

COMMITTEE OF EXPERTS ON THE TRANSPORT OF DANGEROUS GOODS AND ON THE GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION AND LABELLING OF CHEMICALS

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EXPLOSIVES AND RELATED MATTERS

Review of the UN Test Series 7

Report of the Working Group

Transmitted by the Chairman of the working group (United Kingdom)

Introduction

1. The Sub-Committee will recall that at the 30th session of the UN sub-Committee of Experts on the transport of dangerous goods, July 2007, the expert from the United Kingdom produced ST/SG/AC.10/C.3/2007/30 which outlined problems in the current test series 7 for classifying explosives in division 1.6. The military community had spent many years in developing insensitive munitions but unfortunately test series 7 had not kept pace with these developments with the result that these insensitive munitions did not meet the criteria for inclusion in division 1.6. The expert of the United Kingdom proposed a review of test series 7 to see if changes were possible to take account of these new developments and he offered to host an intersessional working group to examine this topic. This paper was considered by the July explosives working group and both it and Plenary agreed that work should go ahead. This was confirmed at the following December 2007 session.

2. The Intersessional Working Group Meeting was held at the Defence Academy of the United Kingdom, Shrivenham on 6th and 7th March 2008. Attendees representing Finland, France, Germany, the Netherlands, Romania, Sweden, the United States of America and the United Kingdom were present. This information paper summarises the discussions of the Intersessional Working Group Meeting and suggests draft proposals for further consideration and comment by the explosives working group.

Background

3. UN Test Series 7 is used to test extremely insensitive detonating substances (EIDS) and articles containing EIDS and is aimed primarily at military explosives. The military community

has spent a lot of resources over the past 30 years or so developing low vulnerability High Explosives substances and the munitions containing them, as part of an Insensitive Munitions (IM) initiative, but to date there are very few articles that have been classified as Division 1.6.

4. The description of Division 1.6 is:

“Extremely insensitive articles which do not have a mass explosion hazard. This division comprises articles which contain only extremely insensitive detonating Substances, and which demonstrate a negligible probability of accidental initiation or propagation.

NOTE: The risk from articles of Division 1.6 is limited to the explosion of a single article.”

Compatibility Group N is defined as Articles containing extremely insensitive detonating substances.

5. It should be noted that the main difference between Division 1.1 to 1.4 and Division 1.6 is that the former are all consequence based classifications whereas the latter is risk and consequence based taking into account both the probability of initiation and/or propagation and the consequences if this occurs.

Insensitive munitions

6. Insensitive Munitions (IM) are defined by North Atlantic Treaty Organisation (NATO/OTAN) as:

“. . . munitions which reliably fulfil their performance, readiness and operational requirements on demand but which minimize the probability of inadvertent initiation and severity of subsequent collateral damage to weapon platforms, logistic systems and personnel when subjected to unplanned stimuli.”

7. However insensitive munitions are excluded from Division 1.6 because some of the explosives they contain do not meet the criteria for EIDS¹ in that they will not meet all of the requirements of Test Series 7. Historically these tests were designed to accommodate certain types of weapon system such as cased bombs and are not applicable to the majority of IM/Low vulnerability munitions now available to the military.

8. NATO determines whether an explosive article is an insensitive munition using STANAG 4439 and the guidance in its associated document AOP-39. STANAG 4439 requires the assessment of munitions against the following accidental and combat threats: Liquid Fuel / External Fire (STANAG 4240), Bullet Impact (STANAG 4241), Slow Heating (4382), Sympathetic Reaction (SR) (STANAG 4396), Fragment Impact (4496) and Shaped Charge Jet

¹ EIDS -A substance which, although capable of sustaining a detonation, has demonstrated through tests that it is so insensitive that there is very little probability of accidental initiation.

(SCJ) (STANAG 4526). AOP-39 contains the majority of Test Series 7 tests or equivalent tests, many of which are conducted as part of the initial EM Qualification in accordance with STANAG 4170.

9. The IM assessment methodology is based upon a systems approach using the body of evidence to compile an IM signature².

In order to be IM compliant, the required response to all the tests except for SR and SCJ must be no more severe than burning (Type V). And for SR and SCJ, there must be no reaction worse than an explosion [Type III] as defined in STANAG 4439.

Current Test Series 7

10. The UK's main issue with classifying explosives into Division 1.6 seems to be with Test 7a, the EIDS Cap Test and Test 7b, the EIDS Gap Test neither of which take into account any mitigation provided by the design of the munition and any associated packaging. The difficulty with Test 7a is that many military articles contain an explosives train and part of that explosives train includes a shock sensitive booster which would not pass the Cap Test but would pass the NATO IM criteria. The issue with Test 7b is the threshold level which is such that nearly all explosives are excluded except for those with large critical diameters.

Modern Low Vulnerability Explosive Materials

11. Modern low vulnerability explosive materials have been shown to be incapable of detonating without a very strong shock stimulus. Modern munitions design is capable of ensuring that there is no credible stimulus that can detonate these low vulnerability compositions in a munition in a transport accident scenario. These low vulnerability explosive materials were unavailable when Test Series 7 was finalised at the UN many years ago.

Discussions

12. At the intersessional working group meeting it was clear that the general concerns detailed above were supported by the nations represented. Since Division 1.6 was first introduced some 20 years ago the understanding of what is involved in manufacturing IM/Low vulnerability explosives has evolved as has the understanding of the science behind the testing.

It was also considered that it would be possible to more closely align the testing to support the assessment of an article's HD to that used to assess its status as an IM. This would very quickly yield savings in time and money in the testing of munitions.

² IM Signature – A representation of the IM level of the munition, i.e., the response level of the munition to the IM threats (from STANAG 4439).

