

**Committee of Experts on the Transport of Dangerous Goods  
and on the Globally Harmonized System of Classification  
and Labelling of Chemicals**

2 November 2016

**Sub-Committee of Experts on the  
Transport of Dangerous Goods**

**Sub-Committee of Experts on the Globally Harmonized  
System of Classification and Labelling of Chemicals**

**Fiftieth session**

Geneva, 28 – 6 December 2016

Item 7 (c) of the provisional agenda

**Issues relating to the Globally Harmonized System  
of Classification and Labelling of Chemicals:  
classification criteria for flammable gases**

**Thirty-second session**

Geneva, 7– 9 (morning) December 2016

Item 2 (b) of the provisional agenda

**Classification criteria and related hazard  
communication: work of the TDG Sub-Committee on  
matters of interest to the GHS Sub-Committee**

**Classification criteria and hazard communication for  
flammable gases: “track-changes” version of the proposal in  
document ST/SG/AC.10/C.3/2016/58-  
ST/SG/AC.10/C.4/2016/12**

**Transmitted by the experts from Belgium and Japan**

This document shows the text of Chapter 2.2 of the GHS and its annexes 1 and 3, as amended by the proposal in ST/SG/AC.10/C.3/2016/58–ST/SG/AC.10/C.4/2016/12 for consideration of both sub-committees.

## Annex I

### Proposed amendments to Chapter 2.2 of the GHS

#### “CHAPTER 2.2

#### FLAMMABLE GASES

##### 2.2.1 Definitions

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

2.2.1.2 A *pyrophoric gas* is a flammable gas that is liable to ignite spontaneously in air at a temperature of 54 °C or below.

2.2.1.3 A *chemically unstable gas* is a flammable gas that is able to react explosively even in the absence of air or oxygen.

##### 2.2.2 Classification criteria

2.2.2.1 A flammable gas is classified in ~~one of the two categories for this class~~ Category 1A, 1B or 2 according to the following table: Flammable gases that are pyrophoric and/or chemically unstable gases are always classified in Category 1A.

Table 2.2.1: Criteria for categorisation of flammable gases

Category		Criteria
1A	<u>Flammable gas</u>	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. <u>unless data shows them to meet the criteria of category 1B</u>
	<u>Pyrophoric gas</u>	<u>Flammable gases that ignite spontaneously in air at a temperature of 54 °C or below</u>
	<u>Chemically Unstable gas</u>	A <u>Flammable gases which are chemically unstable at 20°C and a standard pressure of 101.3 kPa</u> B <u>Flammable gases which are chemically unstable at a temperature greater than 20°C and/or a pressure greater than 101.3 kPa</u>
1B	<u>Flammable gas</u>	<u>Gases which meet the flammability criteria for Category 1A, but which are not pyrophoric, nor chemically unstable, and which have at least either: (a) a lower flammability limit of more than 6% by volume in air; or (b) a fundamental burning velocity of less than 10 cm/s;</u>
2	Flammable gas	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:** Aerosols should not be classified as flammable gases. See Chapter 2.3.

**NOTE 3:** In the absence of data allowing classification into Category 1B, a flammable gas that meets the criteria for Category 1A is classified per default in Category 1A.

**NOTE 14:** Spontaneous ignition for pyrophoric gases is not always immediate, and there may be a delay.

**NOTE 52:** In the absence of data on its pyrophoricity, a flammable gas mixture should be classified as a pyrophoric gas if it contains more than 1% (by volume) of pyrophoric component(s).

2.2.2.2 A flammable gas is additionally classified as pyrophoric if it meets the criteria in the following table:

**Table 2.2.2: Criteria for pyrophoric gases**

Category	Criteria
<b>Pyrophoric gas</b>	Flammable gas that ignites spontaneously in air at a temperature of 54°C or below.

