

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

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

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Item 10 (c) of the provisional agenda

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

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

Thirtieth session

Geneva, 9 – 11 December 2015

Item 2 of the provisional agenda

**Classification criteria and related hazard communication:
Classification criteria for flammable gases**

**Proposal for label elements for the new sub-categories arising
from the revision of the criteria for flammable gases**

Transmitted by the experts from Japan and Belgium

Objective

1. The objective of this informal document is to propose a thought starter for the discussion on the label elements of flammable gases following the revision of the criteria.

Background

2. Following the mandate given during the plenary session of December 2014, an Informal Working Group (IWG) was set up. This IWG held two meetings, the first one in March 2015 and the second one in September 2015.

3. As noted in the reports from this IWG, a first consensus was reached in March for the creation of an additional subcategory for flammable gases to promote knowledge and safety, and during the second IWG meeting, a consensus for the criteria defining this additional subcategory was reached: LFL>6% volume or FBV<10 cm/s would be an appropriate delimitation between subcategory 1a and subcategory 1b. The subcategorisation would be optional. Experts from Japan and Belgium participated in the IWG and support this consensus.

4. The current label elements for flammable gases Category 1 and Category 2 are set out in Chapter 2.2, Table 2.2.4: Label elements for flammable gases (GHS, Sixth revised edition).

Table 1: Current GHS Label Elements for Flammable Gases, Category 1 and Category 2, from Table 2.2.4 of GHS Revision 6

	Flammable Gases	
	Category 1	Category 2
Symbol	Flame	<i>No Symbol</i>
Signal word	Danger	Warning
Hazard statement	Extremely flammable gas	Flammable gas

Discussion

5. In addition to the creation of a new subcategory and set up of parameters to define these categories, it is necessary to ascertain appropriate label elements: (hazard statements, signal words, and pictograms (symbols)) to encourage hazard communication for these subcategories.

6. During the second IWG meeting, a preliminary discussion about hazard communication took place but no consensus could be achieved and it was decided to leave this issue for discussion and decision by the GHS Sub-Committee.

7. The label elements should be:

- (a) Based on factual data from the concerned gases found in those subcategories;
- (b) Consistent with GHS hazard communication for flammable liquids; and,
- (c) In line with the way in which Flammable Gases are dealt within a number of consensus standards.

In addition, it is desirable that, as described in section D) of this paper, assigning label elements would cause only a negligible change to current commercial practice in hazard communication.

A. Based on factual data from the concerned gases found in those subcategories

8. Data and videos have been presented regarding a range of flammable gases. It has been seen that most hydrocarbon fuel gases in air, for which there is a stoichiometric concentration of the fuel *vis-a-vis* oxygen, ignite readily and burn strongly. In a semi-enclosed area, like conditions of a small to moderate size warehouse, or standard shipping container placed in a warehouse or stockyard, fires from relatively small, unintended releases of these gases may burn with high destructive over-pressures and temperatures. Videos and data presented during the second IWG meeting have shown that a small release of this type of gases can create in those circumstances fatal pressures and temperatures. Those data and videos are available at <https://vimeo.com/146174877> (High resolution, needs high speed internet) and <https://vimeo.com/146176112> (Low resolution). Please use the password Uj33eJ4ZPw. The hazard statement, “Extremely Flammable”, accurately describes them, and the signal word “Danger”, shows the high amount of attention needed.

9. In contrast, Category 2 gases (LFL>13%v, Burning Range <12%v) would be difficult to ignite, even under their optimum fuel concentrations. (We do not have data on actual combustion of Category 2 gases, and indeed, there seems to be some doubt that such

gases or gas mixtures currently exist). During the IWG meeting, Professor Volkmar Schröder from the BAM of Germany pointed out, in reference to Category 1b, that it would be extremely rare in an enclosed space or semi enclosed space, to reach the ignition/flammable concentration (LFL) of even 6% (See the minutes of the second IWG meeting ^(*)). *A fortiori* it would be nearly impossible to reach the concentration of 13% volume in air, which is the LFL for a Category 2 gas. So, while these gases are currently termed “Flammable”, the term “Combustible” would be more correct: Combustion will occur if they can be ignited, but it will be rare that the conditions may arise to ignite them or sustain a flammable state. For these gases, like in the Flammable Liquids classification, “Combustible” is more accurate than “Flammable”. We are aware of no fire incidents reported relating to Category 2 gases, so the lesser Signal Word, “Warning” is appropriate as “pro-safety” distinction from the Extremely Flammable category gases.

10. Between “Extremely Flammable” and “Combustible”, the term “Highly Flammable” or “Flammable” could be selected if we refer to the hazard statements used for flammable liquids. We note that there is a group of gases and mixtures that burn with distinctly less force than the hydrocarbon fuel gases but that will remain in subcategory 1a if the current recommendations of the IWG are adopted. Such gases are represented by Difluoroethane, and by the 90/10 nitrogen/propane mixture in the videos and data presented in the IWG. These gases clearly show combustion and pressures that are in an intermediate range, lower than the pure hydrocarbons but higher than the proposed Category 1b gases.

