Proposed Changes to NATO Hazard Division 1.2 Criteria for Storage Sub-Divisions 1.2.1, 1.2.2, & 1.2.3

Ken Tomasello
Naval Ordnance Safety and Security Activity
3817 Strauss Avenue, Indian Head, VA 20640
Phone: 1-301-744-6078, Email: ken.tomasello@navy.mil

Eric J. Deschambault
Department of Defense Explosives Safety Board
4800 Mark Center Drive, Room 16E12, Alexandria, VA 22350
Phone: 1-571-372-6775, Email: eric.j.deschambault.civ@mail.mil

Presenter - Jerry M. Ward, PhD
Booz Allen Hamilton, 1550 Crystal Drive, Suite 1100, Arlington, VA 22202-4158
Phone: 1-703-412-6563, Email: ward_jerry@bah.com

INTRODUCTION

OBJECTIVE

The objective of this paper is to inform the international Insensitive Munitions and Munitions Safety communities on the status of the actions of the NATO AC/326 (Ammunition Safety Group) Sub-Group C (In-service and Operational Safety Management) Hazard Division (HD) 1.2 Technical Working Group (NATO AC/326 SG C HD 1.2 TWG) to revise the NATO requirements and quantity-distance (QD) criteria for the HD 1.2 Storage Sub-Divisions (SsDs). SsD is the NATO designation for Storage Sub-Divisions; specifically, for HD 1.2 (non-mass explosion, projection hazard) and HD 1.3 (fire hazard with minor blast and projection hazard). The TWG mission is to:

1. Revise the requirements and the QD criteria for the HD 1.2 SsDs so as to rationalize the assignment of the proper HD 1.2 SsD hazard classification to the munitions and
2. Apply QD criteria consistent with the hazards posed by HD 1.2 munitions for:
    a. SsDs 1.2.1 and 1.2.2, when subjected to threats experienced during routine transportation and storage and
    b. Munitions assigned to SsD 1.2.3, when subjected to specific Insensitive Munitions (IM) threats - Thermal (fast cook-off (FCO) and slow cook-off (SCO)), shock (sympathetic reaction (SR)), and (bullet Impact (BI)).

BACKGROUND

The origins of the development and the application of the current (as of 2014) HD 1.2, and its SsDs, for purposes of storage and transportation of military munitions by NATO and the US Department of Defense (DoD), are given in Reference 1. The current United Nations (UN) HD classification system (HDs 1.1, 1.2, 1.3, 1.4, 1.5 & 1.6), for Class 1 (Explosives) for transportation was initially adopted by the United States (US) DoD and NATO (AC/258) for transportation and storage of military ammunition and explosives in 1976, References 2 and 3, respectively. The NATO HD / SsD classification system for Class 1 (Explosives) defined in Reference 4 is provided in Table 1, which cites References 5 – 10.

Although the work on revising the earlier HD 1.2 requirements and criteria began in the late 1990's, the current (2014, unchanged since 2010) HD 1.2 SsDs were finally adopted by the US DoD in 1999 and officially published 2004 (Reference 11) and by NATO in 2000 and officially published in 2006 (Reference 12).

There have been four recent meetings, listed below, held at the DoD Explosives Safety Board (DDESB), Alexandria, Virginia, US with representatives from interested NATO AC/326 SG C nations to address improvements to the current HD 1.2 requirements and QD criteria.

1. 22-24 May 2012 – Meeting of the Lead Nations, US and the United Kingdom (UK), for the HD 1.2 criteria revision initiative.
2. 15-17 August 2012 – 1st NATO AC/326 SG C HD 1.2 TWG meeting. Participating nations: Germany (GE), Norway (NO), UK, and US.
3. 13-15 August 2013 – 2nd NATO AC/326 SG C HD 1.2 TWG meeting. Participating nations: Canada (CA), GE, UK, and US.
4. 08-09 July 2014 – 3rd NATO AC/326 SG C HD 1.2 TWG meeting. Participating nations: Belgium (BE), CA, France (FR), UK, and US. The NATO Project Office Munitions Safety Information Analysis Center (MSIAC) was also represented.

