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 **17 June 2011**

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

Alternative Flash Composition Test

Transmitted by the expert from the United States of America

Background

1. At the Sub-Committee's 37th Session, the expert from the United States presented an alternative test method (DDT Flash Composition Test) to the current HSL Flash Composition Test method for evaluating pyrotechnic mixtures (see ST/SG/AC.10/C.3/2010/31). In support of this proposed new method, ten pyrotechnic mixtures of various compositions were tested to verify its adequacy. Following discussions within the Explosives Working Group, twelve additional pyrotechnic mixtures were tested using the proposed new method and have been added to the "Examples of Results" shown in the original proposal. None of these twelve additional mixtures tested confined in 25 gram quantities met the test criteria for a "Flash Composition", i.e., when ignited with a standard electric match, none punctured or pierced the 1 mm thick steel witness plate placed directly in contact and below the 25 gram test charge.

2. In addition to the tests carried out by the expert from the United States of America, experts from Japan and Germany have also kindly evaluated the proposed DDT Flash Composition Test, and their results generally appear to verify the ease, simplicity and accuracy of the test. The expert from Japan submitted DDT test data (see UN/SCETDG/39/INF.22) which lists the results of testing five compositions as both powders and mixtures of powder with diluents such as rice chaff, cottonseed core, or cork core. For the powder samples tested, the results were consistent with Japanese hazard assessment for firework compositions. The expert from Germany has also submitted DDT test data (see UN/SCETDG/39/INF.16) which utilized a slightly modified setup. In this paper nine pyrotechnic mixtures were tested and the results compared favorably with the testing previously reported in ST/SG/AC.10/C.3/2010/31 and/or results from HSL flash composition testing.

3. Based on the additional data acquired by the United States, Germany, and Japan, the expert from the United States is now prepared to propose the adoption of this alternative test method as a new "Appendix 8" within the UN Manual of Tests and Criteria.

Proposals

Proposal 1: In Note 2 of 2.1.3.5.5 (UN Model Regulations Default Fireworks Classification Table), add the following at the end of Note 2: *"…or unless there is a positive (+) result in the DDT Flash Composition Test in Appendix 8 of the Manual of Tests and Criteria."*

Proposal 2: Add the following as a new Appendix 8 to the UN Manual of Tests and Criteria:

Appendix 8
DDT Flash Composition Test

1. *Introduction.*

This test is used to determine the tendency of a pyrotechnic loose powder to undergo a small scale deflagration to detonation and thereby be classed as a 1.1G (UN0094) “Flash Composition” or “flash powder”.

2. *Apparatus and materials.*

The experimental set up for the DDT Flash Composition Test is shown in Figure 1. A twenty-five (25) gram sample of a loose powder confined in a heavy-wall cardboard convolute sample tube with an inside diameter of 25.4 mm and height 152 mm with a maximum wall thickness of 3.8 mm, closed at the base with a paper or thin cardboard cap membrane just sufficient to retain the sample. The ignition source is provided by an electric match-head inserted centrally in the top of the explosive sample in the tube to a depth approximately equal to its length. Surrounding the sample tube and also resting on the witness plate is placed a rugged mild steel confinement cover or “cap” with inner walls and head section approx. 32 mm thick with an inside diameter of 38 mm, an outside diameter of 63 mm and a height of 152 mm and weighs approx. 2.8 kg. Below the sample tube and surrounding steel confining cap is the square shaped steel witness plate, which is 1.0 mm thick and 152 mm on edge. The steel witness steel plate is then placed on a steel ring of approximately 51 mm height with an inner diameter of 90 mm and 3.5 mm wall thickness. The apparatus is placed onto a square shaped steel base plate of approx. 13 mm thickness and 152 mm on edge.

3. *Procedure*

The sample compositions were uniformly mixed and then twice passed through a Number 40 mesh screen immediately prior to testing to insure maximum uniformity and minimum segregation. Twenty-five (25) grams of the candidate substance tested is weighed into the cardboard sample tube. It should fill the sample tube somewhere between 1/3 and 2/3 full, depending on its density. For free-flowing granular substances, the sample is consolidated by allowing the tube to fall vertically through a height of 51 mm. In all cases, the final density of the explosive in the tube should be as close as possible to its density in a fireworks device. Those explosives whose sensitivity could be moisture dependent should be stored for at least 24 hours in desiccators at a temperature of 28 - 30 °C prior to testing. The sample tube is placed in the centre of a heavy steel confining sleeve fixture shown in the diagram in Figure 1. which rests on the witness plate, steel ring and steel base plate. The electric match-head is inserted centrally into the top of the explosive formulation. The electric match-head igniter is then initiated from a safe position. After initiation and a suitable interval to allow for falling debris, if any, the witness plate is recovered and examined. The test is conducted three times or until a detonation of the substance occurs and a positive result is achieved.