2.2.2.3 A flammable gas that is also chemically unstable is additionally classified in one of the two categories for chemically unstable gases using the methods described in Part III of the Manual of Tests and Criteria according to the following table:

**Table 2.2.3: Criteria for chemically unstable gases**

Category	Criteria
<b>A</b>	Flammable gases which are chemically unstable at 20°C and a standard pressure of 101.3 kPa
<b>B</b>	Flammable gases which are chemically unstable at a temperature greater than 20°C and/or a pressure greater than 101.3 kPa

### 2.2.3 Hazard communication

2.2.3.1 General and specific considerations concerning labelling requirements are provided in *Hazard communication: Labelling* (Chapter 1.4). Annex 1 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 2.2.42: Label elements for flammable gases**

	<u>Category 1A</u>	<u>Gases categorized as 1A by meeting pyrophoric or unstable gas A/B criteria</u>			<u>Category 1B</u>	<u>Category 2</u>
		<u>Pyrophoric gas</u>	<u>Chemically unstable gas Category A</u>	<u>Chemically unstable gas Category B</u>		
<u>Symbol</u>	Flame	Flame	<u>No additional symbol</u> Flame	<u>No additional symbol</u> Flame	Flame	<u>No symbol</u>
<u>Signal word</u>	Danger	Danger	<u>No additional signal word</u> Danger	<u>No additional signal word</u> Danger	Danger	Warning
<u>Hazard statement</u>	Extremely flammable gas	Extremely flammable gas May ignite spontaneously if exposed to air	Extremely flammable gas May react explosively even in the absence of air	Extremely flammable gas May react explosively even in the absence of air at elevated pressure and/or temperature	Flammable gas	Flammable gas

2.2.3.2 If a flammable gas or gas mixture is additionally classified in one or more sub-categories as pyrophoric and/or chemically unstable, then all relevant classification(s) should be communicated on the safety data sheet as specified in Annex 4, and the relevant hazard communication elements included on the label.

