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Munitions Safety Information Analysis Center

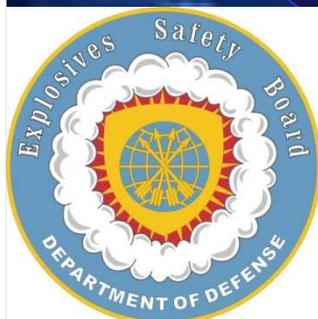


Changes to United Nations Test Series 7 for Hazard Division 1.6 Explosive Articles



Michael Sharp, MSIAC

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What is UN TS 7

UN Test series 7 is used for hazard classification purposes

- It defines the tests and assessment criteria for Hazard Division 1.6 for extremely insensitive articles
 - Articles which demonstrate negligible probability of accidental initiation or propagation
- UN TS7 contains Substance and Article Tests



Introduction

The goal of this work is to modify UN test series 7

- To enable more opportunities for UN HD 1.6 hazard classification assignments where articles (munitions) continue to be deemed as posing a negligible probability of accidental initiation or propagation
- To better align with IM full scale tests
 - Changes required to allow newly developed “extremely insensitive articles,” which do not exactly align with the current criteria, access to Division 1.6
 - Current definition of HD 1.6 to be maintained, and HD 1.2.3 and HD 1.6 relative relationship important

Background

- Currently only a handful of articles classed HD 1.6

Series of substance and article test criteria must be met

- Fuzed munitions do not qualify because most initiating and boosting energetic materials do not pass substance tests
- Energetic materials contained in explosive actuators or pyromechanical devices within complex munitions also typically fail substance testing, leading to disqualification



Contents

- Progress
- Accepted changes
- Proposed follow-on work

Progress

- **Phase 1 (accomplishable in current UN biennium)**
Focused on article tests and a methodology for applying substance tests
- **Phase 2 (next biennium)**
To make proposals on Extremely Insensitive Substance Tests (EIS). Now under way.
 - Acceptance of submitted proposal to the UN (June 2010)
 - Agreement to continue with IWG
 - Task taken on by NATO AC/326 SG/1



Progress

- United Nations (UN) Test Series (TS) 7 Intersessional Working Group (IWG) held 6th March 2008 meeting in Shrivenham, England
- MSIAC sponsored NATO AC-326 SG1 meeting to discuss EIDS tests
- United Nations (UN) Test Series (TS) 7 Intersessional Working Group (IWG) held 17th-18th March 2009 meeting in Bath, England
- Progress reported to the UN explosives Working Group 22nd-25th June 2009
- United Nations (UN) Test Series (TS) 7 Intersessional Working Group (IWG) held 13th-14th October 2009 meeting in Bath, England
- Progress reported at UN meeting December 2009
- Proposal submitted to UN April 2010

Latest News

- Proposed modification for Test Series 7 submitted to UN for consideration at the *Sub-Committee of Experts on the Transport of Dangerous Goods Thirty-seventh session Geneva, 21-30 June 2010*
 - Paper: ST/SG/AC.10/C.3/2010/40 (United Kingdom and United States of America) Proposed modifications to Test Series 7

<http://www.unece.org/trans/doc/2010/ac10c3/ST-SG-AC10-C3-2010-40e.pdf>

Proposals accepted June 24th 2010
Changes will be implemented end 2011

Phase 1 Changes

- Changes to definition; to cover “extremely insensitive substances and articles”
 - HD 1.6 not exclusively for articles containing substances which detonate
 - Result: EIDS becomes EIS

Changes to EIS requirements

- Recognition that more sensitive energetics (not EIS) may be included in extremely insensitive articles. Risk managed by applying the following constraints:
 - Only fuzes including two or more independent effective protective features allowed
 - All boosting components with a cross sectional dimension of $> 50\text{mm}$ or % volume $> 5\%$ relative to their main EM fill must pass:
 - UN TS 7 Type 7 (c) (ii) Friability test
 - UN TS 7 Type 7 (e) EIDS External Fire test
 - Allow other EM containing components, e.g., explosive actuators or pyromechanical devices, to be included provided their functioning is demonstrated to not cause any main EM fill reaction



Logic behind EIS requirement changes

- Negligible probability of accidental initiation or propagation maintained in extremely insensitive articles
 - UN treats munitions containing fuzes with two or more independent effective protective features as not having their own means of initiation
 - Current EIDS tests not appropriate for tiny energetic components in fuzes
 - Tests not representative in terms of confinement and geometry; results conflict with article behavior; difficult or impossible to manufacture samples suitable for testing



