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

12 November 2015

Sub-Committee of Experts on the Transport of Dangerous Goods

Forty-eighth session

Geneva, 30 November – 9 December 2015

Item 10 (c) of the provisional agenda

Issues relating 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 Labelling of Chemicals

Thirtieth session

Geneva, 9-11 December 2015

Item 2 of the provisional agenda

Joint work with the Sub-Committee of Experts on the Transport of Dangerous Goods (TDG Sub-Committee)

Report of the Joint TDG-GHS Informal Working Group (IWG) dealing with categorization of flammable gases

Transmitted by the experts from Belgium and Japan on behalf on the informal working group

Tuesday 8 September 2015

1. The second meeting of the Joint TDG-GHS IWG dealing with the categorization of flammable gases within the Globally Harmonized System for Classification and Labelling of Chemicals (GHS) was organized in Brussels from September 8th to September 10th 2015 by the Belgian and the Japanese GHS & TDG delegations. Mr. Patrick Van Lancker was appointed as chairman. Both delegations welcomed the participants. The list of participants (physically and by phone) can be found in Annex 1 of this report.

2. The purpose of this IWG was to discuss possible modifications to the GHS Flammable Gas Category 1 (Extremely Flammable Gases). The participants were reminded of the mandate[1] given to this IWG during the plenary sessions of the GHS and TDG (1-12 December 2014, Geneva) as well as on the progress already made in the first meeting of the IWG[2] (March 2015) for the various mandate items. The endorsed mandate can be found in Annex 2 of this report.

3. The group was also reminded of the discussions from the plenary sessions of the GHS and TDG (20 June - 1 July 2015, Geneva). In particular, some delegations suggested that possible modification of Category 2 should be considered. In response, it was determined that the IWG should continue to work on the development of sub-categories within Category 1, given that there was no amendment to the mandate. Should the possibility of using Category 2 arise as a possible solution, this option may be discussed for consideration at a later stage with the agreement of both sub-committees[3].

[1] See the report of the TDG Sub-Committee of Experts on its 46th session (ST/SG/AC.10/C.3/92, paragraph 88)

[2] See informal document INF. 3 (GHS 29th session) – INF.5 (TDG 47th session)

[3] See the report of the GHS Sub-Committee on its 29th session (ST/SG/AC.10/C.4/58 paragraphs 13-15) and the report of the TDG Sub-Committee on its 47th session (ST/SG/AC.10/C.3/94 paragraphs 91-92).

4. Action items from IWG 1

Mandate Item 1 (d): *A review of regulatory and industrial standards in related fields*

A/ Presentation "Clarification of Technical Standards Using Amended Categories" by Dr. Scott Davis.

Dr. Davis, on behalf of GEXCON, gave an overview about Fundamental Burning Velocity (FBV) and how it is used in technical standards (NFPA68 + EN14994). The presentation demonstrated that FBV is a fundamental property of flammable gases that summarizes substance reactivity. It is correlated with other flammability characteristics like Heat of Combustion (HoC)/Heat of Oxidation (HoO). Computational Fluid Dynamics (CFD) simulations showed the different deflagration of higher (~40cm/s), medium (~25cm/s) and lower (≤10cm/s) FBV gases.

Discussion followed regarding:

– Further standards using FBV,

– Other characteristic properties mathematically correlated with FBV like Minimum Ignition Energy (MIE) and propagation of flames and their consequences on constructions and design of equipment.

B/ Presentation "Classification of technical standards using amended category" by Dr. Denis Clodic

Dr. Clodic gave an update about relations between FBV and Quenching Distance (d_q). He noted that since flammable gases must replace more and more traditional gases for refrigeration, plastics foaming and other purposes, these gases need to be more accurately classified for safe use in their applications. Hence ASHRAE 34:2013 and ISO 5149:2014 have already introduced FBV as an additional parameter for sub classification of flammable refrigerants.

