steel plates and strips for pressure purposes – Technical delivery conditions. Part 2: unalloyed and low alloyed steels with specified room temperature and elevated temperature properties) or a similar type shall be used;
- for testing aluminium, non-clad types 7075-T6 or AZ5GU-T6 shall be used.

An acceptable test is prescribed in ASTM G31-72 (Reapproved 1990).