The results of the first three meetings are documented in Reference 13, which contains the final proposed changes to SsDs 1.2.1 and 1.2.2 criteria in NATO AC/326 Allied Ammunition Storage and Transport Publication – 1 (AASTP-1), Manual of NATO Safety Principles for the Storage of Military Ammunition and Explosives (Reference 14) and future proposed changes to AASTP-3, Manual of NATO Safety Principles for the Hazard Classification of Military Ammunition and Explosives (Reference 4). Those changes have been incorporated into the ratification version of AASTP-1 (Ed B Ver 1), currently out for national ratification and expected to be promulgated by NATO by mid-2015.

The results of the fourth meeting are documented in Reference 15, which contains proposed changes to SsD 1.2.3 and an assessment of the impact on the footprints (QD arcs) of examples of current US and NATO explosives safety sitings.

ORGANIZATION OF THE PAPER

Following the **INTRODUCTION** section, this paper discusses the:

1. Status and gives a summary of the revisions to NATO HD 1.2 (SsDs 1.2.1, 1.2.2, and 1.2.3) requirements and criteria (Reference 13).
2. Status and gives a summary of the proposals to further change NATO HD 1.2 (SsD 1.2.3) requirements and criteria (Reference 15).
3. Implications for explosives safety QD siting criteria for SsD 1.2.3 (Reference 15).
4. Gives a summary and a discussion of the Way Ahead in the **CONCLUDING REMARKS.**

Table 1. NATO Class 1 Hazard Classification System[1, 2, 3]

Hazard Division (HD)	Storage Sub-division (SsD)	Type of Hazard
1.1		Substances and articles that have a mass explosion hazard. The major hazards are blast, high velocity projections and other projections of relatively low velocity. The mass explosion results in severe structural damage, the severity and range being determined by the amount of high explosives involved. There may be a risk from heavy debris propelled from the structure in which the mass explosion occurs or from the crater.
1.2		Substances / articles with a projection hazard but not a mass explosion hazard.
	1.2.1	Articles that give fragments with a considerable range. These articles are generally high explosive (HE) projectiles (with or without propelling charges) with an individual net explosive quantity (NEQ) greater than 0.73kg.
	1.2.2	Articles that give fragments of a moderate range. Also, these articles include HE projectiles (with or without propelling charges) with an individual NEQ less than or equal to 0.73kg and other items not containing HE such as cartridges, rounds with inert projectiles, pyrotechnic items or rocket motors.
	1.2.3	A special SsD, with its own unique set of QDs, is applicable to munitions that exhibit at most an explosion reaction in sympathetic reaction (SR) testing per Standardization Agreement (STANAG) 4396 (Reference 5) and a burning reaction in bullet impact (BI), slow cook-off (SCO), and fast cook-off (FCO) testing per STANAGs 4241 (Reference 6), 4382 (Reference 7) and 4240 (Reference 8), respectively.
1.3		Substances and articles which have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard.
	1.3.1	Substances and articles that give rise to considerable radiant heat emitting considerable thermal radiation (mass fire hazard).
	1.3.2	Substances and articles that burn one after another, producing minor blast or projection effects or both. Items in this division may explode but do not usually form dangerous fragments. Firebrands and burning containers may be projected.
1.4		Substances and articles which present no significant hazard. The effects are largely confined to the package and no projection of fragments of appreciable size or range is to be expected. An external fire shall not cause virtually instantaneous explosion of almost the entire contents of the package. **Note:** Substances and articles of this division are in Compatibility Group S if they are so packaged or designed that any hazardous effects arising from accidental functioning are confined within the package unless the package has been degraded by fire, in which case all blast or projection effects are limited to the extent that they do not significantly hinder fire-fighting or other emergency response efforts in the immediate vicinity of the package.
1.5		Very insensitive substances which have a mass explosion hazard but are so insensitive that there is very little probability of initiation or of transition from burning to detonation under normal conditions.
1.6		Extremely insensitive articles which do not have a mass explosion hazard These articles only contain extremely insensitive substances and demonstrate a negligible probability of accidental initiation or propagation. **Note.** The risk from these articles is limited to the explosion of a single article.