Logic behind EIS requirement changes (Continued)

- **Munition designs shield typically embedded fuzing and boosting components from direct mechanical threats**
 - Fuzing and boosting components to be present, however, during article testing and appropriately targeted in bullet and fragment impact article tests
- **As larger embedded boosting components can influence article test outcomes, those are to be subjected to substance testing**
 - 7(c)(ii) Friability test - determine propensity for deflagration-to-detonation transition (DDT) of a damaged and ignited booster
 - A pass gives confidence that a mechanical threat which disrupts and ignites the article is unlikely to result in a detonation (via the DDT mechanism).
 - 7(e) EIDS external fire test - to characterise the likely response of embedded boosters when exposed to heating.
 - A pass gives confidence that the booster will not influence the response of the main explosive fill (will not prompt a detonation response of the EIS main fill when the article is burning)

Article Test Changes

- A number of changes to UN TS7 article tests were made to achieve the following objectives:
 - To improve confidence in the behaviour of more vulnerable non EIS:
 - Reinforcement of the need for all energetic substances to be present in article tests
 - Addition of a UN Test Type 7 (l) fragment impact: a test to determine the sensitivity of an article to shock directed at vulnerable components.
 - Specific targeting of vulnerable areas often associated with fuze or boosting components, in UN TS 7 (j) bullet impact and 7 (l) (new) fragment impact tests.
 - Provide improved guidance on test procedures
 - Develop consistency between article tests
 - Introduce response descriptors developed under NATO AC326 SG3 now contained in AOP-39 Ed3

Inclusion of Response Descriptors

- Included the new *AC/326 SG/3 Insensitive Munition Response descriptors*
 - Recognised that *Detonation, Explosion, Burning* were poorly defined (with the exception of HD 1.4s)
 - Proposed as new annex to ‘UN Manual of Tests and Criteria’
 - Only specifically referred to by UN TS 7, but also likely equally useful in UN TS 6 applications

Comparison of HD1.6, IM, HD SsD 1.2.3

UN HD 1.6			IM STANAG 4439 Pass	HD SsD 1.2.3 Pass
Article Test	Before, Fail (+)	Proposed, Fail (+)		
7(g) 1.6 Article or component level external fire test	a reaction more severe than burning	a response level more severe than burning	Type V (Burning)	Type V (Burning)
7(h) 1.6 Article or component level slow cook-off test	a reaction more severe than burning	a response level more severe than burning	Type V (Burning)	Type V (Burning)
7(j) 1.6 Article or component level bullet impact test	detonation	a response level more severe than burning	Type V (Burning)	Type V (Burning)
7(k) 1.6 Article stack test	a response level more severe than burning or deflagration	a response level more severe than explosion	No propagation of reaction Type III (Explosion)	No propagation of reaction Type III (Explosion)
7(l) 1.6 Article or component level fragment impact test	X	a response level more severe than burning	Type V (Burning)	X
STANAG 4439 requirement - Shaped charge weapon attack Not included in UN TS7	X	X	Type III (Explosion)	X

Proposed Follow-on Work

- UN IWG recognised need for a Phase 2 programme of work to develop proposals on substance tests for the next UN change opportunity in two years time (June 2012 proposals).
- Why is this needed?
 - EIDS tests are severe when compared to the article tests
 - UK position that the tests are too severe and screen out potentially viable substances because of the shock criteria
 - What level of risk are we trying to achieve?
 - EIS provide confidence in the article behaviour, but they need to be set at the right level
 - However, we need to maintain the confidence that the EIS is sufficiently insensitive such that the probability of accidental initiation or propagation of an article remains negligible.
 - It is agreed that EIS tests should continue to be used



Benefits of UN TS7 Work

- Improved science
- Harmonisation of IM and HC small scale tests
 - Potential for agreed common set of screening tests for energetic materials in AOP-39 and UN orange book
- Reduce risk to the logisticians and Warfighters (users)

