

Review and update of STANAG 4526 Shaped Charge Jet, Munitions Test Procedure

International Explosives Safety Symposium & Exposition
6-9 August 2018
San Diego CA

Dr. Brian Fuchs¹, Dr. Ernie Baker², Mr. Ken Tomasello³, Mr. Manfred Becker⁴

¹ U.S. Army ARDEC Picatinny Arsenal, New Jersey 07806

² Retired from U.S. Army ARDEC Picatinny Arsenal, New Jersey 07806

³ US Navy, NOSSA, NATO AC326 Subgroup B Chairman

⁴ Retired from MSIAC NATO Headquarters Boulevard Léopold III Brussels B-1110
Belgium

Abstract

The custodial working group for STANAG 4526, Shaped Charge Jet, Munitions Test Procedure is developing an updated Allied Ordinance Publication (AOP) that will replace STANAG 4526 which was ratified in 2004. Since the ratification there have been significant improvements in the understanding of: initiation by shaped charges, testing procedures, improved insensitive munitions, and a clearer definition of the threat. The STANAG is dated and no longer provides a working structure for improving the safety of munitions and international coordination of munition development. Multiple international meetings have been held including a technical workshop under the auspices of NATO's Munitions Safety Information Analysis Center (MSIAC): ENSTA Bretagne Brest France 12 – 15 May, 2014 and two Custodial Working Group meetings: Brest France 16 May, 2014 and Bofors Test Center, Karlskoga, Sweden 03 September 2014. In addition two update meetings were held in conjunction with the Response Descriptors Working Group to discuss the implementation strategy in relation to the new Standards Related Document being written. In absence of clear guidelines due to the dated STANAG, member nations developed new test procedures based upon real world threats. These test procedures share many commonalities. An AOP is being developed that will codify the use of the new tests, allow for a comparison between the tests, and develop a set of guidelines to assist the development of new tests that address the common threat. This is an update on the progress since the presentation at the 2015 IMEM.

Introduction

In order to promote the development of safer munitions and increase interoperability NATO has established a "Policy for Introduction and Assessment of Insensitive Munitions (MURAT)" in STANAG (Standardization Agreement) 4439. A series of tests for determining the compliance of munitions with IM requirements have been established. One of these procedures is STANAG 4526 "Shaped Charge Jet Munition Test Procedures". This document was last updated on 15 July 2004 with STANAG 4526 Edition 2. Since that time the munitions community has developed a better understanding of the threats from shaped charges. Additionally, there have been improvements in the science initiation mechanisms. As this document no longer met the needs of the community each member nation had been creating and adopting independent methods. A review of the document and adoption of a new standard is required, and a new Allied Ordinance Publication (AOP-4526) is being prepared.

The problems with STANAG 4526 were identified during the MSIAC workshop on IM Technology Gaps in June 2011. Most attendees expressed concerns about the representativeness of these V^2D , as they were considered far too high for the different classes of aggressions. AC326 SGB requested MSIAC support in May 2012 on the following needs¹:

- Introduce more realistic aggression levels / V^2D values into the STANAG 4526;
- Better define shaped charge jet characteristics and how to measure them;
- Make some recommendations for an update of STANAG 4526.

Also an issue is the reproducibility of the threat munitions, and the characteristics of the resultant shaped charge jets.

The US is the custodian of STANAG 4526. An international custodial working group was established with the co-chairs of Drs. E. Baker and B. Fuchs with the assistance of Mr. M. Becker of MSIAC. Dr. Baker has since retired and Dr. Fuchs has assumed the position of chair. Additionally Mr. Becker has also retired from MSIAC. The guidelines for a successful new STANAG are:

- Test standards should be written to address real threats, making improvements to the safety and survivability for the defense personnel.
- Testing should be able to identify and help correct technical problems causing the unintended response of the systems.
- Testing should have enough fidelity to allow the confidence of all using the data that it is accurate and representative of real world situations.

