



**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****Fifty-fifth session**

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Item 2 (a) of the provisional agenda

Explosives and related matters: review of test series 6**Review of the criteria of Test 6 (d)****Transmitted by the Sporting Arms & Ammunition Manufacturers'
Institute (SAAMI)*****Introduction**

1. Test 6 (d), called the unconfined package test, evaluates a single package of explosives to determine if any hazardous effects arising from accidental functioning are confined within the package unless the package has been degraded by fire, in conformance with the definition of compatibility group S of Division 1.4.
2. Since its adoption in 2008, Test 6 (d) has been welcomed internationally as a method to assess effects of explosives while still in their package. Unlike other tests in Series 6, the 6 (d) test results are not obscured by confining material or external fire and smoke. It also requires a minimal amount of explosive material and set-up to perform the test. These facts have made the test useful beyond its official purpose of evaluating the suitability of explosives for classification as 1.4S. This test has also been used to make observations for any purpose, or in lieu of Test 6 (a) because Test 6 (d) is easier to perform, or for excluding explosives from Class 1 using the alternate criteria in the Model Regulations, section 2.1.3.6.4. It would not be surprising for additional uses to be proposed in the future.
3. Despite the above benefits, the test criteria do not align with the practice of experts who proposed the test, nor the 1.4S definition, and sufficient experience now exists which could be utilized to improve the criteria. Currently the test criteria create two different flavours of 1.4S, which was not the intent:

* In accordance with the programme of work of the Sub-Committee for 2019-2020 approved by the Committee at its ninth session (see ST/SG/AC.10/C.3/108, paragraph 141 and ST/SG/AC.10/46, paragraph 14).

- (a) creates a double standard by overemphasizing differences in the two-part definition of compatibility group S:
 - (i) Requiring almost no effects outside the packaging when functioning the explosive, depending on the criteria, is more conservative than limiting blast or projection effects so they do not significantly hinder fire-fighting or other emergency response efforts in the immediate vicinity of the package in a fire.
 - (ii) Perhaps a decision should be taken on whether it is really intended to require that accidental functioning is subject to more strict criteria than in a fire, or whether providing for the safety of emergency responders is the appropriate level of control. We bear in mind that there is no history of accidental functioning in transport motivating the adoption of this test, and that the 8 Joule projection criterion is already designed to protect bystanders, i.e. not only responders wearing personal protective equipment.
- (b) The test is applied by special provision to less than 50% of the 1.4S entries on the dangerous goods list. Since the phrase “hazardous effects” has never been defined, the test criteria became the definition, and they are arguably too conservative in some cases, which would negatively impact many explosives, but presently only impact those to which the special provision is assigned.

4. SAAMI understands that these test criteria are of broad interest within the Sub-Committee, and that there is interest in reviewing them. We expect this proposal to facilitate discussion and further development. We re-propose the originally proposed criteria for this test to adopt criteria consistent with those in Tests 6 (a) and (c).

History of the 6 (d) test and its criteria

5. Creation of the 6(d) test was motivated by occasional accidents in assembly operations of shaped charges (not in transport), and knowledge that certain explosives have a more severe reaction when functioning as intended than when subjected to fire.¹

6. We refer to the original proposals in ST/SG/AC.10/C.3/2006/62 and ST/SG/AC.10/C.3/2007/29 from Canada at the twenty-ninth and thirty-first sessions respectively. It was argued that the Model Regulations (Rev.14) classification of 1.4S relied solely on the results of the 6(c) Test, which principally evaluates a package that has been degraded by fire, and no test covered that portion of the definition concerning accidental functioning when not subjected to fire. Canada stated in ST/SG/AC.10/C.3/2006/62 paras 6 and 7:

“The portion of the definition for 1.4S, “any hazardous effects arising from accidental functioning are confined within the package”, is not addressed. The substance or the article is not initiated or ignited in a manner that could determine effects outside the package if the substance or article functioned as intended. There is a possibility that products classified as 1.4S based on behaviour in a fire may produce a hazardous effect when functioned. Examples are small amounts of detonating explosive which will burn in a fire but would detonate if initiated and would possibly produce hazardous effects outside the package ...”.

¹ It was counter-argued at the time that, in the experience of those producing the explosives of greatest concern, accidental initiations were not relevant because there was no history of them in transport. The proposal was based on the knowledge of known effects, and that these were in some cases worse than what was seen in the 6 (c) bonfire test. The proposal was not driven by accidents or risk in transport, but rather the mandate to control the hazard to an acceptable level as defined for 1.4S.

“Initiation or ignition as a result of fire, after the package is degraded, may produce different results from functioning with the intended means of ignition or initiation. Knowledge of the behaviour of the article or substance in both cases is needed to allow proper classification.”

7. Classification criteria should cover all relevant ignition scenarios. The intent was to capture occasional results where an intentional initiation produced more hazardous effects than the existing bonfire test. There was no intention to impose new safety criteria on an intentional initiation which were stricter than those controlling the behaviour in a fire. The Canadian proposal was to make sure that all possible effects were evaluated according to the existing criteria.

