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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EXPLOSIVES AND RELATED MATTERS

UN Test Series 6

Transmitted by the Institute of Makers of Explosives (IME)

Introduction

1. IME is the safety association of the commercial explosives industry in the United States and Canada. IME's member companies have affiliates, subsidiaries, parent companies, operations in many countries on all continents (except Antarctica), including: USA, Canada, Mexico, Argentina, Australia, France, Germany, Spain, United Kingdom, Norway, Sweden, South Africa, Abu Dhabi, China, Thailand, and Indonesia. The primary emphasis of IME is the safety and security of employees, users, the public, and the environment in the manufacture, transportation, storage, handling, use, and disposal of commercial explosive materials used in mining, construction and other infrastructure development and maintenance operations. IME encourages and supports the development of policies, procedures, guidelines, and regulations that further this cause.

2. At its thirty-fourth session the Sub-Committee adopted Test 6(d), an unconfined package test to be applied to certain candidates for classification into Division and Compatibility Group 1.4S[1]. The purpose of this test is to evaluate whether hazardous effects occur outside of the package as a result of accidental ignition or initiation of the explosives inside the package.

Comments

3. IME participated in the development of the new 6(d) test. During its participation, IME cautioned about issues regarding interpretation of the results of the test[2]. Additionally, IME expressed concern about the implementation of the test[3].

[1] ST/SG/AC.10/C.3/68, paragraphs 8 – 12

[2] ST/SG/AC.10/C.3/2008/10

[3] UN/SCETDG/34/INF.39

4. Earlier this year, acting on recommendations made even before this Sub-committee had formally accepted the 6(d) test, a proposal was introduced to the ICAO Dangerous Goods Panel to implement the 6(d) test beginning on 1 January 2009, without a transition period, that would have applied to the air transport, both passenger and cargo, of all 1.4S entries rather than the eight entries identified by this Sub-committee. Through joint efforts of various national authorities and industry, the proposal was revised to include transition periods and was limited to the air passenger transport of the 8 entries identified by this Sub-committee.

5. In April 2009, the IME performed a series of demonstrations of the UN Series 6 Tests. Representatives from the Pipeline and Hazardous Materials Safety Administration (PHMSA) and the Federal Aviation Administration (FAA) of the U.S. Department of Transportation attended the demonstrations. The purpose of the IME demonstration was to:

(a) Provide an opportunity to witness performance of these tests first hand.

(b) Demonstrate IME's claim[4] that data exists in the 6(a) test that can be used to evaluate if hazardous effects might result from accidental functioning. This data could be used in transitional implementation of the 6(d) test, similar to the approach that ICAO took in Special Provision A165, adopted in March 2009[5].

(c) Identify opportunities to enhance set up and performance of the tests.

(d) Identify opportunities to enhance more consistent interpretation of the test results (especially the new 6(d) test).

(e) Provide additional test data for any continued study of the 6(d) test that this Sub-committee may pursue.

6. Tests were performed as follows:

Sample	Tests Performed			
	6(a)	6(b)	6(d)	6(d)
UN0323 (6.5g black powder igniter)	x			x
UN0455 (0.6g CLCP non-electric detonator)	x			x
UN0456 (0.4g HNS electric detonator	x			x
UN0441 (25g RDX perforator)	x	x	x	x

(a) Samples of UN0366, UN0445, and UN0500 were unavailable for testing.

(b) No product has been approved in USA under UN0460; therefore, samples were unavailable for testing.

(c) As this was a demonstration and due to the number of tests to be performed, and the short time period (2 days) available, tests 6(a), (b), and (d), which are normally performed three times, were performed only once per each sample.

7. A report was prepared and presented at ICAO DGP-WG/09 and at the IME Spring Meeting in May 2009. Details of the tests, including descriptions, photos, and videos of the samples, test procedures, and test results are in this report. A copy of this report is provided in the annex to this paper.

