NATO STANDARD

AEP-98

PRECISION ASSESSMENT OF NON-LETHAL KINETIC ENERGY WEAPONS AND AMMUNITION

Edition B, Version 1
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NATO LETTER OF PROMULGATION

15 July 2021

1. The enclosed Allied Engineering Publication AEP-98, Edition B, Version 1, PRECISION ASSESSMENT OF NON-LETHAL KINETIC ENERGY WEAPONS AND AMMUNITION which has been approved by the nations in the NATO ARMY ARMAMENTS GROUP (NAAG), is promulgated herewith. The agreement of nations to use this publication is recorded in STANAG 4744.

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Major General, GRC (A)
Director, NATO Standardization Office

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RECORD OF RESERVATIONS

CHAPTER	RECORD OF RESERVATION BY NATIONS
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RECORD OF SPECIFIC RESERVATIONS

[nation]	[detail of reservation]
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CHAPTER 1 INTRODUCTION

1.1. SCOPE

The scope of the document presented here is to define a precision test procedure for non-lethal (NL) kinetic-energy (KE) projectiles and weapons. The tests make no attempt to stipulate acceptance or rejection criteria (except possibly with regards to safety). Their purpose is to provide NATO and PfP countries, with all relevant test and analysis data to assist in appraisals of weapons and ammunition designs against the agreed requirements. As applicable, control weapons and ammunition will be used to provide comparative data. In the few instances where desirable performance figures are quoted in this manual, these are to be taken as a guide only.

The tests in this manual can be used not only for NATO tests, but also for purely national testing against particular national criteria. They would then give a basis of comparison with previous NATO testing and with other national testing based on this manual.

1.2. BOUNDARIES OF THE DOCUMENT

1.2.1. Weapon and ammunition

This manual covers testing of the following main categories of ammunition and weapons:

1. Weapons family

Categories of NLKE weapons taken into account in this manual are:
- Launcher with smooth barrel
- Launcher with rifled barrel

2. Munitions

The following NLKE munitions are taken into account:
- Single projectiles
- Multiple projectiles (pellets)

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CHAPTER 2 TEST FACILITY AND EQUIPMENT

This section describes the equipment to be used for the assessment of precision. Test facilities may use in-house test facilities, materials and equipment not specified by this document provided they specify those variations in their test report and provide evidence that when tested according to the methods in this procedure the results would still be valid. The NA shall determine the acceptability of the modified test procedure.

2.1. TEST FACILITY AND ARRANGEMENT

The test facility employed for the precision assessments shall be similar to those shown in Figure 1.

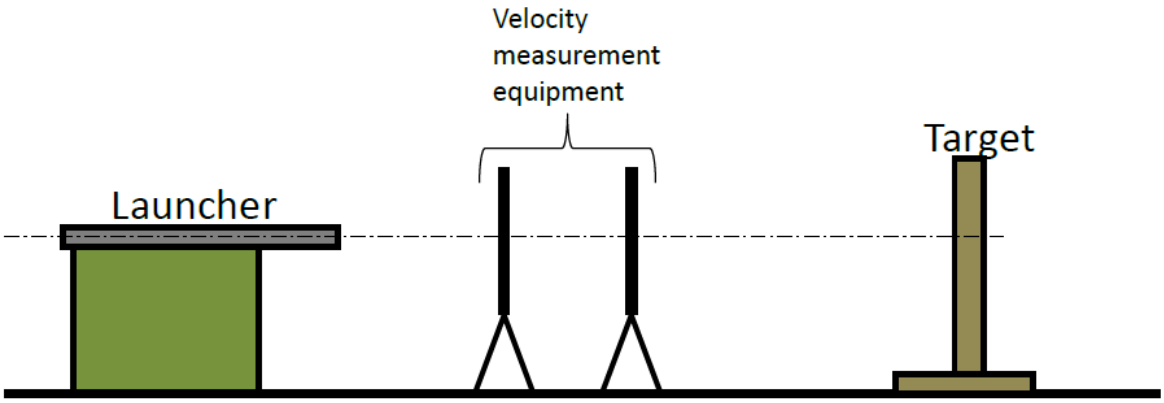

Figure 1 Example of experimental arrangement used for ballistic testing

2.1.1. Launching system

The test weapon/launcher shall be the original system or as close as possible. If for any reason (e.g. shooting distance, hit probability) the original system cannot be used, a proof barrel may be used. In this case, the National Authority has to verify that the impact conditions (velocity, yaw) are equivalent to the original system.

2.1.2. Support weapon mounting

In technical tests, test mounts will have to be used. Although ideally, for purposes of comparison, a common mount with fittings for each different weapon should be used, technical difficulties in achieving this may make it impractical.

2.1.3. Launcher to target distance

The launcher to target distance should be chosen based on the following parameters:

- User requirements
- Manufacturer's instructions

Several distances can be chosen in order to determine the run of the dispersion curve along the whole engagement distance.