4. *Test criteria and method of assessing results*

The result is considered "+" and the substance is considered to have “detonated” if in any trial the witness plate is torn, perforated, pierced or otherwise penetrated (i.e. light is visible through the plate). NOTE: Bulges or folds in the witness plate are not to be considered to be proof of “detonation”. Otherwise, the result is considered “-“.

5. *Examples of Results*

1	Goex Black powder -- 5Fa “Unglazed”	**(-)**
2	35% Potassium Nitrate (100% < 37 µ)/ 31% Potassium Perchlorate (100% < 37 µ) /13.5% Potassium Benzoate (fine powder)/ 10% Sulfur (fine powder)/10.5%Lampblack (nano-material).	**(-)**
3	**70% Potassium Perchlorate (100% < 37 µ) / 30% “Semi-coarse” Magnesium powder -- (297µ<25%>149µ; 148µ<58%>53µ; 52µ< 5%>44µ; 12%<43µ)**	(+)
4	**65% Potassium Perchlorate (100% < 44µ)/ 35% Magnesium (105µ 5%>74µ; 73µ <39%>44µ; 46%<43µ)**	(+)
5	**65% Potassium Perchlorate (100% < 44µ)/ 35% “Ground” Magnesium (100% <43µ)**	(+)
6	**70% Potassium Perchlorate (100% < 37 µ)/ 30% “Atomized” Aluminum powder (74µ<2.4%>53µ; 52µ<2.9%>44µ; 4.7%<44µ)**	(+)
7	**65% Potassium Perchlorate (100% < 44µ)/ 35% “Flake” Aluminum “A” (105µ <72%>53µ; 52µ <17%>44µ; 11.5%<43µ)**	(+)
8	**65% Potassium Perchlorate (100% < 44µ)/35% “Flake ” Aluminum “B” (74µ<39% >53µ; 52µ<22%>44µ; 40%<43µ)**	(+)
9	**70% Potassium Perchlorate (100% < 37 µ)/ 30% “Ground” Magnalium powder --(74µ<37%>53µ; 52µ<11%>44µ; 52%<44µ)**	(+)
10	68% Barium Nitrate (105µ < 10% > 74 µ; 73 µ<12%>44 µ; 43 µ< 24%>37 µ; 53%<37 µ)/23% “Dark Flake” Aluminum (100%< 73 µ)/9% Sulfur (fine powder)	**(-)**
11	85 wt % Potassium Perchlorate (97% < 74µ & 30% < 37µ)/ 10 wt % Sulfur (very fine ground flour)/ 5 wt % powdered charcoal	(-)
12	80 wt % Potassium Perchlorate (97% < 74µ & 30% < 37µ)/10 wt % Sulfur (very fine ground flour)/10 wt % powdered charcoal	(-)
13	75 wt % Potassium Perchlorate (97% < 74µ & 30% < 37µ)/10 wt % Sulfur (very fine ground flour)/15 wt % powdered charcoal	(-)
14	70 wt % Potassium Perchlorate (97% < 74µ & 30% < 37µ)/10 wt % Sulfur (very fine ground flour)/20 wt % powdered charcoal	(-)
15	65 wt % Potassium Perchlorate (97% < 74µ & 30% < 37µ)/10 wt % Sulfur (very fine ground flour)/25 wt % powdered charcoal	(-)
16	60 wt % Potassium Perchlorate (97% < 74µ & 30% < 37µ)/10 wt % Sulfur (very fine ground flour)/30 wt % powdered charcoal	(-)
17	52 wt % Potassium Perchlorate (97% < 74µ & 30% < 37µ)/17 wt % Sulfur (very fine ground flour)/5 wt % powdered charcoal/26 wt % Antimony trisulfide	(-)
18	50 wt % Potassium Perchlorate (97% < 74µ & 30% < 37µ)/30 wt % Sulfur (very fine ground flour)/20 wt % powdered charcoal	(-)
19	70 wt % Potassium Perchlorate (97% < 74µ & 30% < 37µ)/20 wt % Sulfur (very fine ground flour)/10 wt % powdered charcoal	(-)
20	60 wt % Potassium Perchlorate (97% < 74µ & 30% < 37µ)/30 wt % Sulfur (very fine ground flour)/10 wt % powdered charcoal	(-)