- Test procedures should be written in a manner that they can be conducted by all member Nations.

Two custodial working groups meetings have been held to date in Brest, France (May 2014) and Karlskoga, Sweden (September 2014). Two update meetings were held in conjunction with the Response Descriptors Working Group Meeting in Brussels, Belgium in Sept. 2015 and April 2016. These updates did not change the technical aspects of the new AOP, but rather reported the progress and discussed release strategies. At the 2015 meeting it was decided to delay the implementation of the new AOP 4526 until the new Standards Related Document (SRD) IM testing could be completed. The new SRD will consolidate standards across multiple tests reducing duplication and streamline updates. While the AOP 4526 is near completion, delaying the implementation to allow the removal of duplicative sections that are in the new SRD assures the document is not outdated shortly after release.

Threat

World events since the last ratification of STANAG 4526 have shown that shaped charges are not only a direct threat to military personnel they also have ability to cause violent reactions in munitions greatly increasing fatalities and injuries. In the current edition of STANAG 4526 a series of threats are defined:

Threat	Representative V^2D ($\text{mm}^3/\mu\text{s}^2$)
Top Attack Bomblet	200
SCJ with characteristics of 50mm Rockeye	360
Rocket Propelled Grenade	430
Anti-Tank Guided Missile	800

- Bomblet – Based on Cluster Munitions Convention, this threat has reduced probability. However, there is a significant threat at this level for 30-40 mm grenades. US is currently developing a surrogate warhead.
- Rockeye – No longer used in the US per IM policy (MIL-STD-2105D).
- RPG – Is a very viable threat.
- Anti-Tank Missile – Typical threat under conventional warfighting tactics. Much less observed threat under urban warfare scenarios.

STANAG 4526 lists general guidance for shaped charge jet aggression levels in IM testing uses Held Criteria (V^2D) to define jet energy level, where V is the jet tip velocity

(mm/μs) and D is the jet tip diameter (mm). For the listed aggression levels, V²D represents the impact of the jet on the outside of the munition or munition shielding, but it does not reflect the complex jet interaction with the energetic material. The representative values reported in the STANAG for the Held Criteria could not be verified.

Current Test Methods

Without an updated standard each member nation developed test methods to address relevant shaped charge threats. Most member nations adopted some form of the Rocket Propelled Grenade (RPG) as the prevalent threat. No nation uses the Rockeye munition from the current STANAG. The following were the reported tests.²³

Typical Shaped Charges used by MSIAC Member Nations

Nation	Shaped Charge	Threat Level	Jet Velocity (mm/μs)	Jet Diameter (mm)	V ² D (mm/μs)	Specified in IM Policy	Laboratory/ in service *
France	CCEB 62 (Former Version)	RPG-7	8	3	203	Yes	Laboratory
	CCEB 62 (New Version)	RPG-7	To be assessed	To be assessed	To be assessed	Yes	Laboratory
Germany	KB44	Bomblet	8	1.9	122**		Laboratory
	RPG 7 NB	RPG-7	7.2	3.1	166**	Yes	Laboratory
Netherlands	Small Bomblets	Bomblet					In Service
Sweden	RPG-7's	RPG-7					In Service
United Kingdom	BL 755	Bomblet				No	In Service
	M42	Bomblet				No	In Service
	K4	RPG-7				Yes	Laboratory
USA	81 mm SC	RPG-7	6.4	3.5	141	Yes	Laboratory

- *In Service means that the shaped charge is produced in large scale
- **The jet tip is not considered

Workshop Findings

The first workshop in Brest was very productive and an agreement was achieved on several key points. The Bomblet, Rockeye, and Anti-Tank shaped charges are to be removed from the standard. The old inaccurate V²D table should also be removed. The Ballistic Pendulum test will be removed as an option from official testing.