[4] UN/SCETDG/33/INF.57

[5] Doc 9284-AN/905, Addendum No. 3/Corrigendum No. 2

Comparison of 6(a) test to 6(d) test

8. 6(a) results: In the case of UN0323, UN0455, and UN0456, observations of the 6(a) test indicated that no hazardous effects would result in the case of accidental functioning. In the case of UN0441, observations of the 6(a) test indicted that hazardous effects would result in the case of accidental functioning[6]. In the case of all samples tested (UN0323, UN0441, UN0455, and UN0456), no mass explosion occurred[7].

9. 6(d) results:

(a) In the case of UN0323 and UN0456, observations of the 6(d) test indicated that no hazardous effects would result in the case of accidental functioning.

(b) In the case of UN0441, the package was completely destroyed. Hazardous effects would result in the case of accidental functioning[8].

(c) The observers could not agree upon the results of the 6(d) test performed on UN0455. This will be discussed further in the section "Problems in interpreting the results of the tests" later in this paper.

6(b) and 6(c) results

10. 6(b) results: There was no mass explosion and no propagation from package-to-package. Some disturbance of the confining material was noted; however, this was caused by the length of detonating cord required to communicate with the buried packages and the detonator, which was attached to the detonating cord outside of the confining material.

These results are consistent with assignment to 1.4S.

11. 6(c) results: There was no explosion, no projections, no jets of flame or fireballs reaching or extending beyond the witness panels, and all 300 charge cases were recovered with explosive partially or completely burned out.

These results are consistent with assignment to 1.4S.

Observations relative to the performance of the tests

12. 6(b) test: The amount of confinement (1 meter in all directions) prescribed for this test presents some logistical problems in performance of this test. The setup is such that you have a stack of packages on a metal plate and then must have the confinement (including surrounding packages) applied from all sides of the donor (package to be tested) package. Various means are employed in providing this confinement including sandbags or similar packagings filled with sand or dirt. To provide this over a large stack of products would mean many hours of filling sandbags, boxes, or other containers. In the IME demonstration a section of corrugated metal culvert was placed around the test packages and then filled with dirt. This provided a quick means to contain the confining material and may have contributed to the confining effect on the test packages.

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[6] IME remains committed to its position that accidental functioning of 1.4S articles has not and most likely will not occur under transport conditions. Except for 1.4S initiators (detonators, igniters, etc.), these devices are transported without their means of initiation, are not sensitive to initiation from external stimuli, and are designed and packaged to not function until they are armed to do so.

[7] The purpose of the 6(a) test is to evaluate the possibility of mass explosion.

[8] See footnote 6

13. In this instance, packages of 25 gram perforators were tested, and the observers at the demonstration felt that the amount of confining material used was appropriate. However, it seemed to the observers that the full meter of confinement for much smaller articles is unnecessary and that possibly a method of scaling the amount of confining material to the sample size would be appropriate.

14. <u>6(d) test:</u>

(a) Paper

(1) New Section 16.7.1.4(b) of the Test Manual states that evidence of hazardous effects outside the package include a "A flash or flame capable of igniting an adjacent material such as a sheet of 80 ± 3 g/m² paper at a distance of 25 cm from the package". This type of paper appears to be normal A4 laser jet printing paper and may be readily available in Europe. However, in North America, paper of that weight is not commonly available, although papers of similar weight are. We were able to locate a couple of packages of paper at the upper end of the tolerance level for this paper, i.e., 83 g/m^2 (see figure 1).

Figure 1: Paper for 6(d) Test

The package of paper depicted in Figure 1 is old and an Internet search did not find any sources for this paper. However paper just above and just below 77 – 83 g/m^2 is commonly available in North America. Perhaps the Sub-committee should consider changing the requirement to something more general like "…such as a sheet of normal weight laser jet paper …"

(2) Additionally, the test procedure states that the paper is located 25 cm from the package, but no information is provided as to whether this should be on one or more sides. Additionally, no information is provided regarding how to mount the paper for the test. It could be suspended in a free-standing frame, hung from a wire or string, mounted on a board that stands in place next to the package, etc. IME chose to mount it onto a metal sideboard adjacent to test package by means of a sheet magnet (see Figures 2 and 3).

