

NATO STANDARD

AOP-4509

**TECHNICAL PERFORMANCE
SPECIFICATION PROVIDING
FOR THE INTERCHANGEABILITY
OF 5.7 mm x 28 AMMUNITION**

Edition A, Version 1

DECEMBER 2020



NORTH ATLANTIC TREATY ORGANIZATION

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NATO LETTER OF PROMULGATION

4 December 2020

1. The enclosed Allied Ordnance Publication AOP-4509, Edition A, Version 1, TECHNICAL PERFORMANCE SPECIFICATION PROVIDING FOR THE INTERCHANGEABILITY of 5.7 mm x 28 AMMUNITION, which has been approved by the nations in the AC/225 NATO ARMY ARMAMENTS GROUP, is promulgated herewith. The agreement of nations to use this publication is recorded in STANAG 4509.
2. AOP-4509, Edition A, Version 1, is effective upon receipt.
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4. This publication shall be handled in accordance with C-M(2002)60.


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Brigadier General, HUNAF
Director, NATO Standardization Office

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<p style="text-align: center;">CHAPTER 1</p> <p style="text-align: center;">AMMUNITION INTERCHANGEABILITY PRINCIPLES</p>
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1. The aim of this standard is to standardize 5.7 mm x 28 Ammunition designs to ensure functional interchangeability between NATO Forces on the battlefield.
2. STANAG 4509 covers 5.7 mm x 28 combat ammunition. Ammunition natures other than these natures such as, blank or training cartridges, are outside the scope of STANAG/AOP-4509.
3. The following paragraphs in Chapter 2 amplify and interpret the essential NATO military characteristics and specify the technical performance requirements for designs of 5.7 mm x 28 ammunition submitted for NATO Qualification to ensure functional interchangeability.
4. Under the scope of this standard, interchangeability is understood if the ammunition is in conformance with the performance, functioning and safety criteria as detailed in AEP-97, the Multi-Calibre Manual of Proof and Inspection (MC-MOPI) procedures for 5.7 mm x 28 ammunition.
5. The ammunition shall function safely and with the specified performance out of all 5.7 mm x 28 NATO Nominated Weapons to provide direct evidence testing of battlefield interchangeability.
6. The ammunition shall comply with the specifications prepared by national government agencies, which as a minimum should be in accordance with AOP-4509 for the performance requirements (Chapter 2 & Annex B) and the referenced dimensions (Annex A).
7. Where appropriate, the ballistic levels cited in Chapter 2 are to be obtained from the standard proof barrels described in AEP-97, Multi-Calibre Manual of Proof and Inspection after correction using the NATO Reference Ammunition.
8. NATO Reference Ammunition shall be used to verify barrel ballistics characteristics and test equipment as defined in Volume 8 of AEP-97.
9. It should be noted that this standard by itself should not be used for acquisition purposes.

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<p style="text-align: center;">CHAPTER 2 TECHNICAL PERFORMANCE REQUIREMENTS FOR 5.7 mm x 28 AMMUNITION</p>

1. PRESSURE

(AEP-97, Volumes 12 & 13)

1a. For ammunition conditioned at + 21 °C, the corrected mean case mouth pressure plus 3 standard deviations shall not exceed 370 MPa. *(AEP-97, Volume 12)*

1b. For ammunition conditioned at + 52 °C or - 54 °C, the corrected mean case mouth pressure shall not vary from the corrected mean case mouth pressure of ammunition conditioned at + 21 °C by more than ± 40 MPa. *(AEP-97, Volume 12)*

1c. For ammunition conditioned at + 52 °C or - 54 °C, the corrected mean case mouth pressure plus 3 standard deviations shall not exceed 370 MPa. *(AEP-97, Volume 12)*

1d. For ammunition subjected to the climatic conditioning of Exposed Desert, Continuous Heating or Continuous Arctic, the corrected mean case mouth pressure plus 3 standard deviations shall not exceed 370 MPa. *(AEP-97, Volume 13)*

1e. For ammunition subjected to the climatic conditioning of Exposed Desert, Continuous Heating or Continuous Arctic, the mean case mouth pressure of the treated ammunition shall not vary from the mean case mouth pressure of the untreated ammunition by more than ± 45 MPa. *(AEP-97, Volume 13)*

2. VELOCITY

(AEP-97, Volumes 12 & 13)

2a. For ammunition conditioned at + 52 °C or - 54 °C, the corrected mean velocity shall not vary from the corrected mean velocity of ammunition conditioned at + 21 °C by more than ± 30 m/s. *(AEP-97, Volume 12)*

2b. For ammunition subjected to the climatic conditioning of Exposed Desert, Continuous Heating or Continuous Arctic, the mean velocity of the treated ammunition shall not vary from the mean velocity of the untreated ammunition by more than ± 20 m/s. *(AEP-97, Volume 13)*

3. ACTION TIME

(AEP-97, Volumes 12 & 13)

3a. For ammunition conditioned at - 54 °C, the mean plus 5 standard deviations shall not exceed 2 ms. (AEP-97, Volume 12)

3b. For ammunition subjected to the climatic conditioning of Exposed Desert, Continuous Heating or Continuous Arctic and then conditioned at - 54 °C, the mean action time plus 5 standard deviations shall not exceed 2 ms. (AEP-97, Volume 13)

4. FUNCTION AND CASUALTY

(AEP-97, Volume 11 & 14)

The ammunition shall perform satisfactorily in the NATO Nominated Weapons listed in AEP-97, Volume 10 when fired in accordance with the test requirements defined in AEP-97, Volume 11 at temperatures (+21 °C, -54 °C and +52 °C). The Function and Casualty firing defects shall not exceed the permitted number defined in the relevant table in AEP-97, Volume 14 for any NATO Nominated Weapon type.