Suggestions for further (or future) consideration

13. The following draft suggestions are therefore made to the Explosives Working Group:

- a) The definition of Division 1.6 is reviewed; the following definition is offered for consideration:

“Division 1.6 – Extremely insensitive articles which may exhibit a fire hazard or mass explosion hazard and which demonstrate a negligible probability of accidental initiation or propagation.”

- b) The definition of Compatibility Group N is revised, the following definition is offered for consideration:

“CG N – Articles and packaged substances which have passed the appropriate Series 7 tests. They may contain explosives that are not EIDS provided those non-EIDS explosives are separated, until use, from the EIDS explosives by a shutter and that they are held out of line by two independent safety features. In the event of the inadvertent initiation of the non-EIDS explosives they must not cause any event more severe than burning in the main charge.”

This revised definition would align the definition of Division 1.6 with other Divisions by explaining the consequences of an accidental initiation. The description of IM articles is then explained by their compatibility group. This revision would also allow munitions into Division 1.6 which although they may contain substances that would not meet the sensitivity tests but as an article they will meet all the IM tests. Munitions which meet the Division 1.6 criteria would not exhibit a response worse than burning when exposed to fast heating, slow heating, bullet attack and fragment attack, this includes events which may be encountered in typical transport accident scenarios. At worst an explosion response may occur as a result of a shaped charge jet attack or exposure to the detonation of an adjacent article.

- c. The working group has considered proposals that the Series 7 tests should cover the following areas:

- i. Substance Tests to demonstrate low explosiveness and consistency of response to thermal threats.

That as result of the presentation by the UK on the proposed changes to Test Series 7 the test series 7 working group consider the proposal that the UK charge hazard tests (EMTAP Tube Tests – Test 41 Fast Heating, Test 42 Electrically Heated (Slow Heating)) be assessed by NATO AC/326 SG 1 for consideration as alternatives to EIDS External Fire Test (Test 7e) and EIDS Slow Cook Off Test (Test 7f). The benefits of the proposed tests include a demonstration of the consistency of energetic material response through test repetition. The process of adoption will require the UK to produce supporting evidence including comparative data to AC/326 SG 1 for assessment.

- ii. Substance Tests to demonstrate low propensity to DDT as a result of mechanical impact.

The test series 7 working group consider the proposal that the UK charge hazard tests (EMTAP Tube Tests – Test 35 Internal Ignition, be assessed by NATO AC/326 SG 1 for consideration as an alternate for the EIDS Susan Test (Test 7c(i)), EIDS Bullet impact test (Test 7d(i) and the EIDS Friability Test (Test 7c(ii) & 7d(ii)). It was recognised that the test series 7 working group would need to discuss further the tests and assessment methodology of application. In the longer term it is envisaged that this will result in a revised set of tests and assessment criteria to determine propensity to DDT as a result of a mechanical impact.

iii. Substance Tests to demonstrate an appropriate sensitiveness and consistency of response.

It is proposed that the assessment methodology and acceptance criteria for the Cap and Gap Test (Test 7a & 7b) be reviewed by NATO AC/326 SG 1. This is the result of a number of the test series 7 working group expressing uncertainty in the relationship between a munition's response in article tests and the shock sensitivity of the explosive components.

iv. Article Tests to demonstrate the invulnerability of the munition to credible accident stimuli. It is proposed that the following changes are given consideration by the test series 7 working group.

Test 7g: Article external fire test – Change the article external fire test to require a total volume of at least 0.15 m³ (5.3 ft³) or a minimum of three packages or articles, whichever is greater.=

Test 7(h): Article Slow Heating Test – Align the IM test with UN Series 7 (h) article slow cook-off test procedures, modify IM criteria such that if 365°C is achieved (or exceeded) without a reaction occurring during NATO STANAG 4382 testing, the munition is considered to have passed for IM purposes regardless of the violence of any reaction occurring above 365°C. This will be passed to the NATO AC 326 SG 3 for discussion.

Test 7(j): Article bullet impact test – change the acceptable response to “a reaction no more severe than burning in accordance with the IM test.” The working group are also considering whether the test should consist of three firings of a three round burst and each firing to be at a designated point of aim.

Test 7(k): Article Stack Test – Change the article stack test to perform two trials rather than three; one confined and the other unconfined. Munitions where propagation of detonation occurs are considered to fail the test, which is in accordance with the IM test (STANAG 4396).

It was also proposed by the US that two further tests be added to the article tests, these being a fragment impact and shaped charge jet attack test. It was noted that this information was required

as part of the IM assessment and hence will be available and should be used as part of the HD 1.6 assessment. It is proposed that the following changes are given consideration by nations:

Fragment Impact Test – It is proposed that a fragment impact test is conducted on the article using a 18.6g conical-ended cylindrical steel fragment at a velocity of 2530 ± 90 m/s (8300 ± 300 ft/s). This should be conducted as per STANAG 4496. Note: this is proposed for inclusion as it is deemed to represent a credible terrorist threat during transportation.

Shaped Charge Jet Attack – It is proposed that an 81mm shaped charge jet (mimicking a robust RPG 7 threat, which is currently most prevalent), technical details to be confirmed, is used to test the article to determine whether an acceptable explosion or lower level response is observed. The test should be completed as per STANAG 4526. Note: this is proposed for inclusion as it is deemed to represent a credible terrorist threat during transportation.

14. The Chairman of the intersessional working group asks that the Sub-Committee refer the proposals in this paper to the explosives working group for consideration.

Finally, if the explosives working group agrees, the Ministry of Defence of the United Kingdom may be prepared to host another test series 7 working group on outstanding issues if required.