NOTES: 1. UN, NATO and National Departments of Transportation do not recognize SsD classifications for transportation.
2. The US does not recognize SsDs 1.3.1 and 1.3.2 classifications for storage in / on non-NATO sites.
3. As indicated in the table, munitions that satisfy the criteria for passing the harmonized Insensitive Munitions / Hazard Classification (IM / HC) test requirements in References 5-8 are classified as SsD 1.2.3. If the munitions also pass the harmonized IM / HC test requirements in STANAG 4496, fragment impact (FI), Reference 9, and STANAG 4526, shaped charge jet (SCJ), Reference 10, then the munitions are considered IM compliant and could satisfy the requirements for HD 1.6 if the energetic materials in the munitions also satisfy the substance test criteria for extremely insensitive subasrtances..

NOTE: Though not addressed in this paper, the NATO and US HD 1.2 SsDs definitions / requirements and QD criteria, unchanged since 2010, are provided in References 14 and 16, respectively.

SUMMARY OF REVISIONS TO NATO HD 1.2 (SsDs 1.2.1, 1.2.2, & 1.2.3) REQUIREMENTS AND CRITERIA (REFERENCE 13)

Significant proposed changes to HD 1.2 (SsDs1.2.1 and 1.2.2) criteria, and two changes to SsD 1.2.3 criteria, in AASTP-1, Ed 1, Change 3 (Reference 14) are documented in Reference 13 and are listed and summarized below. These changes have been included in the ratification version of AASTP-1 Ed B Ver 1, currently out for national ratification, expected to be promulgated by NATO by June 2015. **NOTE:** Proposed reference 13 changes to Reference 14, incorporated below, are in green font. **In addition, proposed changes to SsD 1.2.3 are highlighted in bold.**

1. Recommend changing, in many places, the SsD 1.2.1 / 1.2.2 explosive weight boundary criterion from 0.73kg (1.6lbs), which includes high explosive (HE) and propellant weight, to 0.136kg (0.30lbs), which only includes applicable HE content / weight.

2. Recommend inserting the following definition for "Applicable HE Content" at paragraph 1.3.1.5 b), and also include the definition in AASTP-3, Ed 1, Change 3 (Reference 4): "Applicable HE Content: The weight of the explosive material in any individual explosive train of one payload component within a HD 1.2 munition system that, by design, will detonate with the intention of producing metallic fragments from the payload's outer case. The largest determined weight of a payload component's explosive train may be used to assign SsD 1.2.1 or SsD 1.2.2 to the munition."

3. Recommend revising paragraph 1.3.1.5 a) by revising the third factor to be considered before appropriate munitions' QDs can be selected, and adding a fourth factor, MCE (maximum credible event) as indicated: "The third factor is the behaviour of some types of HD 1.2.1 ammunition inside a structure 1.3.1.5.g). Structure types (both PES and ES) and MCE at the PES significantly impact SsD 1.2.1 quantity distances. Additionally, for SsD 1.2.1, there is a fourth factor; whereby the items' MCE must be considered."

4. Recommend revising paragraph 1.3.1.5 b) to add the following (paraphrased) information: SsD 1.2.1 munitions have fragment hazards characteristic of 81 mm and 105mm ammunition. Based on 81mm and 105mm testing the largest HD 1.1 equivalent event (the MCE) for a HD 1.2.1 round will be less than 50kg

5. Recommend expanding the text in paragraph 1.3.1.5 c) to provide examples of munitions that are included in SsD 1.2.2: "It will also typically comprise ammunition which does not contain HE, such as rounds with inert projectiles, pyrotechnics, WP rounds, illumination rounds, and similar items." And also to include the statement: "Rocket motors are an exception and should be assessed as they may be more appropriately addressed by assignment to SsD 1.2.1."

6. Recommend expanding the text in paragraph 1.3.1.5 d) to include: "0.136 kg equates to the quantity of HE contained in the German 40 mm ammunition used in the NATO HD 1.2 trials. This ammunition reacted differently to the 105 mm and 81 mm and as such formed the known upper limit of SsD 1.2.2."

7. Recommend removing the following footnote to 1.3.1.5 g) because the MCE concept will be applied to SsD 1.2.1 munitions: "[1]For Change 3: MCE concept is accepted but not applied in current Table 2G for HD 1.2.1. PFP(AC/326-SG5)(UK)IWP/3-2005 dated 18 March 2005 'Inconsistencies between HD 1.1 and 1.2' would imply a D7 and a D8 column for applying MCE. This IWP and its implications will be dealt with in the next Change." **NOTE:** PFP is "Partnership for Peace" and IWP is "informal working paper."