Dr. Clodic explained that several methods exist to measure FBV e.g. vertical tube and spherical flask tests. The standard method ASTM E582-7 for quenching distances may be developed into a quick indicative test for FBV. Dr. Clodic referred to Dr. Kenji Takizawa's (National Institute of Advanced Industrial Science and Technology, (AIST), Japan) study describing a correlation between quenching distance and FBV, which can serve as a clear "go" / "no go" indication for gases meeting a certain FBV criterion. A video of a quenching distance/burning velocity test analogous to ASTM E882-7 finished the presentation.

The discussion that followed was about how the quenching distance test can be used to determine whether new gases, especially gas mixtures, meet a certain FBV criterion.

C/ Presentation "Large Scale Combustion Study 50m³ module tests" by Dr. Scott Davis.

Dr. Davis showed CFD simulations and videos of actual 50m³ combustion tests with: Propane (FBV 46cms^{-1} / Mix in air 4.6% vol.), Difluoroethane (C2H4F2) (23 cms^{-1} / 7.7% vol.), Mixed Propane 85%vol/ Nitrogen 15%vol (15 cms^{-1} / 30%), Mixed Propane 91%vol/ Nitrogen 9%vol (10 cms^{-1} / 23%), Ammonia NH3 (7.2 cms^{-1} / 25%) and Difluoromethane CH2F2 (6.7 cms^{-1} / 19%). It was clear that there is a strong positive correlation between FBV, flammability and pressure increase.

The second part of his presentation was about jet flame tests of large scale releases of pure pressurized Propane and CH2F2.

D/ Presentation "Decision tree flammable gases" by Mr. Edward Lampert

Mr. Lampert, on behalf of CEFIC, gave a short presentation about a possible decision tree, originally conceived by the German Institute for Materials Research and Testing (BAM), considering that pyrophoric and unstable gases shall remain under category 1/1a. During the first meeting of the IWG, concerns were raised that pyrophoric gases could be invented which are categorized as "flammable" but not "extremely flammable" if only judged by LFL and FBV. Categorization of gases under the procedure described in the presented decision tree would assure that pyrophoric and unstable gases always remain classified in Category 1/1a, and have the Hazard Statement as Extremely Flammable.

E/ Presentation "Overview of NFPA Regulatory Review" by Mrs Kathy Landkrohn

Mrs K. Landkrohn, on behalf of OSHA, gave an update about possible impacts on US codes and standards if GHS flammability categorization were to be changed as discussed during the first meeting of the IWG. The study / review was carried out by NFPA. The review aimed to determine potential effects of the proposed options for classification and labeling of flammable gases on U.S. codes and standards. In the US, the NFPA develops consensus standards which are often referred to in regulatory codes and by bodies like the EPA, Homeland security and OSHA. The preliminary results of the study show that no impact is expected for NFPA codes, DHS-CFR6, EPA-RMP. Changes by GHS/TDG may affect international fire codes, CGA standards, ASHRAE standards and OSHA regulations. The final report is expected at the end of September 2015.

Following this presentation the main discussion points were:

– Are there any conflicts with Department of Transportation (DOT) CFR49? So far DOT was not contacted but no changes for the DOT CFR49 are expected.

– Is there any impact on CGA standards? CGA standards are adopted by consensus within the industry for the industry. An optional "1b" has no impact on CGA rules. The current cut-off between category 1 and 2 is base for CGA standards. Hence a possible change of this cut-off is a matter of big concern. The cat. 2 discussion is fair but unnecessary and has an impact e.g. on storage requirements. All CGA downstream rules use the same definition.

F/ Phone conference with externals participants (moderated by Mr. Michael Bogaert)

A summary and the outcome of the day's presentations and discussions were given by Mr. Bogaert.

A deeper discussion evolved around a possible cat. 2 discussions as announced in the agenda. Concerns were expressed by OSHA and CGA, mainly linked to:

– No declassification of cat.1 gases to cat.2

– TDG has decided only to regulate cat.1. Elimination of cat.1 / cat.2 differences requires a different analysis.

Mr. Bogaert confirmed that the mandate from last December hasn't changed and that the IWG should continue to work and conclude according the given mandate.