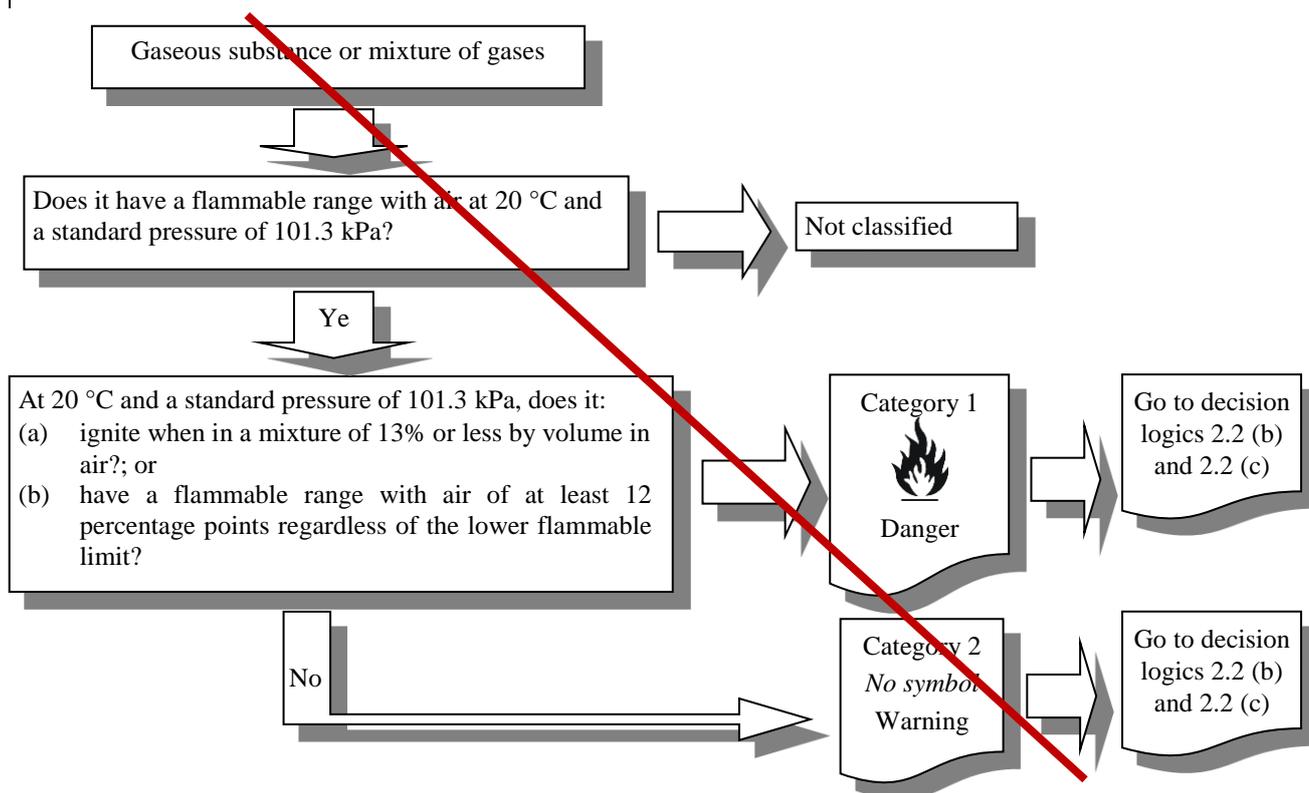
## 2.2.4 Decision logic and guidance

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 for flammable gases

To classify a flammable gas, data on its flammability, on its ability to ignite in air and on its chemical instability are required. In case of categorisation in Category 1B, data on its lower flammability limit or its fundamental burning velocity is required. The classification is according to decision logic 2.2-(a).

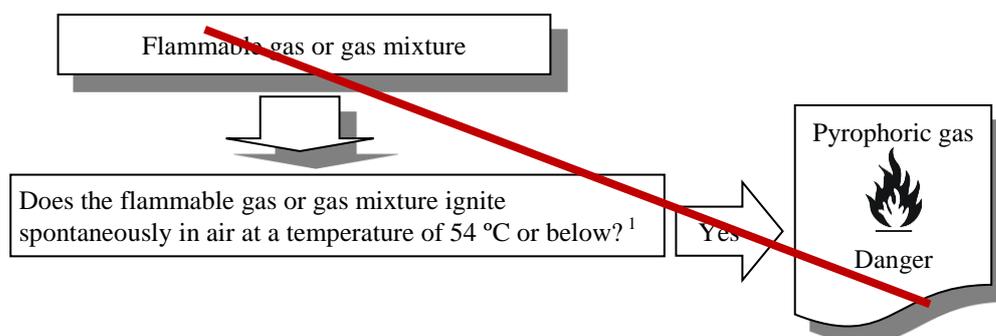
#### Decision logic 2.2 (a)



#### 2.2.4.2 Decision logic for pyrophoric gases

~~To classify a flammable gas as a pyrophoric gas, data on its ability to ignite in air are required. The classification is according to decision logic 2.2 (b).~~

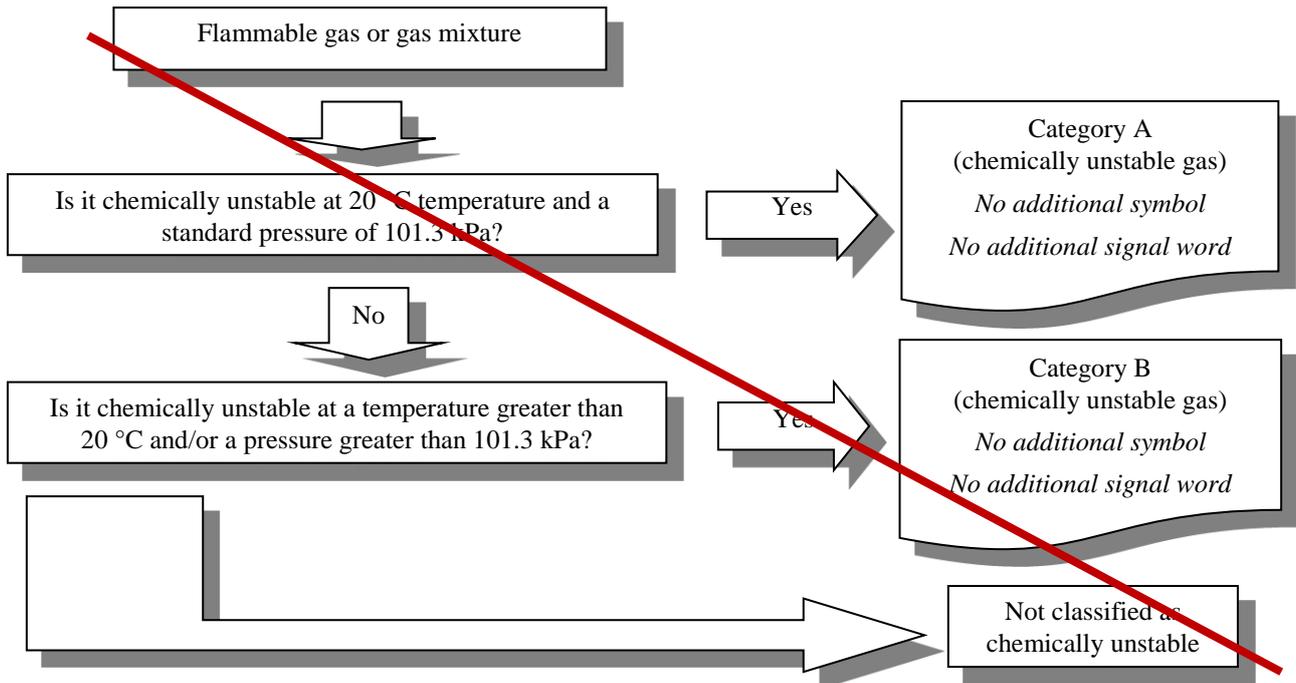
#### Decision logic 2.2 (b)