8. Recommend re-writing / expanding paragraph 1.3.1.5 g) as follows to address the application of MCE to SsDs 1.2.1 **and 1.2.3:** "MCE is applicable to SsD 1.2.1 and SsD 1.2.3 munitions only. **The MCE for SsD 1.2.3 is the NEQ of one item or package, as determined through testing**. SsD 1.2.1 munitions that produce effects similar to 81 mm and 105 mm, as tested in the HD 1.2 Test Program can be considered to have a default MCE less than 50 kg. Where the default 50 kg MCE is not being applied, then: The MCE can be determined in one of three ways:
    a. Established by testing or analogy (i.e. comparison to a like munition packed in a like manner). This will be typical of all new items being developed.
    b. When no specific test data is available, by multiplying the HE content of an item times the number of items in three unpalletized, outer shipping packages. This will typically be used with older SsD 1.2.1 items, for which data is not available. It should be understood that this method could give an extremely conservative value that will likely exceed the 50 kg default value discussed later, thereby requiring very stringent QD application.
    c. Assessing SsD 1.2.1 munitions on a case-by-case basis using available data to arrive at a reasonable value. This will typically be used with older SsD 1.2.1 items where the very conservative MCE/QD as discussed in 1.3.1.5.g.2 above is not acceptable."

9. Recommend re-writing / expanding paragraph 1.3.5 h) to address debris generation in subsequent SsD 1.2.1 events, plus taking the SsD 1.2.1 MCE into account, as indicated below: "To advise situations where the 50 kg MCE is exceeded. Where the MCE exceeds 50 kg, up to 500 kg, in any structure that can contribute to the debris hazard, default distance/criteria of Tables 2A(1) through 2C(1) are no longer applicable, leading to the need to apply Tables 2A(2) through 2C(2). Tables 2A2 through 2C2 address structural debris and fragmentation hazards. In Table 2C(2), for open stack, structural debris hazards do not apply, thus the minimum HD 1.1 Inhabited Building Distances – for projections (i.e., 270 m or 400 m, based on PES type) do not need to be considered. Where the MCE exceeds 50 kg (in the open or in a structure), refer to paragraph 1.3.1.10 for IMD requirements." **NOTES:** IMD is "intermagazine distance." For the original paragraph 1.3.5 h) the QD Matrix Tables 2A → 2C address QDs for SsD 1.2.1, whereas Tables 2D → 2F address QDs for SsD 1.2.2. Now, with the application of MCE to SsD 1.2.1 the number of QD Matrix Tables 2A → 2C are expanded to account for SsD 1.2.1 MCE values as follows:
    a. Table 2A→Table 2A(1)–MCE≤50kg & Table 2A(2)–50kg<MCE≤500kg, Table 2A(1) is the original Table 2A.
    b. Table 2B→Table 2B(1)-MCE≤50kg & Table 2B(2)-50kg<MCE≤500kg, Table 2B(1) is the original Table 2B.
    c. Table 2C→Table 2C(1)-MCE≤50kg & Table 2C(2)-50kg<MCE≤500kg, Table 2(C1) is the original Table 2C.

10. Recommend supplementing the text in paragraph 1.3.1.10 as follows, to show the actual IMD based on a 50kg MCE in Tables 2A(1) through 2C(1) and to show the actual IMD in Tables 2A(2) through 2C(2) based on a MCE between 50kg and 500kg:

"A default MCE of up to 50 kg is used for the distances (to include "No QD") in Tables 2A(1) through 2C(1) (see 1.3.1.5.b). With regards to SsD 1.2.1 inside heavy structures (earth covered magazine or heavy brick/concrete of appropriate thicknesses), this 50 kg default MCE, which has been conservatively established, represents the breakpoint at which a heavy structure can no longer sufficiently contain the effects to provide equivalent IMD. SsD 1.2.1 munitions with an MCE between 50 kg and 500 kg are addressed in Tables 2A(2) through 2C(2)." **NOTE:** SsD 1.2.1 MCEs > 500kg should not exist - The items should be treated as HD 1.1.