Figure 2: Package & Test Paper Setup for 6(d) Test

Figure 3: Close up of Paper Setup for 6(d) Test

(b) Means of initiation

(1) The UN0323 and UN0456 samples were electric igniters and electric detonators and are themselves “means of initiation”. To perform the 6(d) test, it was a simple matter to attach the leads from these devices to the firing line.

(2) The UN0441 and UN0455 samples were perforators and (percussion initiated) non-electric detonators. They require a separate means of initiation to cause them to function. For the UN0441 demonstration, a length of detonating cord was affixed to the perforator and was initiated by a detonator attached to the opposite end of the detonating cord. Hazardous effects observed during the test may have been influenced by the means of initiation, but to no significant amount and not enough to cause misinterpretation of the results.

For the UN0456 demonstration a 0.6 gram (PETN/RDX) EBW detonator was used to initiate the 0.4 gram (HNS) UN0455 detonator. In retrospect, given the problems in interpreting the results (see next section); IME probably should have devised a way to remotely initiate the UN0455 detonator with some sort of percussion striker mechanism. After the test was performed, damage to the package was observed. It is unclear if this damage is the result of functioning the UN0455 detonator, the EBW detonator, or a combination of the two.

Observations relative to interpreting the results of the tests

15. The results obtained in the 6(a), 6(b), and 6(c) tests were unequivocal, as were the results of the 6(d) tests for UN0323, UN0441, and UN0455.

16. Two observations were made in the 6(d) test on UN0456 that led to disagreement as whether hazardous effects had occurred outside of the package: package damage and witness plate damage.

(a) Package damage – Figure 4 depicts the package damage resulting from the UN04 55 6(d) test. Questions arising from this damage include:

(1) What caused the damage, the UN0455 sample, the EBW initiator, or a combination of the two? Most believed that the EBW initiator contributed significantly to the damage observed, but this has not been verified by additional testing.

(2) Is the damage evidence of hazardous effects or simply effects? What energy produced this damage, and is that energy significant enough to be hazardous?

(3) Despite the damage to the package, all the contents remained within the package. Since criterion (c) of new section 16.7.1.4 of the Test Manual reads, "Disruption of the package **<u>causing projection of the explosives contents</u>**" (emphasis added), most of the observers felt that this damage was not evidence of hazardous effects; however, there was some disagreement.

Figure 4: Package damage (6(d) / UN0455)

(b) Witness Plate Damage – Figure 5 depicts the witness plate damage resulting from the UN04 55 6(d) test. At the 33rd Session, IME expressed concern over the 6(d) acceptance criteria concerning damage to the witness plate[9] and the criterion was revised to read, "Denting or perforation of the witness plate beneath the package".

Figure 5: Witness plate damage (6(d) / UN0455)

An observer (one in a regulatory position) felt that the damage shown (the scratch) in Figure 5 was a dent and was evidence of hazardous effects outside the package. However, it is IME's opinion that this damage is a scratch and is not the type of damage intended by the Sub-committee when it chose the wording "Denting … of the witness plate …"

Conclusion

17. The results of the 6(a), 6(b), and 6(c) tests on all products examined are consistent with assignment to 1.4S.

18. The 6(a) test, although designed to check for mass explosion, can provide evidence as to whether hazardous effects can result from accidental functioning. This may be useful in development of transition periods for implementation of the test.

19. The 6(b) test is difficult to perform, especially in providing and containing the amount of confining material required. In some cases, it may be appropriate to use less confining material and it is suggested that some scaling method based upon sample size be considered.

20. In addition to examining the potential for hazardous effect outside of the package, the 6(d) test provides clear evidence of mass explosion. In cases where the 6(d) test is required, it seems redundant and expensive to also perform the 6(a) test.