Finally an outlook was given of the next day's schedule regarding the decision on the different options to subcategorize cat.1. The three options to be discussed were shown by Mr. Bogaert (and are provided in Annex 3 to this report). No conclusions or further comments were reached during the call.

5. Mandate Item (e) *Impact analysis on the existing classifications of flammable gases (with feedback from other gases – sectors) and (f): Details of possible modifications for GHS TDG*

Three compromise proposals were developed during the first meeting of the IWG. The consideration of mandate subject (e) led to the production of an impact analysis table for each of the three options for subcategorization (available on the IWG google drive – link provided in Annex 4 to this report). These options are subdivided into multiple sub-options based on the different cut off values being considered for LFL (i.e. for options 2 and 3).

A/ Presentation: "Analysis of the criteria of option 1 from 1st IWG" by Mr. Edward Lampert

Option 1

Using the LFL and FBV for sub-dividing

Category 1		Category 2
Default : Sub-category 1a	Option : Sub-category 1b	
Gases, which at 20°C and a standard pressure of 101.3 kPa are ignitable when in a mixture of 13% or less by volume in air or UFL-LFL ≥12 %	Gases from 1a with : 1) LFL > 5% And 2) FBV < 10 cm/s	Gases with : LFL > 13% and UFL-LFL < 12 %
 Extremely flammable gas (H220) Danger	 [Flammable gas] [H221][Hxxx] [Danger]/[Warning]	Flammable gas (H221) Warning

Date: 11 March 2015

Amongst the 70 GHS Flammable Gases, 17 gases are potentially affected by any of the options outlined at the first IWG (March 9-11, 2015). Differences and similarities in results between the two proposed criteria were presented. With option 1, seven gases are explicitly qualified as 1b by both criteria. It is important to note that two "footnoted" gases (Ammonia and Methyl Bromide) are outside the scope of the evaluation. Additionally, three gases (in addition to the "footnoted" ones) are notified under the toxic hazard category and five unstable gases as well as one pyrophoric gas should not be candidates for re-categorization. It was also noted that two gases qualify under the LFL criterion but fail under the FBV. Only one gas, CH3F (R41), is changing between cat.1a and cat.1b considering the different criteria of the three options. Results regarding issues around the option 1 as discussed during the first IWG meeting were shown:

– FBV unknown of some of the considered gases

– FBV of most pure, stable, non-pyrophoric gases with LFL greater than 5%vol known, only Methylamine missing

– Measuring FBV is not complicated

Different methods exists (e.g. vertical tube) as described in ASHRAE 34:2013 and ISO 817:2014, easy "go or no go" test using ASTM E 582 apparatus is under development

– Accuracy ± 5% achievable with standard test methods vs. most accurate test method

Correlation exists between FBV and HoC/HoO (see presentation Dr. Davis). The probability that high LFL gases delivers enough energy to achieve a combustible state is quite low (Prof. Schröder). The formation of an explosive atmosphere is much more unlikely for gases with a higher LFL (e.g. >6%). If no explosive atmosphere is formed in the first place, the potential energy release (or FBV) is not relevant because no explosion can occur.

Wednesday 9 September 2015

B/ Presentation "Analysis of criteria of option 2 from 1st IWG" by Dr. Scott Davis

Option 2

Category 1		Category 2
Default : Sub-category 1a	Option : Sub-category 1b	
Gases, which at 20°C and a standard pressure of 101.3 kPa are ignitable when in a mixture of 13% or less by volume in air or UFL-LFL ≥12 %	Gases from 1a with : 1) 4% < LFL ≤ [6%]/[8%] AND FBV < 10 cm/s OR 2) LFL > [6%]/[8%]	Gases with : LFL > 13% and UFL-LFL < 12 %
 Extremely flammable gas (H220) Danger	 [Flammable gas] [H221][Hxxx] [Warning]/[Danger]	Flammable gas (H221) Warning

Date: 11 March 2015

CO was identified as an outlier under the 2nd cat.1b option. Furthermore depending on the LFL threshold of 6 or 8% FBV measurement of Trifluorethane (R143a) were identified to be necessary.
There was discussion about toxicity of some flammable gases related to risk but this is not part of the mandate. Another question came up, how to identify gases that are unstable or pyrophoric. The identification could be done by UN marks or from UN tables.