Since most countries identified the RPG-7 as the most prevalent threat, its adoption in the new STANAG would provide the best and easiest path for collaboration and agreement. While the RPG-7 is the representative threat, a Threat hazard variation (THA) will be allowed so that the tests can be tailored to specific warfighter scenarios. The STANAG is being written to maintain the current German, French and US test standards. An approach of identifying requirements is being adopted to define the jet characteristics and test configurations. In this manner, a Nation can design and produce their own shaped charge and test configuration and have it be accepted under the STANAG. The tests within the STANAG will include drawings of the acceptable test configurations so that replication is possible. Additionally, requirements for the documentation of the jet characteristics for the test conducted are outlined, allowing for the understanding of testing by other nations during review.

Status

A draft has been written of the proposed STANAG. The US and French testing ANNEX's have been included. Proposed general criteria for the tests that met the STANAG are:

Jet Characteristic Requirements

- The jet will penetrate a conditioning plate of suitable thickness to remove the first part of the jet.
- Jet diameter at the target impact position shall be 2.5 - 3.5mm
- V^2d : shall be between 120 and 140 $\text{mm}^3/\mu\text{s}^2$

Breakup characteristics

- Jet length, breakup times and accumulated jet mass may be measured for information. Note: this parameter may be very useful for modeling and simulation, and for correlation to small scale testing. Also, accumulated jet mass may be calculated rather than measured.

Shaped Charge Requirements

- The shaped charge will be produced in a precise manner assuring that all components are properly located and that the charge is axially symmetric. Dimensional tolerances shall be selected such that a consistent straight jet is achieved. A jet straightness exhibiting less than $\frac{1}{2}$ of a jet diameter deviation at a 20 charge diameter standoff is desired. The explosive charge diameter should be larger than 60mm and less than 95mm with an explosive fill performance between COMP B and Pure HMX at TMD. The charge liner shall be made from a high quality oxygen free copper and its construction described. Initiation methods will be specified to assure consistent and strong symmetric initiation. Therefore, the use of civil detonator should be avoided.

- The shaped charge shall be designed such that the output after a conditioning plate matches the performance of a shoulder launched rocket propelled grenade. The performance parameters considered shall include the diameter and velocity both at the tip and along the jet. The characterization shall include information as to the placement that replicates the standoff of the RPG threat.

Conclusion

A review and update of STANAG 4526 “Shaped Charge Jet Munition Test Procedures” is ongoing, including the development of a new Allied Ordinance Publication (AOP-4526). The update is centered on the RPG-7 as the most prevalent identified threat. A fairly complete draft has been completed and is currently under review. The implementation of the new AOP is being delayed to allow a New Standards Related Document to be created. At that time duplicative sections will be removed from AOP-4526 assuring the document remains relevant for the longest period of time.

CWG Members:

Brian Fuchs (US - Lead)
 Ernie Baker (US – retired former co-lead)
 Phil Cheese (GBR)
 Nathan White (GBR)
 Pierre-Francois Peron (FRA)
 Florian Pechox (FRA)
 Guillaume Baudry (FRA)
 Gunnar Nevstad (NOR)
 Albert Bouma
 Patrick Brousseau

Participants:

Ken Tomasello (AC-326 SG/B Chair)
 Bill Proud
 Malcolm Cook
 Nathan White
 Pierre-Francois Peron
 Fabien Chassagne
 Franck Dupuis
 Albert Bouma
 Gunnar Nevstad
 Tom Swierk
 Steve Struck
 Hervé Benard
 Jon Toreheim
 Florian Pechoux
 François Davenne
 Albert Bouma

MSIAC:

Matt Andrews
 Manfred Becker (retired)
 Emmanuel Schultz
 Michael Sharp
 Tom Taylor
 Martin Pope

¹ Shaped Charge Jet Review Recommendations for the Review of STANAG 4526 Edition 2 Pierre-François Péron

² Manfred Becker “MSIAC SCJ Assessment Workshop” Parari 2013 Australian Explosive Ordnance Symposium, 13 November, 2013 Canberra, Australia.

³ Notes taken at Brest France 12-16 May, 2014