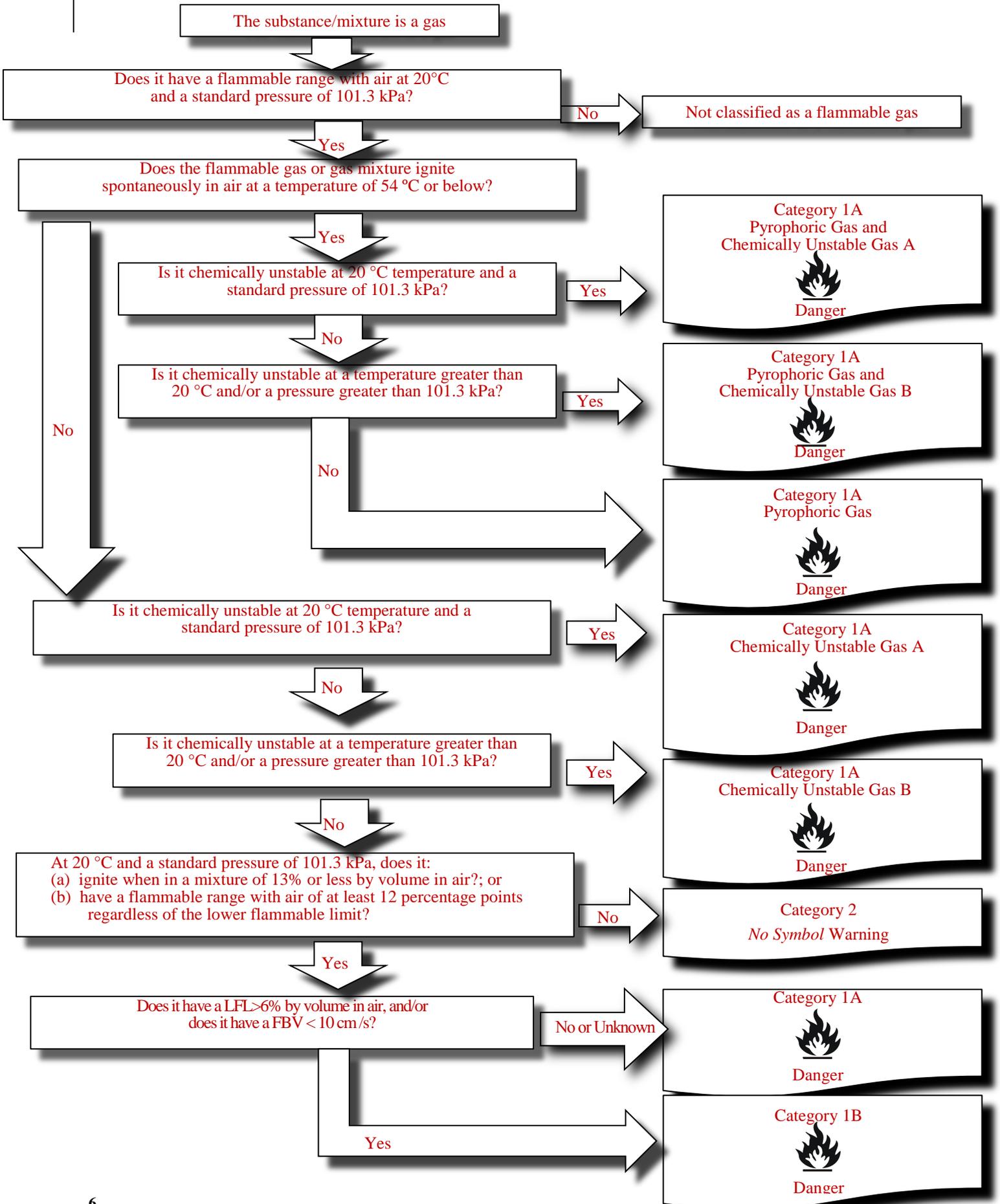
2.2.4.3 *Decision logic for chemically unstable gases*

~~To classify a flammable gas as chemically unstable, data on its chemical instability are required. The classification is according to decision logic 2.2 (c).~~

*Decision logic 2.2 (c)*



Decision logic 2.2



<sup>1</sup> In the absence of data on its pyrophoricity, a flammable gas mixture should be classified as a pyrophoric gas if it contains more than 1% (by volume) of pyrophoric component(s).