C/ Presentation "Subcategorization of flammable gases. – Analysis of the criteria of option 3 from 1st IWG" by Prof. Volkmar Schröder

Option 3

Using the LFL or FBV for sub-dividing

Category 1		Category 2
Default : Sub-category 1a	Option : Sub-category 1b	
Gases, which at 20°C and a standard pressure of 101.3 kPa are ignitable when in a mixture of 13% or less by volume in air or UFL-LFL ≥12 %	Gases from 1a with : 1) LFL > [6% ?] [8% ?] OR 2) FBV < 10 cm/s	Gases with : LFL > 13% and UFL-LFL < 12 %
 Extremely flammable gas (H220) Danger	 [Flammable gas] [H221][Hxxx] [Danger]/ [Warning]	Flammable gas (H221) Warning

Date: 11 March 2015

It was noted that extensive FBV test data exists for refrigerants and for some other flammable gases but not all. No method exists to calculate mixtures without additional testing, and some member states of the UNSCETDG/GHS may lack FBV test facilities.

An example about the relation between LFL and needed volume for a flammable atmosphere for a 400m³ (10m x 10m x 4m small/medium) storage room was shown with Propane (LFL1.7% vol) and Carbon Monoxide (LFL 10.9% vol). While only 6.8Nm³ of Propane were necessary to create an ignitable atmosphere in the room, 43.6Nm³ was needed for Carbon Monoxide.

A benefit of LFL was described to be that it is well known for pure gases, has easy applicability to mixtures by standardized calculation methods, and standardized test methods are available and well known in nearly all member states of the UNSCETDG/GHS.

Difficulties for the FBV were described to be lack of available data for gases outside of refrigerants, no calculation method for mixtures and lack of testing facilities in some member states of the UNSCETDG/GHS.

The total global refrigerant market was estimated to be ~1Mt/a, the total global market for all fluorocarbon gases (incl. aerosols / foam / solvents) was estimated to be ~2Mt/a.

Prof. Schröder concluded with a clear statement combining both criteria with an “or” which offers categorization of most gases and mixtures by LFL and categorization of, especially, refrigerants by FBV. The LFL should be >5% but <8% with and FBV of <10cm/s Prof Schröder stated 6% would be a good cutoff level.

The discussion was mainly about the shown example of LFL zoning and the correlation between risk with only LFL and if shown examples could be considered in standards. For the CGA the consequences of these examples were important especially on workers and the alert from warning signs.

D/ Presentation “Analysis of the criteria of Option 3 from the 1st IWG” by Dr. Denis Clodic

Dr. Clodic emphasized the need to introduce the FBV as an additional criterion. This is important to let new low Global Warming Potential (GWP) refrigerants, plastic foaming gases, and others into a new subcategorized flammability class which shows an appropriate danger/safety classification. These new gases are needed to fulfill the challenges made by international regulations for the reduction of Green House Gas emission from refrigeration industry. With the ASTM E 582-7 test method on quenching distances adapted to screening of FBV, an easy way was described to find a "go" or "no go" criterion for a definable FBV. A table showing the correlation between LFL / d_q / FBV / MIE of different flammable gases confirmed Denis Clodic's statements.

E/ Presentation "Additional Observations -LFL and need for BV" by Ms. Mary Koban

Ms. Koban, speaking on behalf of the Chemours (formerly the DuPont Company Performance Chemicals division) showed an analysis of the growing adoption of low flammability sub-categories in industrial and consensus standards throughout the world. Important refrigeration standards (e.g. ISO 817: 2014 and ISO 5149: 2014, EN378: 2008) already use FBV as one of several parameters for classification. It is the parameter which divides substances with high HOC and low MIE from substances with lower HOC and high MIE. LFL is the basis of characterization. Many new gases (10-15 p.a. in just the refrigeration market) are brought to the market. To make a proper characterization FBV is the key for the subcategorization.