11. Looking again to the data and videos for two other gases, 92/8 nitrogen/propane which has a Fundamental Burning Velocity of 10cm/sec, and is presented as the borderline case for subcategory 1b and Difluoromethane, a gas which is well within the sub-category, it is clear that the gases qualified in Category 1b do not develop highly destructive pressures when burning in container and warehouse type semi-enclosed spaces and while the temperatures of combustion are similar to those of other gases. The slower release of heat from that combustion leads to more moderate, less dangerous and less destructive temperature rises. Dr. Scott Davis stated that slower release also gives greater effect to the property of buoyancy, so flames tend to rise instead of spreading out to adjacent areas and articles^{**}). So, it seems clear that these gases are not “Highly Flammable”: the term “Flammable Gas” is more appropriate and accurate.

B. Consistent with GHS hazard communication for flammable liquids

12. As mentioned briefly above, the closest analogy in other GHS categories is presented by flammable liquids. As set out in Chapter 2.6, Table 2.6.2 the categories and hazard statements are:

TABLE 2: GHS Table 2.6.2: Label Elements for Flammable liquids, GHS Revision 6

	Category 1	Category 2	Category 3	Category 4
Symbol	Flame	Flame	Flame	<i>No Symbol</i>
Signal word	Danger	Danger	Warning	Warning
Hazard statement	Extremely flammable liquid and vapour	Highly flammable liquid and vapour	Flammable liquid and vapour	Combustible liquid

So, it can be seen that there is precedent within GHS for distinction between “Combustible” and “Flammable” and general consistency in categorization is beneficial to overall understanding.

C. In line with the way in which flammable gases are dealt within a number of consensus standards

13. Presentations at the IWG meetings have shown that besides GHS, several gas classification standards exist in which the category corresponding to the GHS Extremely Flammable category has been considered too broad. It has been shown that the Association for Heating and Refrigeration Engineers, from its original flammable category, has divided that category into high flammable and flammable, and then divided the flammable category into flammable 2 and flammable 2L, in which 2L represents a category with FBV<10 cm/s. The same was done by the international organization ISO in ISO 817. NFPA, in the United States, has divided gases in NFPA 497, Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors, and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas, (2012 edition). In this classification there are four Divisions, based on Maximum Experimental Safety Gap, all within the group of gases that in GHS are in Flammable Gas category 1. In NFPA Standard 68, the differences between gases within the large group of flammable gases is recognized by using a continuous scale/calculation, based on the actual Fundamental Burning Velocity rather than grouping gases into categories. So, it is clear that the industrial world has recognized the need to classify gases more accurately, and that industries achieved this by different ways. Here we can hope to provide the building blocks for more industries and regulators to build their own risk mitigation structures, and in doing so we should use label elements that most accurately describe the categories that we are setting.

D. A negligible change to current commercial practice in hazard communication

14. It has been reported and verified that there are no pure gases, and currently either no or few commercial gas mixtures in Category 2. A search of available commercial literature and SDS’s does not reveal any Category 2 gas. For these reasons, the impact of the change from “Flammable” to “Combustible” might be negligible.

15. The qualification of a gas as Category 1b is optional to those wanting to take advantage of that subcategory. So use of “Flammable” would be well within acceptable requirements to take advantage of that option.

16. Because the Model Regulations for the Transport of Dangerous Goods (TDG) do not use the hazard statements from GHS anyway, there would be no impact for TDG.

Proposal

17. For the reasons stated above, the experts from Japan and Belgium propose the following label elements for the different categories/subcategories of flammable gases proposed by the IWG.

Table 3: Proposed Label elements for flammable Gases

	Flammable gases		
	Category 1/1a	Category 1b	Category 2
Symbol	Flame	Flame	<i>No Symbol</i>
Signal word	Danger	Warning	Warning
Hazard statement	Extremely flammable gas	Flammable gas	Combustible gas

(*) The reason, as we understand it, is as follows: These gases are produced in limited quantities and contained in small size (50 liters or less, 200 atm.) pressure bottles. Even if the entire contents of such a bottle leak out, the result may be diffusion of 1 cubic meter of gas under standard atmospheric pressure. In a semi-enclosed space of 25m³ (about the size of a standard half size shipping container) this would amount to only a 4% concentration, below the LFL of the proposed Category 1b. To reach the LFL of Category 2, assuming no leakage to the outside, three of times this concentration would be required.

(**) In the videos, this is seen by the immediate rise in the flame from the ignition source regardless of whether the flammable gas is lighter than air, such as ammonia, or heavier than air, such as difluoromethane. The subsequent spread and downward propagation of the flame in the test vessel is due to the fact that the bottom of the test chamber remains filled with the homogenized fuel/air mixture.