#### 2.2.4.4 *Guidance*

2.2.4.4.1 Flammability should be determined by tests or by calculation in accordance with methods adopted by ISO (see ISO 10156:2010 “Gases and gas mixtures – Determination of fire potential and oxidizing ability for the selection of cylinder valve outlets” [and, if using fundamental burning velocity for Category 1B, see ISO 817:2014 “Refrigerants-Designation and safety classification, Annex C: Method of test for burning velocity measurement of flammable gases”](#)). Where insufficient data are available to use these methods, tests by a comparable method recognized by the competent authority may be used.

2.2.4.4.2 Pyrophoricity should be determined at 54°C in accordance with either IEC 60079-20-1 ed1.0 (2010-01) “Explosive atmospheres – Part 20-1: Material characteristics for gas and vapour classification – Test methods and data” or DIN 51794 “Determining the ignition temperature of petroleum products”.

2.2.4.4.3 The classification procedure for pyrophoric gases need not be applied when experience in production or handling shows that the substance does not ignite spontaneously on coming into contact with air at a temperature of 54 °C or below. Flammable gas mixtures, which have not been tested for pyrophoricity and contain more than one percent pyrophoric components, should be classified as a pyrophoric gas. Expert judgement on the properties and physical hazards of pyrophoric gases and their mixtures should be used in assessing the need for classification of flammable gas mixtures containing one percent or less pyrophoric components. In this case, testing need only be considered if expert judgement indicates a need for additional data to support the classification process.

[2.2.4.4.4 Chemical instability should be determined in accordance with the method described in Part III of the Manual of Tests and Criteria. If the calculations in accordance with ISO 10156:2010 show that a gas mixture is not flammable it is not necessary to carry out the tests for determining chemical instability for classification purposes.](#)

#### 2.2.5 **Example: Classification of a flammable gas mixture by calculation according to ISO 10156:2010**

##### Formula

$$\sum_i^n \frac{V_i\%}{T_{ci}}$$

where:

- $V_i\%$  = the equivalent flammable gas content;
- $T_{ci}$  = the maximum concentration of a flammable gas in nitrogen at which the mixture is still not flammable in air;
- $i$  = the first gas in the mixture;
- $n$  = the  $n^{\text{th}}$  gas in the mixture;
- $K_i$  = the equivalency factor for an inert gas versus nitrogen;

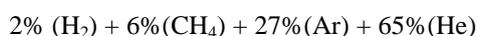
Where a gas mixture contains an inert diluent other than nitrogen, the volume of this diluent is adjusted to the equivalent volume of nitrogen using the equivalency factor for the inert gas ( $K_i$ ).

##### 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



Calculation

1. Ascertain the equivalency factors (Ki) for the inert gases versus nitrogen:

$$K_i (\text{Ar}) = 0.55$$

$$K_i (\text{He}) = 0.59$$

2. Calculate the equivalent mixture with nitrogen as balance gas using the Ki figures for the inert gases:

$$2\%(\text{H}_2) + 6\%(\text{CH}_4) + [27\% \times 0.55 + 65\% \times 0.59](\text{N}_2) = 2\%(\text{H}_2) + 6\%(\text{CH}_4) + 4673.35\%(\text{N}_2) = 5481.35\%$$

3. Adjust the sum of the contents to 100%:

$$\frac{100}{54} \times [2\%(\text{H}_2) + 6\%(\text{CH}_4) + 4673.35\%(\text{N}_2)] = 3.72.46\%(\text{H}_2) + 11.17.37\%(\text{CH}_4) + 85.2\%(\text{N}_2)$$

4. Ascertain the Tci coefficients for the flammable gases:

$$T_{ci} \text{ H}_2 = 5.75\%$$

$$T_{ci} \text{ CH}_4 = 14.38.7\%$$

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

$$\sum_i^n \frac{V_i\%}{T_{ci}} = \frac{3.7}{5.7} + \frac{11.1}{14.3} = 1.42 \quad \underline{1.42 > 1}$$

$$\sum_i^n \frac{V_i\%}{T_{ci}} = \frac{2.46}{5.5} + \frac{7.37}{8.7} = 1.29 \quad \underline{1.29 > 1}$$

Therefore the mixture is flammable in air.