F/ Discussions and recommendations of the IWG regarding the preferred options(s)

Summary Statement by Mr. Michael Bogaert

Based on the outcome of the 1st IWG the 2 parameters to be considered are LFL and FBV. Each of opt. 1, opt.2 and opt.3 combine these parameters. The practicability of FBV was shown in a lot of cases. The support for Option 3 was far more enthusiastic than the support for Options 1 and 2, and there was no objection from any of the participants. All agreed on the importance of LFL to determine the hazard. A strong push for FBV was recognized in relationship for the necessity to support the adoption of technologies to counter global warming issues.

- LFL > 5% seemed to be too low and might allow some gases into the category which shouldn't be in (e.g. methane).
- LFL >8% would create a subcategory which is nearly empty
- LFL >6% offers the potential for a substantial category of gases that are not "Extremely Flammable".

A practical solution is needed for the sub-category. The LFL criterion shows clearly the link to the probability while FBV (with its high correlation with other flammability parameters) provides a hazard parameter that also links to the consequences.

The proposal for consensus of the IWG is: Option 3 with cut off values: "LFL >6% or FBV <10cm/s"

Mr. Pierre Wolfs, from the European Industrial Gases Association (EIGA) Option 3 supported. It is the only solution for reclassification of mixtures. LFL offers calculation method for classification of mixtures, which are often produced in small quantities and where BV measurement is not reasonable.

Dr. Cordula Wilrich from the German Federal Institute for Materials Research and Testing (BAM)

Fully agreed M.Bogaert's summary. Now better understanding of FBV. BAM needs the "or" in the subclassification. Option 3 is supported.

Mr. Lampert

Supports Mr Bogaert's suggestion on Option 3.

Mr. Anicello, from the Compressed Gas Association (CGA)

Wording of a proposal must be very clear that the "or" allows qualification for the category in case the acceptable value is shown for either parameter.

Mr. Wert, from CGA

Not prepared to give a final commitment on Option 3 although it comes quite near to membership's thinking. CGA is in favour to use 1a/b categories. Option 3 with LFL seems to be reasonable.

Mr. Van Lancker, Chair

Noted that the SCE will approve final text and before that, things still can change. The IWG should come with an agreement on the values. Decision on cat.2 are not part of the mandate and will not be discussed. Closed discussion with conclusion.

Mr. Spiegel, from CEFIC
Satisfied with Option 3, LFL is known, it's an easy solution. He would like to make videos available to CEFIC members.

It was agreed to show the videos demonstrating the difference in flammability at the next SC meeting in Geneva.

CONCLUSION

It was concluded to recommend by consensus Option 3 with cut off values for subcategory 1b:
LFL >6% OR FBV < 10cm/s

G/ Discussion on Hazard Communication

The options for the hazard statement vary between "Extremely flammable", "Highly flammable", and "Flammable". Difficulties may exist in some languages to translate the differentiation between "Extremely Flammable" and "Highly Flammable". There was no consensus opinion on a recommendation for the Hazard Statement or Signal Word. The Chair determined it best to leave further discussion and the decision to the GHS SC.

CONCLUSION on the hazard communication of the subcategory 1b

The work on the wording of the Hazard Statement and Signal Word for category 1b is transferred back to the GHS SC. It will be noted that all participants believed that the inclusion of a Flammable pictogram is desirable.

H/ Consideration of the use category 2 for updating GHS

Presentation "UN-GHS Hazard class "Flammable gases" by Dr. Cordula Wilrich
Background is the fact that cat. 2 is virtually empty. Only few mixtures are on the border to cat. 2. Data of historic cat. 2 gases are nowadays outdated. Using cat.2 would allow an appropriate hazard communication. Although there is some effect on TDG model regulations, the wording changes that are necessary are minor. BAM is confident that TDG, in its considerations as the focal point for the physical hazards will consider also GHS interest.