8. The new test was envisioned as an optional tool for potential application to all candidates for 1.4S classification, where in the opinion of the competent authority, an intentional initiation might produce worse effects than a bonfire:

“This test would be an optional one, intended for use in cases where the functioning of the product might be expected to produce effects more severe than those obtained in the 6(c) Test, e.g. where detonating explosives are involved, or where the 1.4S classification is packaging-dependent. It is not envisaged for materials that are inherently Division 1.4S, such as small arms ammunition.”

9. The test was intended to require additional packaging for 1.4S classification, or re-classification, of explosives having hazardous effects outside the package:

“However, the expert from Canada wishes to point out that this proposal does not suggest that hazardous effects are to be eliminated but only that they be confined to the package. If articles or substances already classified fail to meet this proposed test, they also fail to meet the definitions for 1.4S and are not properly classified. *The solution is not to change criteria to allow these substances or articles into this classification but to change the packaging so that they do meet the intentions of the definition, or to reclassify them.*”

10. The 6 (d) Test was proposed as a 6 (a) test without any confinement, using the following criteria in the Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria:

- (a) the Test 6 (a) criterion for the witness plate beneath the package;
- (b) the Test 6 (c) criterion for a flame ball or jet extending from the package;
- (c) an additional criterion of disruption and scattering of the packaging;
- (d) the Test 6 (c) criterion for a metal projectile exceeding 8 joules

11. The current Test 6 (d) criteria follow, along with our assessment of how they relate to the original purpose to better implement the 1.4S definition:

(a) The first criterion is “Denting or perforation of the witness plate beneath the package.” This criterion relates to Test 6 (a), which is because the Test 6 (d) method is based on Test 6 (a) without confining material; it is not related to the 1.4S definition. Test 6 (d) is sometimes substituted for Test 6 (a)², so the plate criterion is necessary. The criterion is acceptable in principle, and could remain as worded. However, for added clarity we recommend new text that the Working Group on Explosives is considering in the work on Chapter 2.1 of the GHS: “A significant change in the witness plate shape (e.g., perforation, gouge, substantial dent/bowing, etc.)”.

(b) The second criterion is “A flash or flame that ignites an adjacent material such as a sheet of 80 ± 3 g/m² paper at a distance of 25 cm from the package”. This criterion

² Section 16.6.2 of the Manual of Tests and Criteria.

was a new idea at the time it was adopted. It is not related to the 1.4S definition as much as it relates to the Model Regulations 2.1.3.6.4 criterion for exclusion from Class 1: “No flash or flame capable of igniting a material such as a sheet of 80 ± 10 g/m² paper in contact with the article.” We think that this represents a change in the scope of 1.4S, and suggest it be replaced to more closely relate to the limitation on flame in Test 6 (c): “A fireball or jet of flame which extends more than 1 m from the package”. We have substituted “package” for “flames of the fire”, which is more conservative.

(c) The third criterion is “Disruption of the package causing projection of the explosives contents”. There are two parts to this criterion:

(i) The concept that the projection of unexploded explosives articles is a hazard to be controlled was novel and not based on any existing concept and is not an implementation of the 1.4S definition. We recommend removing this aspect of the criterion.

(ii) This criterion is still valuable to prevent blast effects. It should not be used redundantly to control projections, as that is addressed in the next criterion. We propose the following wording: “A blast effect causing disruption and scattering of the package and most of its contents.”

(d) The fourth criterion is “A projection which passes completely through the packaging (a projection or fragment retained or stuck in the wall of the packaging is considered as non-hazardous).” This seems more in alignment with the safety level of exclusion from Class 1. SAAMI proposes to revert to the originally proposed wording relating to the 8 Joule energy limit for projections: “A metallic projection with a kinetic energy exceeding 8 J as assessed by the distance-mass relation given in Figure 16.6.1.1.” We add an option to calculate the energy with velocities determined by high speed camera.

Proposals

12. Amend paragraph 16.7.1.4 of the Manual of Tests and Criteria as follows (new text is underlined):

“16.7.1.4 *Test criteria and method of assessing the results*

Inclusion in compatibility group S requires that any hazardous effects arising from functioning of the articles in this test are confined within the package. Evidence of a hazardous effect outside the package includes:

- (a) A significant change in the witness plate shape (e.g., perforation, gouge, substantial dent/bowing, etc.);
- (b) A fireball or jet of flame which extends more than 1 m from the package;
- (c) A blast effect causing disruption and scattering of the package and most of its contents; and
- (d) A metallic projection with a kinetic energy exceeding 8 J, as assessed either by $E=1/2 mv^2$ using a high-speed camera or the distance-mass relation given in Figure 16.6.1.1.

The competent authority may wish to take into account the expected effect of the initiator when assessing the results of the test, if these are expected to be significant when compared to the articles being tested. If there are hazardous effects outside the package, then the product is excluded from compatibility group S.”