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 Transport of Dangerous Goods **31 May 2022**

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Item 2 (i) of the provisional agenda
Explosives and related matters: miscellaneous

Classification of fireworks

Transmitted by the expert from the Netherlands

Introduction

1. In the aftermath of the fireworks explosion in May 2000 in Enschede, the Netherlands, Dutch fireworks regulations were restructured and bundled in the Fireworks Decree. Amongst many other issues this decree requires that "consumer fireworks shall be packed in such a way that a 1.4 classification can be assigned". For a number of fireworks articles, such as rockets, Roman candles, batteries and combinations, this means that a special inner packaging of (metal) wire gauze needs to be applied. This special inner packaging prevents or hinders the fiery projections so that they largely remain within 15 metres and a 1.4 classification can be assigned.

2. These special packings need to be constructed in a specific way and Dutch experience has taught that in many cases the construction does not meet the requirements. For that reason, the Dutch government has tasked TNO[1] to perform UN 6(c) tests twice a year on samples taken by the Human Environment and Transport Inspectorate. Up to 2020 a more or less constant failure rate of 30 – 40% of the samples has been found.

Latest findings

3. During the tests performed in April 2021, unexpected and uncharacteristic violent reactions occurred in several cases during the external fire test. The reaction can perhaps best be described as "close to mass explosion". Ensuing tests performed in November 2021 and March 2022 gave similar results. The violent behaviour was found with batteries of shot tubes and a relatively new type called "compound fireworks". The latter is a sort of "mini fireworks show" in a box and consists of a number of fireworks articles which are securely fixed on the same base and connected together by linking the (protruding and reserve) fuses of each firework and sold in one box. An example of the violent reaction in the 6(c) test is given in Figure 1: on the left hand side the set-up before the test, on the right hand side the steel test table after the test.

4. All articles that gave a violent reaction were disassembled and the pyrotechnic composition were subjected to the HSL Flash Composition Test (test A7.1 of Appendix 7 of the Manual). The results are listed in Table 1. The type of compound is shown in the upper

[1] Netherlands Organisation for Applied Scientific Research; competent authority in the Netherlands for road, rail and inland waterway transport.

row of the table and the percentage flash composition in the last row. Pressure rise time periods below 6 ms (thus indicating flash composition) are marked in grey.

Figure 1

Classification test (6 (c) test) performed with Dutch consumer fireworks. Left the four packagings before the test, right the test table after the test. The table was constructed of 4 mm 'L-profile' steel. Approximately 2.5 minutes after the fire was started, two minor pyrotechnic effects occurred followed by a large explosion.

pyrotech	489A		489B		489C		489D	
part	rise (ms)	mass (g)	rise (ms)	mass (g)	rise (ms)	mass (g)	rise (ms)	mass (g)
mine	9.01	1.84	6.93	1.92	8.07	1.86	6.1	1.80
burst	0.74	2.08	0.46	2.04	0.95	2.05	0.61	2.06
lift	2.76	3.71	3.58	3.78	3.43	3.79	3.45	3.71
effect	7.97	11.43	4.61	11.01	5.27	11.71	7.43	11.18
flash -%	27,7		81.4		83.9		27.8	

pyrotech	3670-1		3670-2		3670-3		3670-4	
part	rise (ms)	mass (g)	rise (ms)	mass (g)	rise (ms)	mass (g)	rise (ms)	mass (g)
whistle	3.06	8.79	1.44	10.75	1.80	8.66	1.80	10.71
burst	0.20	1.78	0.26	1.72	0.63	1.83	0.18	1.57
lift	3.87	2.21	5.05	2.18	5.01	2.24	5.25	2.23
effect	7.51	6.66	10.58	5.82	8.68	5.40	7.87	6.33
flash -%	65.7		71.6		70.2		69.6	

pyrotech	2340		2754		6263	
part	rise (ms)	mass (g)	rise (ms)	mass (g)	rise (ms)	mass (g)
lift	4.38	1.89	3.83	1.67	4.13	1.18
1st effect	9.07	1.28				
transfer			9.44	1.08		
whistle	1.88	9.00	1.57	7.64	0.85	3.76
burst	0.71	1.50	1.74	1.82		
effect	8.34	6.00	10.03	5.96	11.01	2.47
flash -%	65.4		61.3		66.7	

Table 1

Overview of pressure rise times and mass of each pyrotechnic composition for two compounds 489 and 3670 (sampling of all tubes of the article); combination 2340, battery of shot tubes 2754 and compound 6263 (of the latter three only limited sampling was performed because of time constraints). The battery of shot tubes 2594 (not listed in this table) contained 30.5% of flash composition.

Observations

5. All articles contained more than 25% flash composition when tested in test A7.1.

Note 2 to Paragraph 2.1.3.5.5 of the Model Regulations states: "*"Flash composition" in this table refers to pyrotechnic substances in powder form or as pyrotechnic units as presented in the fireworks that are used in waterfalls, or to produce an aural effect or used as a bursting charge, or propellant charge unless*: …". The test results as shown in table 1 indicate that:

– All bursting charges qualify as flash composition;

- Surprisingly, all lifting charges qualify as flash composition while only KNO_3 and S_8 were detected with X-ray diffraction (charcoal cannot be detected with XRD and there were no signs of amorphous substances) and the black powder particles were relatively coarse;
- Not all articles contained whistle compositions but they qualify as flash composition (both the versions with potassium benzoate and with potassium hydrogen phthalate);
- In compound 489 two out of four effect charges had a pressure rise time less than 6 ms. The compositions listed in the data sheet did not give an indication for a possible explanation of the rapid burning of the effects.

Proposal

6. The Sub-Committee is invited to take note of this information and to refer this document to the Working Group on Explosives for more in-depth discussion.

7. At the 58th session the expert from the United Kingdom submitted informal document INF.17, drawing attention to new and novel fireworks compositions. The expert from the Netherlands would like to propose to include those aspects in the discussions in the working group as well. Furthermore, we would like to invite other experts to share similar or comparable test results with the experts in the Working Group on Explosives.