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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

Sub-Committee of Experts on the Transport of Dangerous Goods

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Item 2 (c) of the provisional agenda
Explosives and related matters:
review of tests in parts I and II of the Manual of Tests and Criteria

New design for the standard detonator in the Manual of Tests and Criteria

Transmitted by the expert from Germany[1]

Introduction

1. The expert from Germany proposes an amended specification for the standard detonator as described in Appendix 1 of the United Nations Manual of Tests and Criteria. Since more than a decade detonators for the general market are produced with a number of design features, which make these considerably safer in handling and use. These specific design features are not part of the specification in Appendix 1 of the Manual of Tests and Criteria.

2. The current detonator has little protection against electric discharge. State of the art detonator design would allow electric charges to be neutralised before a spark can hit the fuse head. Sparks to the fuse head always include a danger of ignition, even when aluminium coating is present (see Appendix 1, only referred to as an example).

3. In addition, detonators of the current design may undergo a mass explosion when packaged in the normal way and when one item functions accidentally. By using a steel

[1] In accordance with the programme of work of the Sub-Committee for 2015–2016 approved by the Committee at its seventh session (see ST/SG/AC.10/C.3/92, paragraph 95 and ST/SG/AC.10/42, para. 15).

tube to contain the primary charge the hazard of mass explosion can be greatly reduced (so called NME- or non-mass-explosive design).

4. A further aspect is that environmental issues have led to the development of so called "green" detonators, which avoid the use of lead compounds, primarily in the fuse head. Though this is not meant to be mandatory, it is suggested to include in the detonator specification an encouragement to use lead-free compounds for environmental reasons.

5. The proposal avoids any change to the performance of the detonator, since test results should not depend on the use of the former type or the new type. This aspect has been studied and supporting material will be presented in an informal paper for the forty-seventh session. Also, there are many references to detonators in the Manual of Tests and Criteria which will be revised carefully in the same informal paper to come.

6. Appendix 1 contains two detonator specifications, one for a European type and a second for the USA type. This proposal only addresses the European type. It is suggested to investigate on the benefits of the concepts presented here to the US type, perhaps by discussion in the explosives working group.

Proposal

7. The expert of Germany recommends:

(a) A discharge gap near the bridge wire to enhance electrostatic safety;

(b) A solid steel tubing to contain the very sensitive primary charge between the fuse head and the secondary charge (NME-design); and

(c) The use of environmentally friendly substances in the fuse head.

8. In Appendix 1 of the Manual of Tests and Criteria with the title "SPECIFICATIONS OF STANDARD DETONATORS" the Table and Figure A1.1, to which the table refers, shall be fully replaced with the information in the Annex to this working document. Figure A1.2 which refers to the US detonator is retained without changes.

9. The proposal was drafted following the below principles. Where amendments through the explosives working group are felt to be necessary, the group is invited to consider these:

(a) Make exact specifications including tolerances, where the parameter is relevant for the test results. A suitable standard detonator must be produced to this data.

(b) Leave intentionally specifications open, where these are irrelevant for the test result or where design limitations don't allow for a wide range anyway. It is apparent that the current European specification is almost over specified in comparison to the US detonator.

(c) Give rough ranges for some parameters, where technically any choice is possible, however for practical reasons the parameter should not be unreasonably large or small. This applies for example to the overall length of the detonator.

Annex

Amended Appendix 1 to the Manual of Tests and Criteria

Specifications of standard detonators

1. Description of the standard detonator (European)

According to the elements of the standard detonator indicated in Figure A1.1 by letters A-G the following specifications apply:

A) Blasting cap

The blasting cap shall be hollow-drawn from copper with not more than 5% zinc, where an alloy is used. The cap shall have an outer diameter of 7.0 mm ± 0.1 mm. The wall thickness shall be 0.24 mm ± 0.05 mm. The thickness at the bottom of the cap shall be 0.42 mm ± 0.05 mm.

B) Secondary charge

The secondary charge shall be PETN and with a mass of 0.60 g ± 0.01 g. The secondary charge is pressed into the bottom of the blasting cap and shall have no gaps or air spaces.

C) Primary charge

The primary charge shall be fully contained in the tube (D) and shall consist of not more than 0.10 g of a primary explosive (preferably lead-free). The primary charge usually will not fully fill the space inside the tube (D). It needs to be in direct contact to the secondary charge.

D) Tube

This tube acts as protection of the primary charge against fragments which could cause a sympathetic detonation. The length of the tube hall be 10-15 mm, the outer diameter shall be such to fit snugly into the detonator cap, the wall thickness of the tube shall be not less than 1 mm, and the inner diameter is typically not less than 2 mm.