Summary

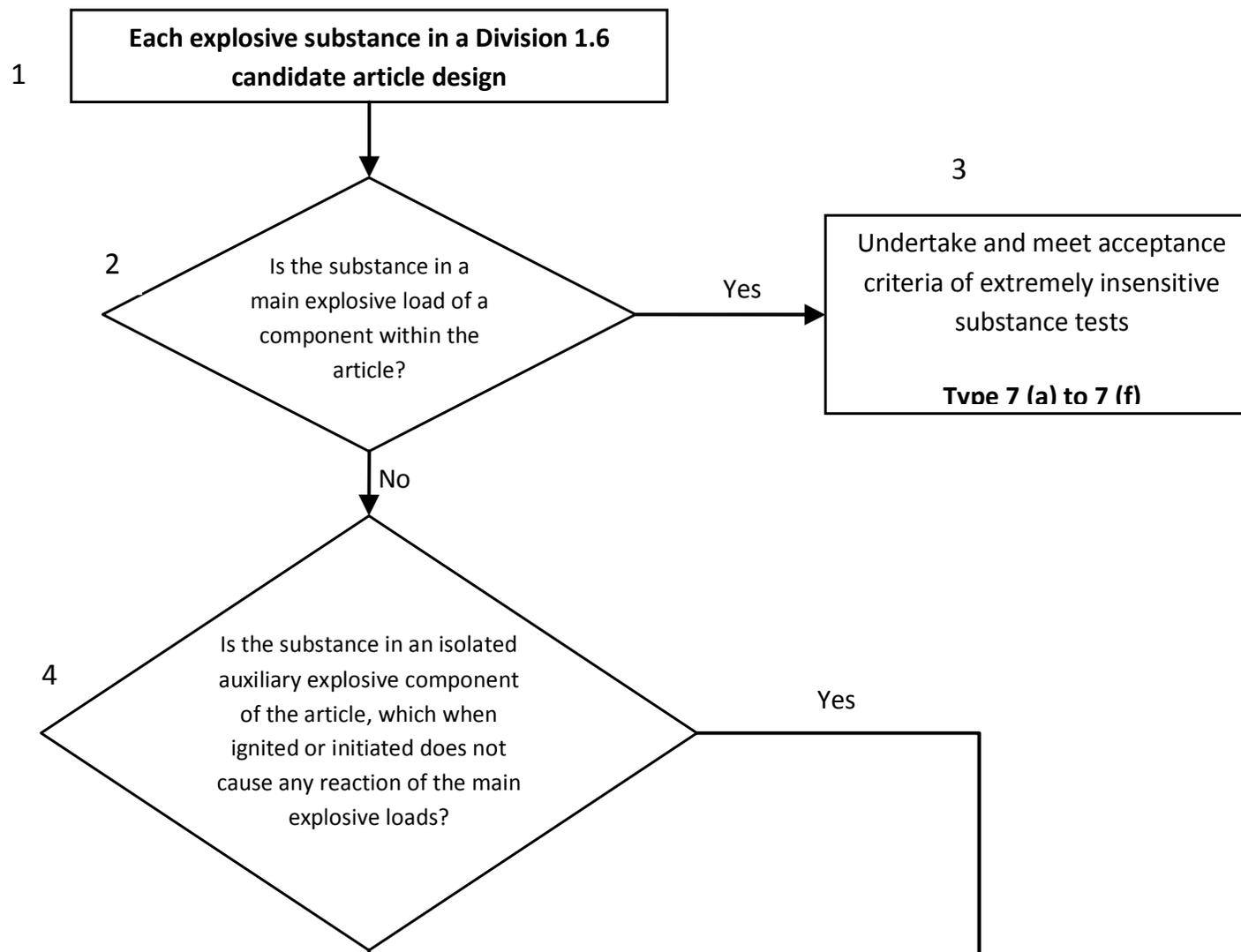
- Described proposals to change United Nations TS 7
 - New methodology and protocol for applying Extremely Insensitive Substance Tests
 - Changes to article tests proposed which bring HC and IM further together
- Discussed the need for follow on work to review EIS tests



