



WORKING PAPER

DANGEROUS GOODS PANEL (DGP)

TWENTY-SECOND MEETING

Montréal, 5 to 16 October 2009

Agenda Item 2: Development of recommendations for amendments to the *Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284) for incorporation in the 2011-2012 Edition

CLASSIFICATION FOR FLAMMABILITY HAZARD OF ETHYL BROMIDE

(Presented by J. Rui)

SUMMARY

This working paper proposes to change the primary hazard of **Ethyl bromide** from toxic to flammable.

Action by the DGP: The DGP is invited to change the primary hazard of **Ethyl bromide** from toxic to flammable as proposed in Part 3;2, Table 3-1 of the *Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284).

1. INTRODUCTION

1.1 In Part 3;2, Table 3-1 of the 2009-2010 Edition of the Technical Instructions, **Ethyl bromide** is listed by name, UN 1891 6.1/II. It is classified as toxic liquid without flammability hazard. But evidence collected indicates that the flammability of **Ethyl bromide** needs to be reconsidered.

1.2 The flash point and boiling point of **Ethyl bromide** obtained from various sources are presented in Table 1. Except for the data provided by Alfa, the data from other sources coincide with each other. Based on the data, the substance has an intrinsic flammable hazard according to the classification criteria of Class 3 stated in 2;3.1 of the Technical Instructions Part 2;3.1.

Table 1. Available flash point and boiling point data for Ethyl bromide

Source of the literature data	Flash point(°C)	Boiling point(°C)
Merck	-20	37-39
Sigma-aldrich	-23	37-40
Acros	-23	37-40
Sciencelab	-10	38.04
Alfa	>60	38
The Physical and Theoretical Chemistry Laboratory, Oxford University	-23	38

Source of the literature data	Flash point(°C)	Boiling point(°C)
Wiley Guide to Chemical Incompatibilities 2nd ed.	-20	
International Chemical Safety Cards	-20	38.4

1.3 As shown in Figure 1, flash point is the temperature at which the concentration of the vapour is at the lower explosion limit.

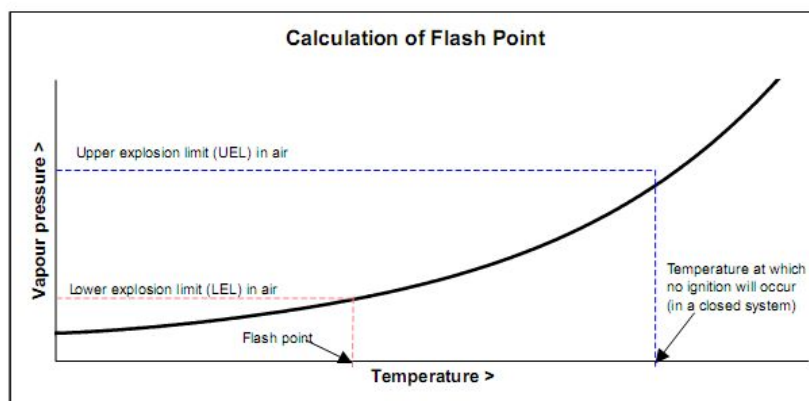


Figure 1. Temperature vs. vapour pressure

According to Antoine equation:

$\log_{10}(Vp) = A - B/(t + C)$ where Vp is the vapour pressure in mm of mercury; t is the temperature in °C; A, B and C are constants. So, the flash point can be calculated as:

$$t = \frac{B}{A - \log_{10}(760 * LEL/100)} - C$$

The explosion limits and Antoine constants obtained from Lange's Handbook of Chemistry, 16th Edition are shown in Table 2.

Table 2. Explosion limits Antoine constants of Ethyl bromide

Substance	Explosion limits(vol % in air, 760mmHg)		Antoine constants		
	LEL	UEL	A	B	C
Ethyl bromide	6.8	8.0	6.9886	1121.9	234.7

The calculated flash point is:

$$t = -22^{\circ}\text{C}$$

The flash point value calculated is normally slightly lower than the one measured because true equilibrium condition is never achieved under test conditions. However, when comparing the calculated flash point and experimental values from different labs which are summarized in Table 1, the values are almost the same. Therefore, the flammability of **Ethyl bromide** is confirmed.

1.4 The other way to further examine if flammable is warranted is to look at the flammability of related compounds of **Ethyl bromide**. Table 3 shows the list of these compounds, molecular weight, associated flash points and current UN classification data.

1.5 It can be seen from the table that, in line with what would be expected, as the molecular weight of the substance increases so does the flash point. What is apparent is that all of the substances are flammable. Thus, the flammability of **Ethyl bromide** does not appear to be out of line with related substances.

Table 3. The classification of relate compounds of Ethyl bromide

Chemical Name	Molecular weight	Flash point(□)	UN No.	Hazard	Packing Group
Methyl bromide	93.94	N/A (Gas)	UN 1062	2.3	N/A
Ethyl bromide	108.97	-20	UN 1891	6.1	II
Bromopropanes	1-bromopropane	-4.5	UN 2344	3	II/III
	2-bromopropane	1			
1-bromobutane	137.02	18	UN 1126	3	II
2-bromobutane	137.02	21	UN 2339	3	II
Bromomethylpropanes	2-bromo-2-methylpropane	16	UN 2342	3	II
	1-bromo-2-methylpropane	18			
2-bromopentane	151.04	20	UN 2343	3	II
1-bromo-3-methylbutane	151.04	21	UN 2341	3	III
1-bromopentane	151.04	32	UN 1993	3	III

1.6 A flash point test was undertaken according to ISO 3679:2004 in a lab. The result is

$$t \leq 0^{\circ}\text{C}$$

Due to the limited testing range of apparatus, the exact flash point can not be determined. But the result has fallen into the category of flammable liquid with the Packing Group I or II, because it is below 23°.

1.7 By looking through the flash point of **Ethyl bromide** from literature, calculating the value according to theory, examining the similar structured compound and the experimental result, **Ethyl bromide** should be classified as flammable. The boiling point of **Ethyl bromide** is 37-40° from literature. Therefore the packing group of flammable is II. According to Part 2; Introductory Chapter, Table 2-1, 3/II takes precedence over 6.1/II. Then, **Ethyl bromide**'s primary hazard is Class 3, sub risk Division 6.1.

APPENDIX

PROPOSED AMENDMENT TO THE TECHNICAL INSTRUCTIONS

Part 3

DANGEROUS GOODS LIST,
SPECIAL PROVISIONS AND
LIMITED AND EXCEPTED QUANTITIES

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Chapter 2

ARRANGEMENT OF THE
DANGEROUS GOODS LIST (TABLE 3-1)

Parts of this Chapter are affected by State Variations AU 1, AU 2, AU 3, BE 3, CA 7, CA 8, CA 10, CA 11, CA 13, GB 3, IR 3, JP 21, NL 1, US 2, US 3, US 6, US 15, ZA 1; see Table A-1

2.1 ARRANGEMENT OF THE DANGEROUS GOODS LIST
(TABLE 3-1)

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Name	UN No.	Class or division	Subsidiary risk	Labels	State variations	Special provisions	UN packing group	Excepted quantity	Passenger aircraft		Cargo aircraft	
									Packing instruction	Max. net quantity per package	Packing instruction	Max. net quantity per package
1	2	3	4	5	6	7	8	9	10	11	12	13
Ethyl bromide	1891	6.1 3	6.1	Liquid flammable & Toxic			II	E4E2	609 305 Y609 Y305	5L 1L 1 L	611 307	60 L

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