The real consequences on the orange book are manageable; it impacts the current definition of Hazard Division 2.1. The orange book refers to cat. 1 of GHS in its own words rather than just referring to cat. 1. In case div 2.1 shall be changed to all flammable gases, only following few words have to be stroked out:

Division 2.1 Flammable gasesGases which at 20 °C and a standard pressure of 101.3 kPa:~~(i)~~ are ignitable ~~when~~ in a mixture ~~of 13 per cent or less by volume~~ with air; ~~or~~

~~(ii) have a flammable range with air of at least 12 percentage points regardless of the lower flammable limit.~~ *Flammability shall be determined by tests or by calculation in accordance with methods adopted by ISO (see ISO 10156: 2010). Where insufficient data are available to use these methods, tests by a comparable method recognized by a national competent authority may be used;*

No further amendments are needed. Exemptions on some gases as given in the Dangerous Goods List can remain.

Currently there are 3 flow charts which could be combined to one, ensuring that pyrophoric and unstable gases remain in the appropriate category and that all interfaces between the supplemental categories become clear.

The discussion following the presentation included:

The SCE was deemed to endorse the existing mandate. So far no further statement was given on this topic. The editorial changes might be simple, but very challenging considering downstream rules e.g. labelling and transport regulations. Cat.2 has so far no pictogram. If cat. 2 is broadened, a proper hazard communication including pictogram might come.

There is some uncertainty if cat.2 is in fact empty. Reservations were expressed that cat. 2 might be not as empty as it appears to be from the industry perspective and some mixtures may currently qualify for cat. 2. But it was also reported, that so far no company or organization has responded with actual mixtures in cat.2. In this context it was pointed out that a proper decision tree is very important.

It was clearly mentioned that there was no intention that addressing the cat.2 discussion to the GHC SC would jeopardize the achievements regarding subcategory. 1a/b. According the presenter, it is just a proposal and more or less "some food for thought" to the GHS SC.

I/ Phone conference on 2nd day with external participants (moderated by Mr. Bogaert)

A short wrap up of the activities was given. The consensus on Option 3 with cut off values of LFL>6% or BV<10cm/s was reported. Mr. Bogaert addressed twice the question of any objection regarding this conclusion without response.

The decision to move the hazard communication to the GHS SC was reported including the different views on the appropriate hazard communication for cat.1b.

Furthermore the discussion around the proposal re-categorize cat.2 was reported with a clear statement that this discussion was outside the mandate for this WG.

Discussion summary

During the discussion explanations were given about LFL / FBV likelihood and consequences. Action: It was agreed that a webinar or meeting will be organized to show the videos and give explanations.

It was reported that consequences on other standards were shown in the presentation of Ms. Koban. Ms. Koban offered to meet people in charge in US and Canada for further explanations.

Regarding the hazard communication issue the discussion around the translatability of extremely and highly in other languages was understood. Different views on the flammability statements were exchanged. Whatever will be presented to the GHS SCE, it will be presented in square brackets as wording not yet decided. Interest was expressed as to how the hazard communication would look like in Safety Data Sheets (MSDS). References were given to Difluoromethane and Tetrafluoropropene. Both MSDSs were put on GHS Google drive (see link in Annex 4 to this report).

Regarding the cat.2, it was expressed that whatever is sent in this respect to the GHS SCE, it is out of the mandate of this working group and should be submitted by the expert from Germany with possible joint submission by other interested experts.

6. Closure of the meeting and next steps as presented by the Chair

Mr. Van Lancker informed participants that the meeting report of the second IWG will be sent out by 2nd October and comments will be welcomed until 16th October 2015.

The activities of the second IWG meeting will be reported on during the next joint session of the GHS & TDG subcommittees, expected to be during the afternoon of 9th December 2015.

IWG meeting Chair invited all delegates interested to join a drafting committee to develop a proposal reflecting the conclusion of the IWG led by the Belgian and Japanese GHS & TDG delegations.

The second IWG meeting was closed by the chairman.

