

**NATO STANDARD**

**AOP-4241**

**BULLET IMPACT  
MUNITION TEST PROCEDURES**

**Edition A Version 1  
NOVEMBER 2018**



**NORTH ATLANTIC TREATY ORGANIZATION**

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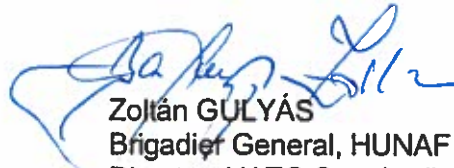
**NORTH ATLANTIC TREATY ORGANIZATION (NATO)**

**NATO STANDARDIZATION OFFICE (NSO)**

**NATO LETTER OF PROMULGATION**

20 November 2018

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## CHAPTER 1 INTRODUCTION

When reviewing requirements for this test, SRD AOP 39.1 should first be read for guidance in the organization, responsibilities and conduct of full-scale testing.

### 1.1 ANNEXES

- A. Recommendations on defining the aiming point and tolerance area
- B. Required specifications of permitted 12.7 mm AP projectiles
- C. Historical Overview

### 1.2 AIM

The aim of this Standard is to specify the test requirements and procedures to provide evidence of the reaction of munitions and weapon systems to the threats represented from being struck by small arms projectile(s).

### 1.3 AGREEMENT

1. Participating nations agree that the requirements and procedures incorporated in this Standard will be used for assessing the reaction, if any, of munitions and weapon systems to bullet impact represented by 12.7 mm Armor Piercing (AP) projectile or more appropriate threat.
2. Participating nations further agree that national standards, orders, manuals and instructions implementing this AOP will include a reference to the STANAG 4241 for purposes of identification.
3. No departure may be made from this agreement without consultation with the NATO Tasking Authorities/Delegated Tasking Authorities (TA/DTAs). Nations may propose changes at any time to the TA/DTAs where they will be processed in the same manner as the original agreement.
4. This Standard is supported by the guidance in SRD AOP 39.1 that makes recommendations on the organisation, conduct and reporting of the tests in this and other full scale tests Standards.

### 1.4 DEFINITIONS

For the purpose of this document, definitions of terms to be used to describe test details and events are given in the NATO Terminology Management System that is available by reference for all Allied Publications.

## 1.5 GENERAL

1. Effort to minimize the violence of the reaction of munitions struck by small arms projectiles is a continuing requirement of weapons designers in order that the safety of personnel and materiel will not be unduly jeopardized.
2. This Standard addresses the situation where munitions and weapon systems may be struck by bullets. This can occur in peacetime as the result of accident, dissident/saboteur activity, or on operations as a consequence of enemy action. Munitions that are stowed in unsheltered stores, magazines or launchers are considered to be particularly vulnerable.
3. The bullet impact test can only represent a particular set of conditions as it is not possible to cater to the wide range of weapons, sizes of bullets, strike velocities or angles of attack which occur in the real world.

## 1.6 DETAILS OF THE AGREEMENT

1. This Standard provides guidance and procedures for Bullet Attack testing. Testing should be conducted by participating nations as a part of the Insensitive Munition (IM) assessment of munitions where required by STANAG 4439, Policy for Introduction, Assessment and Testing for Insensitive Munitions.
2. The Tests may also be used for Hazard Classification (HC) as required by STANAG 4123 and UN Document ST/SG/AC.10/11/Rev 6 and any amendments thereto, and other applications not covered by these documents where the response of a munition to bullet impact is required to be known or assessed.
3. If a test is to be used for Hazard Classification, an agreement must be reached between Hazard Classification and Safety Authorities on the required test, number of test items, their configuration (packaged or unpackaged), and the number of tests to be performed.
4. This Standard specifies 3 test procedures:
  - a. A standard test procedure (Method 1) for determining the reaction, if any, of a munition to an impact of three 12.7 mm Armor Piercing (AP) projectiles;
  - b. A primary alternative test procedure (Method 2) for determining the reaction, if any, of a munition to an impact of one 12.7 mm AP projectile;
  - c. An alternative, tailorable test procedure (Method 3) for determining the reaction, if any, of a munition to the impact of one or more projectiles that are typical of those determined by means of a threat hazard assessment (THA).