Additional Slides



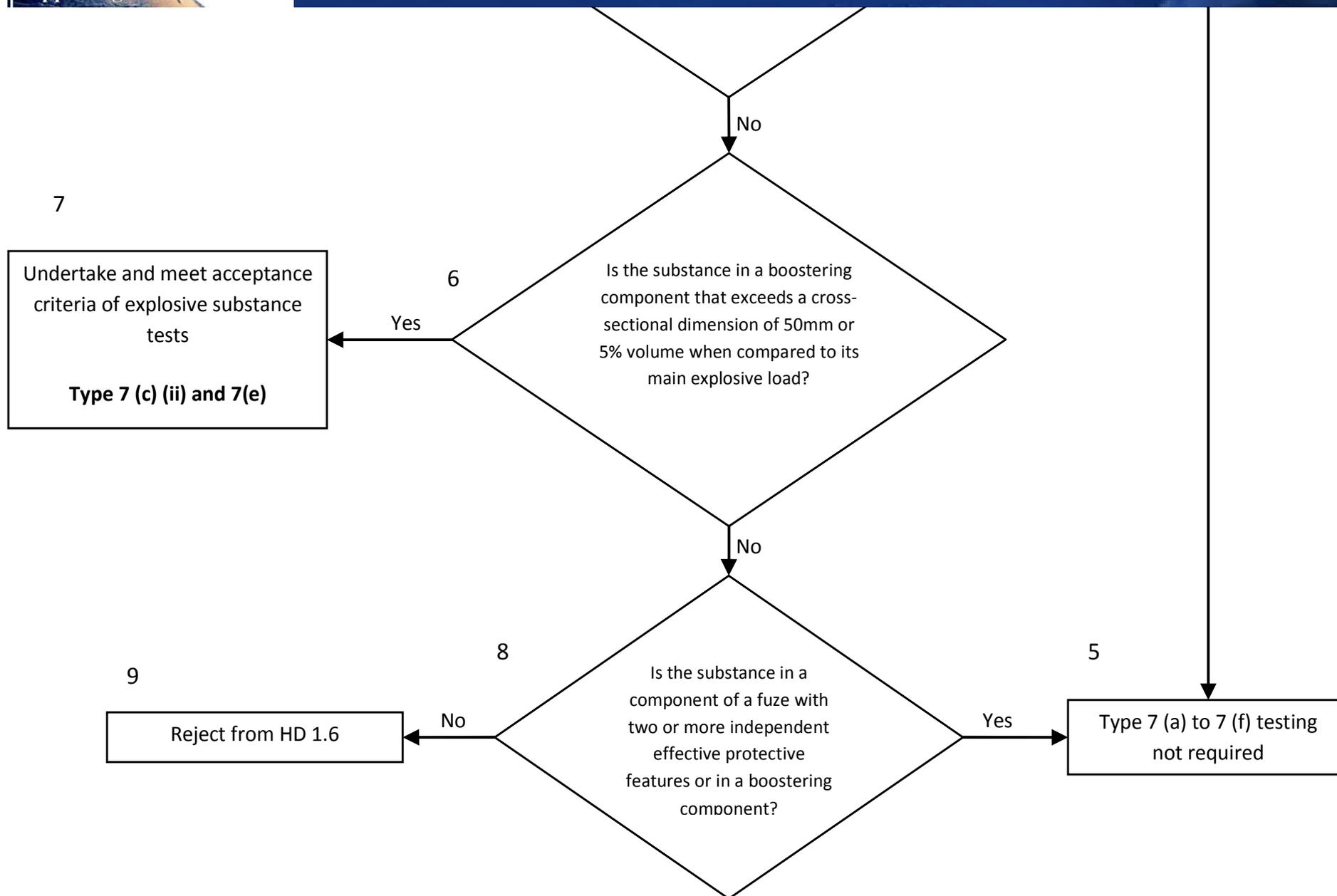
New Protocol Captures the Requirements





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New Protocol Captures the Requirements



Article Test Proposals

- **UN TS 7 Type 7 (j) 1.6 article bullet impact test**
 - Deflagration reactions should be considered positive (failing)
 - Previously detonation was considered a fail
- **Addition of a fragment impact test**
 - Shock stimulus can be directed at sensitive components (non EIS)
 - Gives an improved understanding of the response of the article to shock (taking into account the article's design)
 - 18.6g Conical tipped steel fragment velocity of $2530 \pm 90\text{ms}^{-1}$ as per STANAG 4496

HC / IM HARMONISATION

Key Unaccepted Proposal

- **Inclusion of 1.6 article shaped charge jet (SCJ) test**
 - Requirement was considered by the IWG but was rejected because it was decided that this did not represent a threat present during normal peacetime transportation
 - Noted that test data may well be available from IM assessment
 - National military Competent Authorities may use SCJ data as part of the whole body of evidence on which well-informed decisions are based

HD 1.6 ASSIGNMENT = IM COMPLIANCE?