Annex II

Consequential amendments to Annex 1, Table A1.2 of the GHS

A1.2 Flammable gases (see Chapter 2.2 for classification criteria)

Classification		Labelling				Hazard statement codes	
Hazard class	Hazard category	Pictogram		Signal word	Hazard statement		
		GHS	UN Model Regulations <sup>a</sup>				
Flammable gases	Flammable gas			Danger	Extremely flammable gas	H220	
							Danger
	category 1A Pyrophoric gas (chemical unstable gases)	A		See note b Not required	Danger No additional signal word	Extremely flammable gas Additional hazard statement: May react explosively even in the absence of air	
			Chemically unstable gas				B
	category 1B				Danger	Flammable gas	
	category 2	No pictogram	Not required	Warning			Flammable gas

<sup>a</sup> Under the UN Recommendations on the Transport of Dangerous Goods, Model Regulations, the symbol, number and border line may be shown in black instead of white. The background colour stays red in both cases.

<sup>b</sup> Pyrophoric and chemical unstable gases are covered differently under the UN Recommendations on the Transport of Dangerous Goods, Model Regulations.

## **Annex III**

### **Consequential amendments to Annex 3 of the GHS**

#### **Section 1, Table A3.1.1**

##### **For H220**

In column 4, under “hazard category”, replace “1” with “1A”.

##### **For H221**

In column 4, under “hazard category”, replace “2” with “1B, 2”.

#### **Section 2, Table A3.2.2**

##### **For P210**

In column (4), under “hazard category”, for “flammable gases” replace “1, 2” with “1A, 1B, 2”

#### **Section 2, Table A3.2.3**

##### **For P377**

In column (4), under “hazard category”, for “flammable gases” replace “1, 2” with “1A, 1B, 2”

##### **For P381**

In column (4), under “hazard category”, for “flammable gases” replace “1, 2” with “1A, 1B, 2”

#### **Section 2, Table A3.2.4**

##### **For P403**

In column (4), under “hazard category”, for “flammable gases” replace “1, 2” with “1A, 1B, 2”

### Section 3, paragraph A3.3.5

Amend the matrix tables for flammable gases as follows and move the tables of flammable gases of Category 1B and Category 2 after the tables dealing with pyrophoric gases and chemically unstable gases as these gases are always flammable gases of Category 1A:

**FLAMMABLE GASES**  
**(CHAPTER 2.2)**  
 (Flammable gases)

**Hazard category**

1A

**Signal word**

Danger

**Hazard statement**

H220 Extremely flammable gas

Symbol  
Flame



Precautionary statements			
Prevention	Response	Storage	Disposal
P210 Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.	P377 Leaking gas fire: Do not extinguish, unless leak can be stopped safely.  P381 In case of leakage, eliminate all ignition sources.	P403 Store in a well-ventilated place.	

**FLAMMABLE GASES**  
**(CHAPTER 2.2)**  
 (Pyrophoric gases)

<b>Symbol</b> Flame
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<b>Hazard category</b>	<b>Signal word</b>	<b>Hazard statement</b>
<u>1A</u> , Pyrophoric gas	Danger	<u>H220</u> <u>Extremely flammable gas</u> <u>H232</u> May ignite spontaneously if exposed to air

Precautionary statements			
Prevention	Response	Storage	Disposal
<p><u>P210</u>  <b>Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.</b></p> <p>P222  <b>Do not allow contact with air.</b>  <i>– if emphasis of the hazard statement is deemed necessary.</i></p> <p>P280  <b>Wear protective gloves/protective clothing/eye protection/face protection.</b>            Manufacturer/supplier or the competent authority to specify the appropriate type of equipment.</p>	<p><u>P377</u>  <b>Leaking gas fire: Do not extinguish, unless leak can be stopped safely.</b></p> <p><u>P381</u>  <b>In case of leakage, eliminate all ignition sources.</b></p>	<p><u>P403</u>  <b>Store in a well-ventilated place.</b></p>	