11. Recommend revising paragraph 1.3.1.15 c) as follows, to take into consideration the application of MCE: "Inhabited Building Distances for Hazard Division 1.2. The distances for HD 1.2 are based on an acceptable risk from fragments or structural debris. Annex 1-A, Tables A-F must be used for inhabited buildings using the total NEQ unless otherwise specified. Further information is given in paragraphs 1.3.1.5, et seq, including information on the use of MCE."

12. IBDs (inhabited building distances) and associated distances such as public traffic route distance (PTRD), have been established for SsD 1.2.1 items with MCEs 50kg → 500kg.

13. Recommend all IMDs for SsD 1.2.2 read "No QD", with the exception where there's no intervening structure or barricade, which have a 10m fixed distance because no mitigation is afforded. The proposed IMDs remove inconsistencies and are identified in the proposed HD 1.2 QD Matrices (Reference 14, Annex I-A, Tables 2 D-F).

14. Recommend revising paragraph 1.3.1.5 j) as follows, **for SsD 1.2.3, to incorporate $4.8Q^{1/3}$ as the minimum fixed distance so as to be consistent with recent HD 1.2 MCE work. These fixed distances originate from the US where a minimum distance is required. "The Quantity-Distances for ammunition and explosives of SsD 1.2.3 is as follows: The inhabited building distance for SsD 1.2.3 is determined using D4 of Annex I-A, Table 3G, for the NEQ of the rounds present, but with a minimum inhabited building distance determined as follows: If the SsD 1.2.3 items are situated such that primary fragments will not be interrupted, the minimum inhabited building distance is the hazardous primary fragment distance based on the hazardous fragment density criteria (1 per 55.7 square meters) applied to the worst single SsD 1.2.3 item at the PES. The public traffic route distance is equal to inhabited building distance in high traffic density areas and equal to 67% of inhabited building distance where the traffic density is low. Unbarricaded open or light process building (workshop) distance is 67% of inhabited building distance. Barricaded process building is 36% of inhabited building distance. Unbarricaded open or light structure storage (intermagazine) distance is 4.8Q1/3, with a 10 m minimum, based on the SsD 1.2.3 item's MCE (1.3.1.5 g))The intermagazine distance from a PES containing only SsD 1.2.3 items to an ES containing other than SsD 1.2.3 is based on the largest MCE of the SsD 1.2.3 items in the PES. If the SsD 1.2.3 items are situated such that primary fragments can be interrupted, e.g. heavy structure, earth-covered magazine, intervening barricade the specific minimum separation distances (inhabited building, public traffic route, workshop, and intermagazine) are dictated by practical considerations. For any specific quantity or distance determination, as an alternative to the preceding SsD 1.2.3 QD criteria, when an increase in the allowable quantity or a reduction in the required distance will result, items hazard classified as SsD 1.2.3 may be treated as follows: If the single-round applicable HE content is greater than 0.136 kg (see 1.3.1.5 c)), consider the items as SsD 1.2.1 and apply the Tables 2A through 2C. If the single-round applicable HE content is equal to or less**

than 0.136 kg (see 1.3.1.5 c)), consider the items as SsD 1.2.2 and apply the Tables 2D through 2F."

SUMMARY OF PROPOSALS TO CHANGE NATO HD 1.2 (SsD 1.2.3) REQUIREMENTS AND CRITERIA (REFERENCE 15)

The objective of the 3rd meeting of the AC/326 SG C HD 1.2 TWG was to assess current NATO SsD 1.2.3 criteria in light of:

1. The SsDs 1.2.1 and 1.2.2 criteria work accomplished by the previous two HD 1.2 TWGs
2. Lessons learned and experiences resulting from 15^+ years of harmonized HC and IM testing that has been accomplished since the initial SsD 1.2.3 criteria were developed. SsD 1.2.3 is an incremental product of IM development towards meeting HD 1.6 requirements.