2.1.4. Projectile velocity measurement system and method of correction

The velocity of each projectile shall be measured and if necessary corrected to give the striking velocity. Recommended measurements systems are:

- Doppler Radar
- Optical Screen
- High speed camera

When a velocity other than striking velocity is being measured, this will be corrected, using any method accepted by the National Authority, to allow for the distance between the point at which the velocity is measured and the point at which the projectile was expected to strike the target, using the velocity decrement, in order to give the striking velocity.

2.1.5. Target

The target should be of sufficient size to ensure that all impacts are captured. It is also recommended that the target is selected such that the projectile impact leaves a clean well-defined mark.
If an automatic target is used, it is to be capable of measuring position of strike with an error of less than 5 mm.

2.1.6. Wind

For outdoor shooting ranges: instruments for measuring wind velocity and direction are needed.

2.2. EQUIPMENT CALIBRATION

Before the start of the testing, it must be checked that all equipment is properly calibrated

2.3. AMMUNITION QUANTITY

The test should be performed by shooting a statistically relevant number of projectiles on the target, and measuring the output. The lowest level of confidence interval should be at least 90%. The National Authority should compute and document the statistical results.

CHAPTER 3 BALLISTIC TEST PROCEDURE

This chapter describes in chronological order the conditions, materials and test procedure to assess the precision of the NLKE weapon system at one distance.

3.1. OUTDOOR TESTING

The flight of the bullet is affected by the direction and velocity of the wind over an outdoor firing range. Therefore, judgement of the National Authority is required when testing outdoors.

3.2. TEST CARTRIDGE TEMPERATURE

Cartridges/projectiles shall be conditioned for a minimum of 24 hours at a specified temperature with a tolerance of ± 2°C.

3.3. PERFORMING THE TEST

The rounds can be fired continuously or in groups providing that the target system is capable of accurately discriminating the positions of strike of each projectile. If multiple targets are used, a common reference axis or a correction for different axis should be used.

3.4. MEASUREMENT OF RESULT AND CALCULATION

3.4.1. Single projectiles

For n shots, the distance between the center of each impact and the reference axis are to be measured and recorded.
The following values are to be calculated:
Mean point of impact for n shots

$$\overline{X} = \frac{1}{n}\sum_{i=1}^{n} X_i \text{ and } \overline{Y} = \frac{1}{n}\sum_{i=1}^{n} Y_i$$

Horizontal and vertical standard deviations for the n shots

$$S_x = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^2} \text{ and } S_y = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(Y_i - \overline{Y}\right)^2}$$

3.4.2. Multiple projectiles (pellets)

The spread of the pellet pattern is to be measured and recorded. The area A of the smallest circumscribed rectangle should be measured. The square root of A should be calculated.

3.4.3. Calculation of precision

Metrics described in sections 3.4.1 and 3.4.2 can be used in calculating precision. National Authority has to choose the appropriate statistical method in order to characterize precision as a function of these metrics.

3.4.4. Observation and records

For each assessment the following minimum observations are to be made and records kept.

- Target identification
- Shooting distance
- The date of testing
- The trial series number
- Ammunition conditioning temperature and duration
- Test area ambient conditions (wind, temperature, …)
- Details of the weapon/launcher (including condition)
- Details of the projectile used (type designation, manufacturer, batch or serial number, …)
- For each shot (only for single projectiles):
    - Shot number (traceable to the target)
    - Projectile velocity
    - The shot information shall be reported in the order fired
    - Impact location X_i and Y_i
- For each shot (only for multiple projectiles):
    - Shot number (traceable to the target)
    - Projectile velocity or projectiles velocities
    - The shot information shall be reported in the order fired
- The center and dimensions of the rectangle described in section 3.4.2
- All precision related measurements described in section 3.4.1 or section 3.4.2
- Striking velocity vs measured velocity

CHAPTER 4 REFERENCES

AC/225(LCG/2-SG/1)D/8. (n.d.). Manual of Proof and Inspection Procedures for NATO 5.56mm Ammunition (MOPI).

AC/225(LG/3-SG/1)D/14. (n.d.). Evaluation procedures for future NATO Small Arms Weapon Systems.

Wray, J., McNeil, J., & Rowe, W. (1983). Comparison of Methods for Estimating Range of Fire Based on the Spread of Buckshot Patterns. *JFSCA, 28*(4), 846-857.

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ANNEX A REVISION HISTORY

Various changes have been made to the document for consistency purposes between all AEPs.

1. Phraseology and format

AEP98 has been made consistent with AEP103 format regarding header, chapters, sections and table of contents and accordingly few sentences have been adapted.

2. Temperature

Period, temperature and tolerance on cartridge/projectile conditioning has been adapted in AEPS.

3. Number of shots

The number of shots/impacts adapted based on results of statistical relevance.

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