Annex 1

Participants list

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Annex 2

Formally endorsed GHS-TDG IWG mandate during plenary session (1-12 December 2014, Geneva)

(a) Analysis of the necessity to create GHS subdivisions, within Category 1, for flammable gases including evaluation of the most appropriate additional parameters for modified classification criteria (based on a review of past studies);

(b) Technical analysis of the candidate parameters linked to these criteria and their importance related to risks in workplace, for the users, for emergency services and for the transport of dangerous goods;

(c) Evaluation of the available test methods and their accuracy to define the candidate parameters;

(d) A review of regulatory and industrial standards in related fields;

(e) Impact analysis on the existing classifications of flammable gases (with feedback from other gases – sectors);

(f) Developing details of possible modifications for GHS/TDG Manual of Tests and Criteria;

(g) Reporting to both sub-committees (TDG and GHS) on progress at the next sessions.

Annex 3

Options from first meeting of the Joint TDG-GHS IWG, March 2015

Option 1

Using the LFL and FBV for sub-dividing

Category 1		Category 2
Default : Sub-category 1a	Option : Sub-category 1b	
Gases, which at 20°C and a standard pressure of 101.3 kPa are ignitable when in a mixture of 13% or less by volume in air or UFL-LFL ≥12 %	Gases from 1a with : 1) LFL > 5% And 2) FBV < 10 cm/s	Gases with : LFL > 13% and UFL-LFL < 12 %
 Extremely flammable gas (H220) Danger	 [Flammable gas] [H221][Hxxx] [Danger]/[Warning]	Flammable gas (H221) Warning

Date: 11 March 2015

Option 2

Category 1		Category 2
Default : Sub-category 1a	Option : Sub-category 1b	
Gases, which at 20°C and a standard pressure of 101.3 kPa are ignitable when in a mixture of 13% or less by volume in air or UFL-LFL ≥12 %	Gases from 1a with : 1) 4% < LFL ≤ [6%]/[8%] AND FBV < 10 cm/s OR 2) LFL > [6%]/[8%]	Gases with : LFL > 13% and UFL-LFL < 12 %
 Extremely flammable gas (H220) Danger	 [Flammable gas] [H221][Hxxx] [Warning]/[Danger]	Flammable gas (H221) Warning

Date: 11 March 2015

Option 3

Using the LFL or FBV for sub-dividing

Category 1		Category 2
Default : Sub-category 1a	Option : Sub-category 1b	
Gases, which at 20°C and a standard pressure of 101.3 kPa are ignitable when in a mixture of 13% or less by volume in air or UFL-LFL ≥12 %	Gases from 1a with : 1) LFL > [6% ?] [8% ?] OR 2) FBV < 10 cm/s	Gases with : LFL > 13% and UFL-LFL < 12 %
 Extremely flammable gas (H220) Danger	 [Flammable gas] [H221][Hxxx] [Danger]/ [Warning]	Flammable gas (H221) Warning

Date: 11 March 2015

Annex 4

Link to the IWG Google Drive

https://drive.google.com/folderview?id=0B39bxM4AXnl6fi1tajRRZ250MzVGUkRZdGYyVThWVXVuaXdQU3dUbUx6SHM3dWM1SWp0UUk&usp=drive_web

Annex 5

Glossary

AIST	National Institute of Advanced Industrial Science and Technology, Japan
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BAM	German Institute for Materials Research and Testing
CEFIC	European Chemical Industry Council
CFD	Computational Fluid Dynamics
CGA	Compressed Gas Association
DOT	Department of Transportation, USA
d_q	Quenching distance
EIGA	European Industrial Gases Association
FBV	Fundamental Burning Velocity
GHS	Globally Harmonized System for Classification and Labelling of Chemicals
HoC	Heat of Combustion
HoO	Heat of Oxidation
ISO	International Standards Organisation
IWG	Informal Working Group
MIE	Minimum Ignition Energy
OSHA	Occupational Safety and Health Administration, USA
TDG	Transport of Dangerous Goods
UNSCEGHS	United Nations Sub-Committee of Experts on the Globally Harmonized System of Classification and Labelling of Chemicals
UNSCETDG	United Nations Sub-Committee of Experts on the Transport of Dangerous Goods