Based on the 3rd TWG SsD 1.2.3 discussions, the following points were agreed upon:

1. Recommend changing the approach for determining the minimum fragment distance:
    a. From – Using the HD 1.1 minimum fragmentation density distance (1/56 m^2) based on debris collection from a design mode intentional detonation
    b. To – Using the SsD 1.2.3 MCE value (NEQ for one round/package) in the SsD 1.2.1 QD columns in the SsDs 1.2.1 & 1.2.2 QD table (Table 2G). **NOTE:** SsD 1.2.3 items that would otherwise satisfy the criteria for SsD 1.2.2 will need to use the SsD 1.2.1 (larger QDs) columns.
2. Recommend that the SsD 1.2.3 MCE only be used to determine the entry value into the SsD 1.2.1 QD tables, and will not play a role in determining a structural debris contribution from the PES breakup as is required for SsD 1.2.1.
3. Recommend that a separate SsD 1.2.3 QD table be prepared.
4. Recommend that a SsD 1.2.3 QD flowchart (process) be adopted. See Figure 1.

EXPLOSIVES SAFETY QD SITING CRITERIA IMPLICATIONS FOR SsD 1.2.3

Using the SsD 1.2.3 flowchart (Figure 1), the 3rd TWG participants assessed what the current and revised QDs would be for a range of (potential) SsD 1.2.3 munition MCEs. The results of the exercise are given in Table 2.

EXPLOSIVES SAFETY QD SITING CRITERIA IMPLICATIONS FOR SsD 1.2.3

Using the SsD 1.2.3 flowchart (Figure 1), the 3rd TWG participants assessed what the current and revised QDs would be for a range of (potential) SsD 1.2.3 munition MCEs. The results of the exercise are given in Table 2.

General observations from the SsD 1.2.3 revised criteria assessment exercise documented in Figure 1 are listed below:

1. NATO HD 1.3 QD criteria are greater than the US HD 1.3 QD criteria.
2. Despite the reduction that would result from using the SsD 1.2.3 MCE as the basis for entering the NATO SsD 1.2.1 QD table (to calculate fragmentation related QD), the proposed revised NATO SsD 1.2.3 criteria appear to have minimal impact on overall NATO SsD 1.2.3 QD. The reason for this is that the NATO HD 1.3 QD will

Figure 1.