## CHAPTER 2 TEST SPECIFICATIONS

### 2.1 TEST ITEM CONFIGURATION

1. The test item configuration shall be the final production standard and in accordance with the condition as appropriate to the life cycle phase represented by the test, or representative as approved by the national authority.
2. Guidance on variations to the production standard and condition (like; live vs inert, pre-conditioning, packaged vs unpackaged, All Up Round vs Components) as given in SRD AOP 39.1 Annex B shall be considered.

### 2.2 TEST TYPES

1. For Method 1 and 2 IM tests the standard attack munition (threat) is a 12.7 mm AP M2 round, fired from a rigidly mounted gun. Comparable projectiles are acceptable if they fulfill the specifications of Annex B. Both munition and gun have to be selected to fulfill these specifications for procedure 1 and 2 IM tests:
  - a. Impact velocity:  $850 \pm 20$  m/s;
  - b. Rate of fire:  $600 \pm 50$  rounds per min (only Method 1)
2. Additional measures may be necessary to meet the requirements, depending on local conditions, like
  - a. Warming up the barrel
  - b. Warming or cooling of propellant
  - c. Adjusting the amount of propellant
  - d. Considering the length and the wear of the barrel
  - e. Adjusting the distance to the target
3. For all procedures the shots have to hit a target area consisting of a circle with 5 cm diameter. The aiming point is the center of the target area. Fulfillment of this requirement can be proven with pre-shots (method 1 only) or during the live test with suitable means (e.g. bullet holes in the test item or high-speed video). If the accuracy is proved with pre-shots it is independent of a potential moving or destruction of the test item. It is up to the testing facility to choose the suitable mean due to their set up. An example on proving accuracy with pre-shots can be found in Annex A.
4. To meet the requirements for the target and for reaching the rate of fire, the use of three remotely controlled guns is recommended for Method 1. For Method 3, parameters should be as determined by the THA and approved by the national authority.
5. Any of the selected three test methods shall be carried out twice; once against the most sensitive component/energetic material (e.g. motor igniter, warhead booster) and once against the main charge filling. 'Most sensitive component' means

the component which, if exposed to the threat, is likely to lead to the most violent response of the munition.

6. Methods shall be established to assure the bullet is aimed at the selected aimpoint and that it follows the desired path through the munition. The likelihood of getting a violent response, will normally be maximized by choosing a shot line, which provides the longest possible path length through the energetic material. However, unlikely shotlines should be avoided, which are aimed at components that are quite small when compared to the bulk of the explosive, propellant or aimed at unlikely angles. Prior to testing, shotlines should be agreed to by the appropriate authorities. In this regard, the following considerations may apply: if the energetic material contains a cavity of significant size (such as the bore of a rocket motor), aim the bullet to pass perpendicularly through the cavity. (It has been observed that such cavities can promote the occurrence of violent reactions).

### **2.3 TEST CONDITIONS**

1. The test item state and orientation shall be applied in coherence with the life cycle phase represented by the test, or representative as approved by the national authority.
2. The range from gun to target is to be determined by the test authorities, depending on accuracy and safety aspects. In most cases a range between 15 and 30 m is recommended. A larger or shorter range may be appropriate, if demanded for performing the test and agreed by national authority.
3. Guidance on variations to the test conditions (like; positioning/orientation, aimpoint/shotline, restraints, conditioning, marking, re-use) as given in SRD AOP 39.1 Annex B shall be considered.

### **2.4 DOCUMENTATION AND COMPLIANCE**

1. A test directive, test plan and test report shall be produced and shall be agreed by the national authority. Guidance on completion of documentation, responsibilities for completion and review are discussed in detail in SRD AOP 39.1.
2. It is essential that the test is conducted in accordance with the Test Directive; one of the responsibilities of the Project Team is to confirm compliance.
3. Where deviations from the agreed Test Directive and Test Plan or the procedure agreed at the Trial Readiness Review prove necessary, these must be approved on behalf of the review body by the appropriate Project Team representative, taking advice as necessary from the safety advisor and technical specialists.

