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 **9 June 2011**

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Item 2 (d) of the provisional agenda
Explosives and related matters: DDT Test and criteria for flash composition

DDT Test and Criteria for flash compositions

Transmitted by the expert from Germany

Background

1 During the thirty-seventh session of the Sub-Committee the expert from the United States of America presented a paper (ST/SG/AC.10/C.3/2010/31) dealing with a DDT-test for flash-compositions. The paper addresses the problem of identifying compositions referred to as "flash-composition" in Note 2 pertinent to the "default fireworks classification table" (see section 2.1.3.5.5 of the model regulations). Currently the identification of flash-compositions in this context is linked to a test called "HSL flash composition test" which is described in Annex 7 of the most recent edition of the test handbook. The "HSL flash composition test" is technically based on the UN 2(c) (ii)-test and very similar.

2 The test proposed by the expert from the United States of Amereica in the aforementioned paper is considerably easier to conduct and the interpretation of the test outcome seems less sophisticated as compared to the "HSL flash composition test". Another advantage originates from the fact that 25 g instead of 0.5 g of substance is used, probably generating a more consistent combustion behaviour. Being interested in the details of the test, BAM (German Federal Institute for Materials Research and Testing) conducted this test with similar and some other substances. The results are given further below. It appears that the results obtained with the USA DDT-test for flash compositions are in good agreement with results obtained through other test methods, specifically the "HSL flash composition test".

Proposal

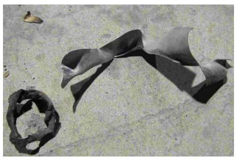
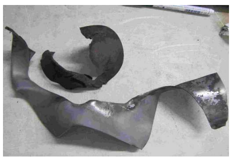
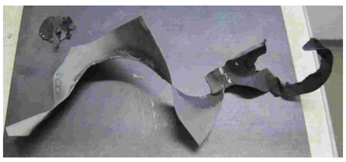
3 The subcommittee (resp. the explosives working group) is asked to consider the data presented in this paper, including other test data as much as available. The expert from Germany suggests in addition that, after consideration the USA DDT-test for flash compositions in the working group, it be accepted as a valid alternative to the currently mentioned HSL flash composition test for the purpose of section 2.1.3.5.5 of the model regulations.

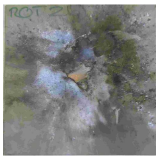
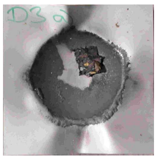
Detailed test results

4 Tests were conducted in agreement with the test set-up described in working document ST/SG/AC.10/C.3/2010/31. On some aspects, where modifications were considered to have no influence, minor deviations to the set-up were allowed. These were using a thin walled paper tube instead of a card board tube to contain the composition and omitting the upper paper plug. Through communications with the testing group performing the original tests it could be learnt, that there was an error in the test description and the outer diameter of the mortar could be made 63 mm instead of 100 mm, the latter figure given in the working document. This and the modified containment for the composition were confirmed by the group from the USA to have no effect whatsoever on the test outcomes. All other dimensions which obviously influence free volume, acting forces and exposed areas were kept strictly the same as in the mentioned document.

5 The test data is summarised in Table 1. For easier readability the composition properties have been moved to a separate table and can be found in Table 2. Images of the witness plate are shown here, though the test outcome is usually unambiguous (and wouldn't require a photograph to confirm the judgement).

Table 1 — Test results

Composition	**Test result BAM**	**Image of witness plate**	**Test result USA (+/-) or other**
Flash composition 1	**(+)**		**(+)**
Flash composition 2	**(+)**		**(+)**
Flash composition 3	**(-)**		**(+)**
$Ba(NO_3)_2$ waterfall	**(-)**		slow burning behaviour in CHAF project trials
KNO_3 waterfall	**(+)**		mass explosion in CHAF container trials

Red colour 1	**(+)**	 minor hole in the center	7.1 to 7.8 ms in HSL flash composition test
Red colour 2	**(-)**		10 to 17 ms in HSL flash composition test
Black powder	**(-)**		grain sizes distributed around 300 µm, almost a meal powder
Blue stars	**(-)**		though the test is not meant for pyrotechnic units, these stars had shown violent behaviour otherwise

6 For flash compositions agreeing results were obtained, as it was expected. The only exception is flash composition 3. The Magnalium powder was very old and possibly not reactive enough any more. This is going to be checked though, because the much earlier mixed red compositions did still ignite properly. The behaviour of the waterfalls is just as one would expect from the test outcomes of the CHAF fireworks project (5th EU framework programme).

7 The red colour compositions were examined in a pressure-time-test study, and give a good comparison of compositions subjected both to the HSL flash composition test and to the USA DDT-test for flash compositions. The results are particularly interesting because the times in the pressure time test are close to the boundary set at 8 ms. It occurred that for the slightly more energetic composition a small hole was punched through the plate, while the other did not damage the plate.

8 Black powder did not show a positive result, though it was a meal powder which could get close to the boundary defined in the HSL flash composition test. The blue stars were subjected to the test just for curiosity. In principle the test only has to be applied to substances in powder form. However, the blue stars did show behaviour close to a detonation when put in a boostered steel-tube test and it was of interest to see, whether the they would be energetic enough to cause a penetration of the witness plate. This was obviously not the case.

9 Table 2 lists the compositions as referred to in Table 1.

Table 2 — Compositions mentioned in Table 1

Composition	**Technical information, composition**	**Additional information**
Flash composition 1	70% $KClO_4$, 30% Al	both sieved to 500µ
Flash composition 2	65% $KClO_4$, 35% Al	both sieved to 500µ
Flash composition 3	70% $KClO_4$, 30% Magnalium	both sieved to 500µ
$Ba(NO_3)_2$ waterfall	48% $Ba(NO_3)_2$, 47% Al, 5% binder	see CHAF reports for further details
KNO_3 waterfall	37% $KClO_4$, 41% Al, 4 %, Mg, 8% S, 8% KNO_3, 2% binder	see CHAF reports for further details
Red colour 1	60 % $KClO_4$, 15% $Sr(NO_3)_2$, 15% Magnalium, 10% Accaroid resin	typical colour composition, though not consolidated as star
Red colour 2	40 % $KClO_4$, 15% $Sr(NO_3)_2$, 25% Magnalium, 20% Accaroid resin	typical colour composition, though not consolidated as star
Black powder	composition as commonly known (C, S, KNO_3)	grain sizes between 100 and 600 µm, distribution peak 300 µm
Blue stars	mostly $KClO_4$, further: PVC, CuO	tested as they are, not ground, a steel tube detonation test showed a tendency to perhaps detonative behaviour