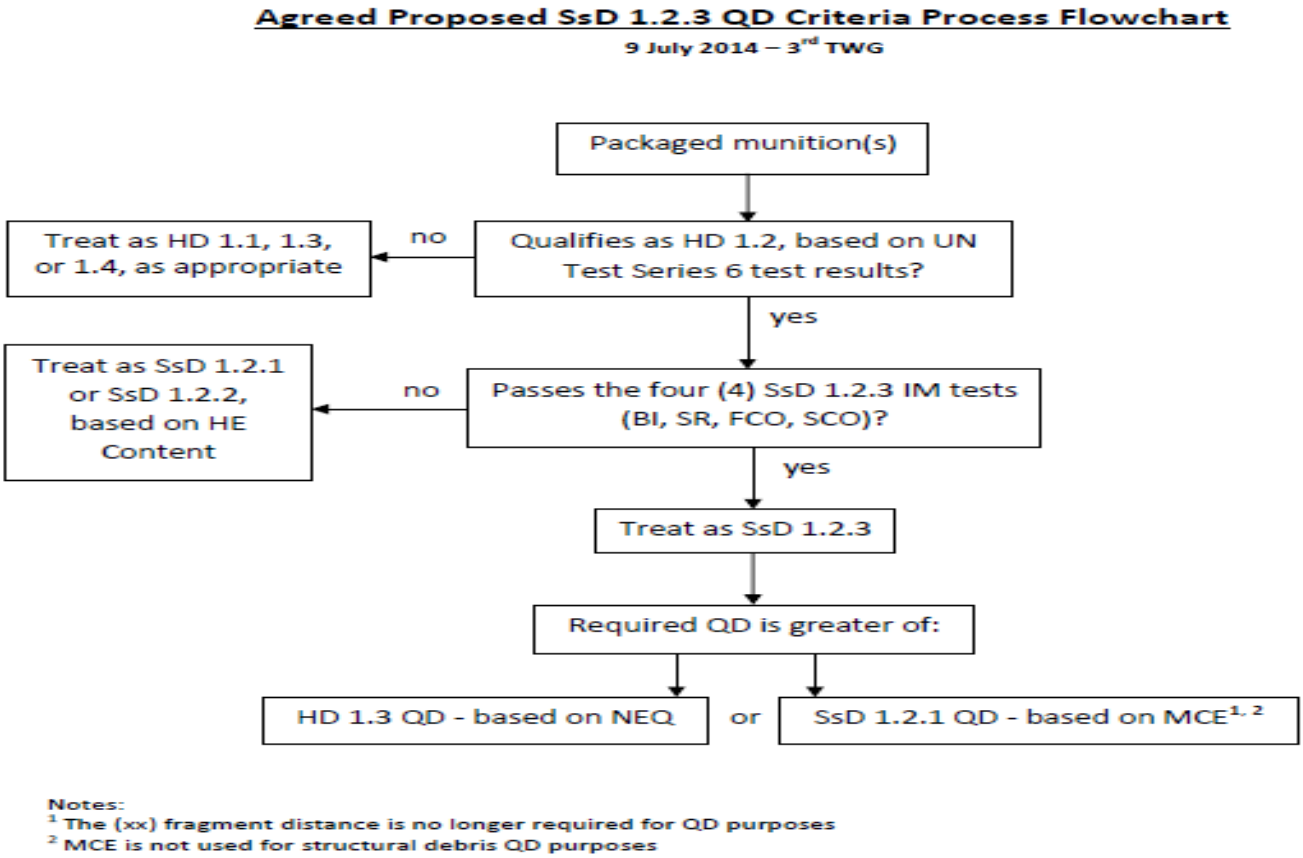

Table 2. Current and Proposed SsD 1.2.3 Criteria Assessment Results

Munition	MCE	# of Items	Total NEQ	Current NATO IBD is greater of		Proposed NATO IBD (from Figure 1) is greater of		Current US IBD is greater of		Proposed US IBD (from Figure 1) is greater of	
	(kg)		(kg)	Fragment Distance (1/56m²) (m)	D4 HD 1.3 (using NEQ) (m)	D2 SsD 1.2.1 Table (using MCE) (m)	D4 HD 1.3 (using NEQ) (m)	Fragment Distance (1/56m²) (m)	HD 1.3 table (using NEW) (m)	SsD 1.2.1 table (using MCE) (m)	HD 1.3 table (using NEW) (m)
A	2.8	1000	2800	91	93	60*	93	91	38	61*	38
B	16.8	1000	16800	152	165	60*	165	152	67	61*	67
C	90	1000	90000	120	290	125	290	120	117	122	117
D	109	1000	109000	274	310	135	310	274	126	134	126
E	446	1000	446,000	282	489	215	489	282	242	213	242

continue to drive required SsD 1.2.3 QD (see yellow highlighting in the table above).

3. Both NATO and the US apply a minimum 60m / 61m fragment distance respectively for SsD 1.2.1. This minimal distance will govern QD for small NEQs of SsD 1.2.3 and for SsD 1.2.3 items with low MCEs.
4. The proposed revised SsD 1.2.3 QD criteria process would have a significant effect towards reducing US-required QD for SsD 1.2.3 (see green highlighting in the Table 1). There could be some situations where HD 1.3 would govern, but for the most part, the SsD 1.2.1 table distances (based on the SsD 1.2.3 MCE) will govern. This result varies significantly from the NATO situation, because of the significant

differences between NATO and US HD 1.3 QD. The DDESB has been and is continuing to work towards closer harmonized US DoD/NATO criteria in order to improve interoperability during NATO operations.

CONCLUDING REMARKS

SUMMARY

This paper provides a summary of the:

1. Revisions to the NATO HD 1.2 SsDs' requirements and criteria based on the results and recommendations of the 2nd AC/326 SG C HD 1.2 TWG, which have been included in AASTP-1 Ed B Ver 1, expected to be ratified by NATO nations by June 2015.
2. 3rd AC/326 SG C HD 1.2 TWG discussion / recommendations to change the NATO HD 1.2 (SsD 1.2.3) requirements and criteria.
3. Results of the 3rd TWG exercise to assess the implications of the proposed changes to the SsD 1.2.3 requirements and criteria to NATO and US explosives safety siting.
4. WAY AHEAD for the TWG initiative in the section below.