### **2.5 OBSERVATIONS AND RECORDS**



Guidance on specific aspects of the conduct of testing, observations and data recording is discussed in more detail in SRD AOP 39.1. Unless noted as “optional”, for IM purposes, the following minimum observations must be made and records kept. Test requirements, records and observations for HC testing and assessment are mandated in the UN Manual of Tests & Criteria and are not optional.

- a. Test item identification and configuration (model, serial numbers, number of test items, etc.); Type of energetic material and weight; Listing of environmental preconditioning test performed; The spatial orientation of the test item;
- b. Test setup/configuration: Type of procedure, details of weapon(s) and munition used, number of rounds; Distance between weapon(s) and test item; Method of mounting and/or restraint; Distances from the test item to any protective wall or enclosure; Identification and location of any other instrumentation if used;
- c. Record of aim point(s) selected, hit point(s) (if possible) and whether the bullets(s) exited from the test item or remained within it (if possible)
- d. Impact velocity of each bullet, firing rate (if applicable) and method of determination;
- e. Record of events against time from the order to fire to the end of the test;
- f. The nature of any reactions by the test item;
- g. Imagery of the item under test and the test setup shall be done before and after performing the test;
- h. The nature and distribution of residue and debris (incl. recovery and mapping);
- i. Meteorological data;
- j. Indication of propulsion (video or other suitable means);
- k. A microphone or other suitable listening device should be placed near the trial site to record audible events. The audio record shall be a sound track on the motion picture film or on the videotape to enable correlation with visible events and indicated time;
- l. Suitable blast or pressure gauges should be positioned around the test item and the location and height of the gauges recorded;
- m. Witness screens as a measure of projection severity (optional);