*Note: This table lists only precautionary statements that are assigned due to the flammability and the pyrophoricity of the gas. For the other precautionary statements that are assigned based on chemical instability~~the flammability~~, see the respective table for Chemically Unstable Gases A and B.s for flammable gases.*

**FLAMMABLE GASES**  
**(CHAPTER 2.2)**  
~~(Chemically unstable gases)~~

<b>Symbol</b> <i>No additional symbol</i> <u>Flame</u>
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Hazard category	Signal word	Hazard statement
<u>1A</u> , Chemically Unstable gas A	<i>No additional signal word</i> <u>Danger</u>	<u>H220</u> <u>Extremely flammable gas</u> H230 May react explosively even in the absence of air
<u>1BA</u> , Chemically Unstable gas B	<i>No additional signal word</i> <u>Danger</u>	<u>H220</u> <u>Extremely flammable gas</u> H231 May react explosively even in the absence of air at elevated pressure and/or temperature



Precautionary statements			
Prevention	Response	Storage	Disposal
<u>P210</u> <u>Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.</u>  P202 <b>Do not handle until all safety precautions have been read and understood.</b>	<u>P377</u> <u>Leaking gas fire: Do not extinguish, unless leak can be stopped safely.</u>  <u>P381</u> <u>In case of leakage, eliminate all ignition sources.</u>	<u>P403</u> <u>Store in a well-ventilated place.</u>	

*Note: This table lists only the precautionary statements that are is assigned due to the flammability and the chemical instability of the gas. For the other precautionary statements that are assigned based on the pyrophoricity flammability see the respective tables for Pyrophoric flammable gases.*

**FLAMMABLE GASES**  
**(CHAPTER 2.2)**

<p><b><u>Symbol</u></b>  <i>flame</i></p>
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<b><u>Hazard category</u></b>	<b><u>Signal word</u></b>	<b><u>Hazard statement</u></b>
1B	Danger	H221 Flammable gas



<b><u>Precautionary statements</u></b>			
<b><u>Prevention</u></b>	<b><u>Response</u></b>	<b><u>Storage</u></b>	<b><u>Disposal</u></b>
<p><u>P210</u>  <b><u>Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.</u></b></p>	<p><u>P377</u>  <b><u>Leaking gas fire: Do not extinguish, unless leak can be stopped safely.</u></b></p> <p><u>P381</u>  <b><u>In case of leakage, eliminate all ignition sources.</u></b></p>	<p><u>P403</u>  <b><u>Store in a well-ventilated place.</u></b></p>	

**FLAMMABLE GASES**

**(CHAPTER 2.2)**

~~(Flammable-gases)~~

<b>Symbol</b> <i>No symbol</i>
-----------------------------------

<b>Hazard category</b>	<b>Signal word</b>	<b>Hazard statement</b>
2	Warning	H221 Flammable gas

Precautionary statements			
Prevention	Response	Storage	Disposal
P210 <b>Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.</b>	P377 <b>Leaking gas fire: Do not extinguish, unless leak can be stopped safely.</b>  P381 <b>In case of leakage, eliminate all ignition sources.</b>	P403 <b>Store in a well-ventilated place.</b>	

## Annex IV

### Guidance on the preparation of Safety Data Sheets (SDS)

In paragraph A4.3.9, table A 4.3.9.2, amend the text in column 3 for the row applicable to chapter 2.2 as follows-:

Chapter	Hazard class	Property/Safety characteristic/Test result and Remarks/Guidance
2.2	Flammable gases	<p><u>for pure flammable gases:</u></p> <ul style="list-style-type: none"> <li>- no data on the explosion / flammability limits is needed because these are indicated based on Table A4.3.9.1</li> <li>- indicate the <math>T_{Ci}</math> (maximum content of flammable gas which, when mixed with nitrogen, is not flammable in air, in %) as per ISO 10156</li> <li>- <u>indicate the Fundamental Burning Velocity (FBV) if the gas is classified as Category 1B based on FBV, generally determined by ISO 817:2014, Annex C</u></li> </ul> <p><u>for flammable gas mixtures:</u></p> <ul style="list-style-type: none"> <li>- indicate the explosion / flammability limits, if tested <u>or indicate whether the classification as flammable and category assignment</u> is based on the calculation as per ISO 10156.</li> <li>- <u>indicate the Fundamental Burning Velocity (FBV) if the gas mixture is classified as Category 1B based on FBV, generally determined by ISO 817:2014, Annex C</u></li> </ul>