WAY AHEAD

Future NATO work:

1. Based on the recommendations from the 3rd TWG, the US is to prepare / submit a US Informal Working Paper (IWP) to AC/326 SG C that includes SsD 1.2.3 narrative text and a SsD 1.2.3 QD Matrix Table for input into a later revision to AASTP-1. The goal of this work is to make SsD 1.2.3 criteria consistent with SsDs 1.2.1 and 1.2.2 criteria and / or simplify SsD 1.2.3 criteria.
2. The need for NATO and the US to apply SsD 1.2.1 minimum distances (60m / 61m, respectively) to SsD 1.2.3 munitions needs to be discussed further. This issue for NATO is to be included in the US IWP (sub-paragraph above).
3. Over the years there have been several discussions that large-scale testing with HD 1.2 munitions larger than 105mm is needed to validate existing HD 1.2 criteria, to include SsD 1.2.3. Specifically, large MCE items have not been tested in poorly venting, heavily confining, small volume magazines. That scenario might lead to over pressurization and subsequent failure of the structure, and generation of building debris. The TWG did not see the need for this testing as an immediate issue because;
    a. There are so few SsD 1.2.3 items (45 total internationally)
    b. The current national HD 1.2 (SsDs 1.2.1 and 1.2.2) stockpiles are predominately of the munition types / sizes that the NATO HD 1.2 Test Program used.
4. The TWG agreed not to re-visit HD 1.6 QD criteria until such time that the full scope of the proposed, revised SsD 1.2.3 QD have been laid out, assessed, and understood.

5. AC/326 SG C is looking into a possible change to a next revision of AASTP-1 (for Ed B Ver 2) that incorporates guidance related to in-process HC (e.g., a SsD 1.2.1 item is brought into a building and removed from its packaging, invalidating its HC).

REFERENCES

1. Tomasello, K. and Ward, J., **Origin of Current Hazard Division (HD) 1.2 Storage Sub-Divisions (HD 1.2.1, HD 1.2.2, and HD 1.2.3) Test Requirements, and Criteria**, Joint Army-Navy-NASA-Air Force (JANNAF) 27th Propulsion Systems Hazards Sub-Committee (PSHS) Meeting, Monterey, CA (3-6 December 2012).
2. DOD 5154.4S, **DOD Ammunition and Explosives Safety Standards** (March 1976).
3. NATO AC/258-D258, **Part I, Manual on NATO Safety Principles for the Storage of Ammunition and Explosives**, 1976, Corrigendum 10 (September 1984).
4. AASTP-3, Ed 1, Change 3, **Manual of NATO Safety Principles for the Hazard Classification of Military Ammunition and Explosives** (August 2009).
5. Standardization Agreement (STANAG) 4396, Ed 2, **Sympathetic Reaction (SR)** (5 April 2003).
6. STANAG 4241, Ed 2, **Bullet Impact (BI)** (15 April 2003).
7. STANAG 4382, Ed 2, **Slow Cook-off (SCO)** (15 April 2003).
8. STANAG 4240, Ed 2 **Fast Cook-off (FCO)** (15 April 2003).
9. STANAG 4496, Ed 1, **Fragment Impact (FI)** (13 December 2006).
10. STANAG 4526, Ed 2, **Shaped Charge Jet (SCJ) Impact** (10 December 2004).
11. DoD 6055.9-STD, **Ammunition and Explosives Safety Standards** (5 October 2004).
12. NATO Allied Ammunition Storage and Transport Publication - 1(AASTP-1), Ed 1, Change 2, **Manual of NATO Safety Principles for the Storage of Military Ammunition and Explosives** (May 2006).
13. Working Paper AC/326(SG/C)WP(2013)0003 (PFP)REV 2, CNAD Ammunition Safety Group (AC/326) Subgroup C on In-Service and Operational Safety Management, **Proposed Change to HD 1.2 Criteria, AASTP-1 Edition (B) Version 1** (6 December 2013).
14. NATO AASTP-1, Ed 1, Change 3, **Manual of NATO Safety Principles for the Storage of Military Ammunition and Explosives** (May 2010).
15. Meeting Minutes, **3rd Hazard Division 1.2 Technical Working Group (**8-9 July 2014).
16. DoD Manual 6055.09, Change 1, DoD Ammunition and Explosives Safety Standards (Volumes 1-8), 12 March 2012. https://www.ddesb.pentagon.mil/.