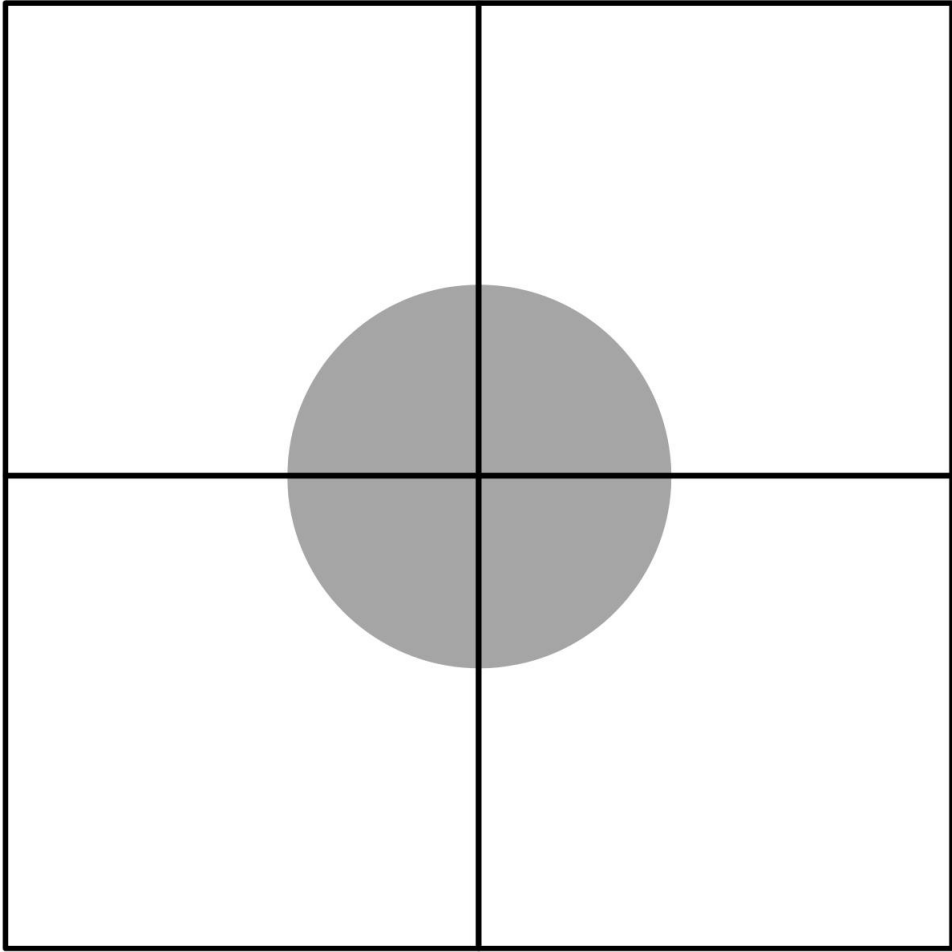
## **2.6 EVALUATION OF TEST RESULTS**

Policy and procedures for evaluation of test results are given in:

- a. STANAG 4439, Policy for Introduction, Assessment and Testing for Insensitive Munitions;
- b. AOP-39, Guidance on the Assessment and Development of Insensitive Munitions (IM).

<b>ANNEX A      RECOMMENDATIONS AIMING POINT AND TARGET AREA</b>
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1. The fulfillment of the accuracy requirements must be proven by suitable means. This can be done by performing pre-shots prior the live test as described in this Annex. Facilities are free to prove accuracy by other means. To prove accuracy by this instruction a provisional target is placed instead the test item on the test rig. The provisional target consists of a card showing the aiming point and the target area.
2. Example drawings of the provisional target can be found below. The aiming point is marked by the crossing lines in the middle surrounded by the target area of 5 cm in diameter. The outer dimensions of the target should be 10 cm or more. All lines and the target area should be in a different color than the background. Prepare a couple of provisional targets like the one shown below. To prove accuracy it is recommended to follow the steps listed below.
3. Place a provisional target on the test rig and perform pre-shots to adjust of the gun(s). Repeat this step until all parameters (accuracy, velocity, rate of fire) are within the required limits. Replace the provisional target after each round if needed.
4. If the gun(s) are adjusted place the test item right behind the provisional target. Take care that the desired region of impact on the test item is placed behind the bullet holes in the provisional target (see drawing below).
5. Remove the provisional target and perform the live test.



**Figure. A-1: Example drawing of provisional target**

<b>ANNEX B      SPECIFICATIONS 12.7 MM AP PROJECTILES</b>
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Munition to be used to perform the Bullet Impact test according to this AOP (Methods 1 and 2) shall fulfill the following requirements.

- Size: 12.7 x 99 mm
- Weight of projectile: > 40 g (617.3 grain) and < 50 g (771.6 grain)
- Hardness of core: > 750 HV (61.2 HRC) or comparable
- Material of core: Steel
- May contain tracer: No
- May contain incendiary composition: No
- May contain pyrotechnics: No
- May contain high explosives: No

The following munitions fulfill the requirements above and are approved for use in context of this AOP.

Modell	Manufacturer	Weight of projectile	Hardness of core
DM51	n/a	About 618 grain About 40 g	n/a
M2 AP	Different	695 grain 45 g	780 HV 63.3 HRC
AP-M8	Different		

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<p><b>ANNEX C    HISTORICAL OVERVIEW</b></p>
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1. Several changes were made in this AOP compared to STANAG 4241 Ed. 2. The changes were worked out by an international working group at several meetings.
2. In opposite to STANAG 4241 Ed.2 now three different methods are allowed to perform the BI-Tests. The first method is equal to procedure 1 of STANAG 4241 Ed. 2. The second method (called primary alternative) allows one to perform the test with a single shot on the target. This method was introduced to examine the reaction of munition to an impact of a single bullet. One reason for this could be that the impact of three bullets in the small target area is of sufficient low probability. Another reason could be that the impact of the second and third bullet of a round would provide additional damage to the energetic material that was already damaged by the first bullet. So the reaction might be worsened by this. The third method is equal to procedure 2 of STANAG 4241 Ed. 2. The parameters of the test are determined by the results of the THA.
3. Annex A contains an example of a tool to proof accuracy of the guns(s) with pre-shots.
4. Parameters of bullets suitable to perform BI-Tests are listed in Annex B.

**AOP-4241(A)(1)**