E) Fuse head

The fuse head shall have a protection against electrostatic discharge. The fuse head charge shall contain not more than 50 mg of a primary explosive (preferably lead-free). The distance between the fuse head (E) and the tube (D) shall be in the range of 3-10 mm. The electric parameters of the bridge wire in the fuse head shall be of an electrically insensitive type. The no-fire current shall be 0.45 A (Ampere) or greater, the no-fire impulse shall be 8 mJ/Ohm or greater.

F) Spark gap

There shall be a narrow air gap ("spark gap") between the exposed lead wires of the fuse head (E) and the blasting cap (A). The plug (G) must leave room for a spark to the lead wires, and a crimping may be used to generate a fold to even further narrow the gap. The distance between the fuse head and the nearest metallic parts shall be sufficiently large, such that the spark gap is functional.

G) Plug

The plug tightly surrounds the lead wires and forms together with the crimping of the blasting cap (A) a tight closure of the blasting cap.

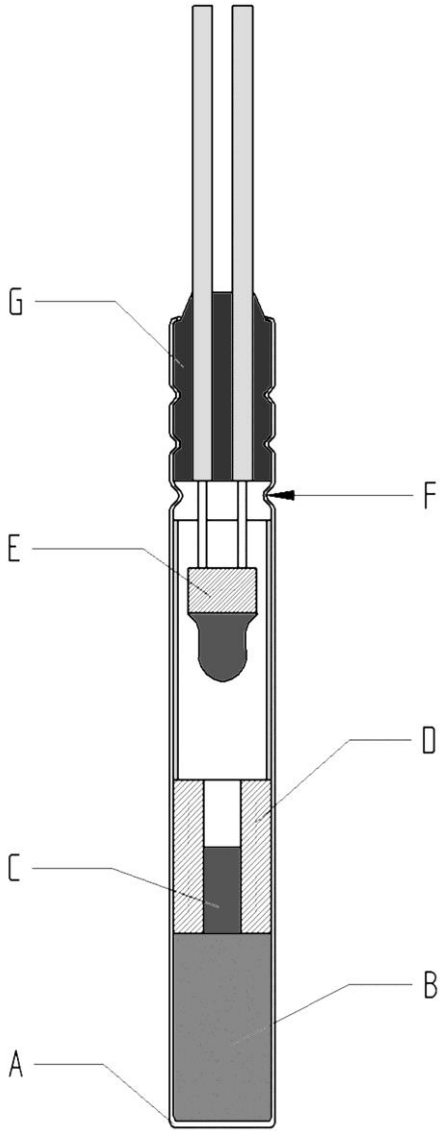
The following information shall serve to understand the permissible variations in design beyond the above specifications:

- The blasting cap (A) may in principle have a hollow, indented, or stamped bottom. In order to exclude shaped-charge effects it is preferred to use only flat bottom caps. The overall length of the blasting cap (A) is not defined. Since it has to contain all elements (B) to (G) it will commonly be not shorter than 45 mm and shouldn't be any longer than 80 mm.
- The secondary charge (A) as described above will have a length of about 12-13 mm.
- The tube (D) containing the primary charge (C) shall prevent the mass explosion of detonators packaged in bundles next to each other. The tube (D) is often made of steel. In order to prove the effectiveness of the tube to prevent a mass explosion, packaged detonators shall be subjected to test series 6 with a result other than 1.1.

Remark:

- Where the tube (D) is made out of sufficiently strong steel it “survives” the functioning of the detonator. I. e. it will stay intact and will not form fragments, which would be detrimental to the intended effect. The tube (D) shall not fragment upon functioning.
- Protection of the fuse head (E) against electrostatic discharge can be achieved in different ways. The fuse head may be surrounded by a plastic tubing, which fits without play inside the detonator cap (A). This can be done to generate a long path for a discharge between fuse head and cap. In Figure A1.1 such a plastic tube is indicated to show this to be a permissible variation. This plastic tube is optional and protection of the fuse head can also be achieved by conductive coating.
- Figure A1.1 shows a closing plug (G) with straight lead wires. Twisted lead wires within the closing plug are also common and irrelevant for the functioning or safety of the detonator. The plug (G) may extend outside the blasting cap (A), which is also irrelevant for the functioning. The plug (G), however, shall at minimum be aligned to the open end of the blasting cap (A).

2. Schematic drawing of the standard detonator



A	Blasting cap	E	Fuse head
B	Secondary charge	F	Spark gap
C	Primary charge	G	Plug
D	Tube		

Figure A1.1: STANDARD DETONATOR (EUROPEAN)