21	60 wt % Potassium Perchlorate (97% < 74µ & 30% < 37µ)/20 wt % Sulfur (very fine ground flour)/20 wt % powdered charcoal	(-)
22	48 wt % Potassium Perchlorate (100 < 37µ)/52 wt % Iron Powder (100% <45µ and 94% < 37µ)	(-) Burned only

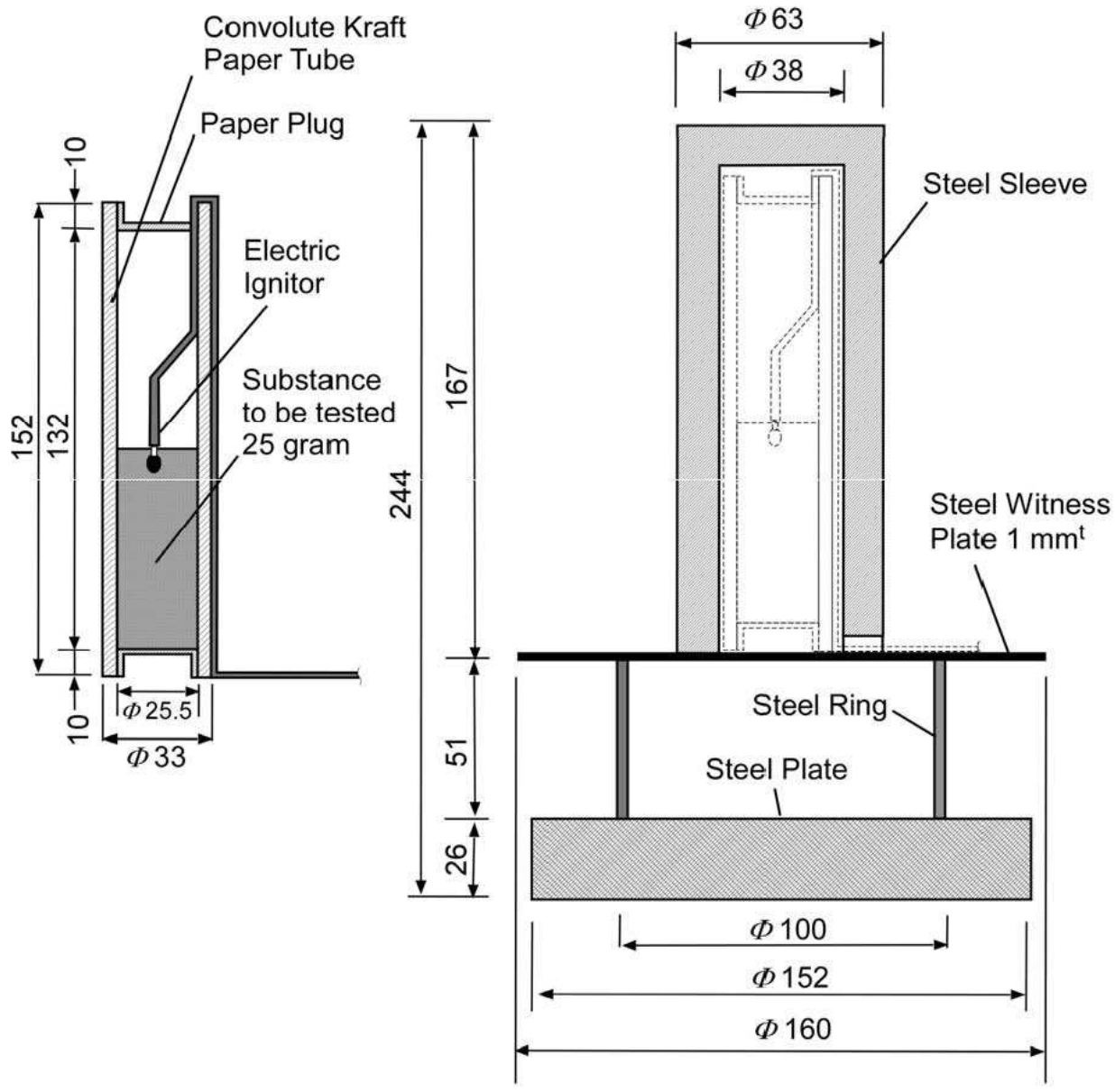

Figure 1: DDT Flash Composition Test Apparatus Drawing