21. Only when one considers other observations in the 6(a) test (for example, significant package damage) or when one performs the 6(d) test does the 1.4S classification come into question. In the case of UN0323, UN0455, and UN0456, other 6(a) observations are consistent with assignment to 1.4S. Additionally, 6(d) data for UN0323 and UN0456 were consistent with 1.4S. There was some question regarding the 6(d) results for UN0455; however, most observers at the

[9] ST/SG/AC.10/C.3/2008/10

demonstration, in addition to other national competent authorities who reviewed the results later, were in agreement that 6(d) data for UN0455 were consistent with assignment to 1.4S.

22. On the other hand, 6(d) for UN0441 is inconsistent with assignment to 1.4S. This is the only product that exhibited this "non 1.4S" behavior, and it did the same in the 6(a) test. One must remember that both the 6(a) and 6(d) tests are intentional function tests and that UN0441 is transported without means of initiation and is unlikely to accidentally function in transport packaging and conditions. However, in the very unlikely event that a UN0441 device was to function, there would be hazardous effects outside of the package. UN0441 devices have been historically classified into 1.4S based upon the defined observations and results of tests 6(a), 6(b), and 6(c). That will no longer be the case with the implementation of test 6(d).

Proposal

23. IME recommends that the Sub-committee:

(a) Consider waiving the 6(a) test when the 6(d) test provides evidence that mass explosion of the package contents did not occur and the CA determines that the additional confinement of the 6(a) test would not change the result.

(b) Consider making the volume of confinement in the 6(b) test scaled to the sample size.

(c) Consider fine tuning the procedure and interpretation of 6(d). Specifically, attention should be given to the type, placement, and mounting of the paper used in the test. Also, consideration should be given to developing recommendations on how to exclude the effects of initiators used to initiate articles that have no means of initiation. IME also believes some additional clarification regarding what is and what is not denting of the witness plate would be helpful. For example, the working group may wish to consider inclusion of a dent depth relating to energy level determined to represent whether effects are hazardous; similar to that given in the 6(c) assessment criteria.

(d) Consider providing guidance on:

(1) the Sub-committee's intended effect of implementation upon existing stocks. There are millions of 1.4S articles already in storage throughout the world. These articles were classified and approved under the previous Test Series 6 system as 1.4S; however, some of these articles will not pass the new 6(d) test and would most likely be classed 1.4D. The Sub-committee should provide guidance on whether the products already in storage should be reclassified and packages remarked and relabeled.

(2) whether the 6(d) test can be waived if clear information has been obtained in 6(a). For example, in the IME demonstration, the UN0323, UN0455, and UN0456 all produced 6(a) results that indicate there were no hazardous effects outside of the package. IME suggests that, if these articles have been previously approved in 1.4S, and the approval is based upon testing that includes 6(a) data that clearly indicates no hazardous effects are expected, the 6(d) test is not necessary.

(3) reasonable time periods for implementation of the 6(d) test. The absence of guidance on implementation has already caused problems with international shipping. The sense of urgency some authorities have displayed over implementation of the 6(d) is not supported by the exceptional safety record of shipping 1.4S articles. There are factors such as weather delays, sample unavailability, laboratory readiness, and pre-existing testing schedules that may prevent immediate performance of the 6(d) tests. It is not uncommon for CA approvals to take 6-12 months after test results have been submitted. The Sub-committee should provide some transitional measures to ensure orderly implementation of the 6(d) test.

(e) Consider revisiting the list of 8 UN entries assigned special provision 347. There may not be valid justification for including some of the articles (e.g. cartridges and detonators). Additionally, the working group may wish to consider inclusion of specific limits to alleviate unnecessary testing of small articles that are obviously capable of passing the 6(d) test based on previous test experience and knowledge of how these articles are designed and are intended to perform in use.

Annex

UN Test Series 6 Demonstration Report
to ICAO DGP-WG/09

This report can be downloaded from

http://www.unreports.com/public/TS6Demo/UN6demo.pdf

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