5. ENVIRONMENTAL REQUIREMENTS

(AEP-97, Volumes 12, 13 & 14)

5a. Compliance with the requirements for performance after temporary heating or cooling will be tested by conditioning the ammunition to + 52 °C and – 54 °C and firing the ammunition at those temperatures. (AEP-97, Volumes 12 & 14)

5b. Compliance with the requirements for performance after prolonged climatic storage will be tested by exposure of the ammunition to appropriate intensified storage cycles and subsequent firing of the ammunition at + 21 °C (- 54 °C for action time). (AEP-97, Volume 13)

6. BARREL EROSION

(AEP-97, Volume 16)

Ammunition with all metal bullets, excluding tracer ammunition, shall be free from design features which render barrels unserviceable because of erosion in less than 5000 rounds while meeting both the bullet yaw criteria and the velocity drop criteria.

6a. Bullet Yaw Criteria - No more than 20 % of bullets in any 100 round group of consecutive shots may show keyholing (yaw exceeding 15° at 25 metres).

6b. Velocity Drop Criteria - The average velocity drop shall be less than 60 m/s at 25 metres when compared to the initial velocity level obtained at the start of the test.

7. FOULING

(AEP-97, Volumes 14 & 16)

The ammunition shall be designed to avoid excessive fouling. Satisfactory functioning in the Barrel Erosion Test on prolonged firing and in the Function and Casualty Test in the NATO Nominated Weapons shall be used as a criterion. If fouling is considered excessive, it will be investigated and recorded by the Test Centre in its report for consideration by appropriate NATO authorities.

8. SMOKE AND FLASH

(AEP-97, Volumes 17)

The ammunition shall be designed to avoid excessive smoke and flash. Observation of these features will be performed during the Barrel Erosion Test and the Function and Casualty Test in the NATO Nominated Weapons. If a standard of comparison is required, this will be provided by the performance of the reference ammunition. If either smoke or flash is considered excessive, the Test Centre will record this in its report for consideration by appropriate NATO authorities.

9. PRECISION

(AEP-97, Volume 18)

When fired from a precision barrel at a range of 100 metres, the pooled mean of the vertical standard deviations and the pooled mean of the horizontal standard deviations from all targets shall be 40 mm or less for all metal bullets and 50mm or less for all tracer bullets.

10. TERMINAL EFFECTS

(AEP-97, Volume 19)

A projectile containing inert materials shall completely perforate six (6) mild steel plates of 1 mm nominal thickness, as defined in AEP-97, when fired to the multiple steel plate target as defined in AEP-97, placed at 100 metres from the muzzle at zero degree obliquity (normal to the line of fire). The ammunition shall be considered to have met the NATO requirement if no less than 90 % of the projectiles meet the conditions for terminal effects.

11. TRAJECTORY MATCH

(AEP-97, Volume 20)

11a. At 50 metres, the mean point of impact for all natures of ammunition must not deviate from the mean point of impact of the reference cartridge more than 30 mm vertically and 25 mm horizontally.

11b. At 100 metres, the mean point of impact for all natures of ammunition must not deviate from the mean point of impact of the reference cartridge more than 70 mm vertically and 50 mm horizontally.

12. TRACER PERFORMANCE

(AEP-97, Volume 21)

12a. Trace Distance - No less than 80% of the tracer ammunition shall be visible by 20 metres and shall maintain continuous visibility between 20 metres and a minimum of 150 metres.

12b. Trace Quality - No less than 80% of the tracer ammunition tested shall exhibit a continuous trace of satisfactory quality throughout its visible range. The requirement applies to daylight visibility conditions in which it is reasonable to expect satisfactory observation of trace.

12c. For ammunition subjected to the climatic conditioning of Exposed Desert, Continuous Heating or Continuous Arctic, a minimum percentage of 70% of the treated tracer ammunition shall meet the Trace Distance and Trace Quality requirements listed above. *(AEP-97, Volume 13)*

13. RESIDUAL STRESS

(AEP-97, Volume 22)

No brass cartridge case shall display either splits or cracks when subjected to the Residual Stress Test, except as permitted in "1" area of the case in accordance with the technical parameters of AEP-97. A split is defined as a separation of the metal entirely through the wall of the case. A crack is a surface condition and represents a separation of the metal not entirely through the case wall.

14. PRIMER SENSITIVITY

(AEP-97, Volume 23)

When tested by a run-down method, using a ball of 55 g, the mean height of fire (H) and standard deviation shall meet the following requirements:

14a. $H + 5$ standard deviations shall be less than or equal to 355 mm.

14b. $H - 2$ standard deviations shall be greater than or equal to 75 mm.

15. BULLET EXTRACTION

(AEP-97, Volume 24)

The force required to extract the bullet from the cartridge shall not be less than 200 newtons.

16. PROPELLANT AND PRIMER MIX COMPOSITION

(AEP-97, Volume 25)

NATO does not specify the chemical composition for propellant or primer composition contained in ammunition submitted for NATO qualification. However, once acceptability of an ammunition design is established and the design is qualified, then all subsequent production of that ammunition design, which bears the NATO Symbol of Interchangeability on the basis of that qualification, must contain the same propellant and primer composition as were identified in the Qualification Approval sample.

17. WATERPROOF

(AEP-97, Volume 26)

The ammunition shall be considered to have met the waterproof requirement if no more than fifteen percent (15%) of the cartridges tested display leaks in accordance with the technical parameters of AEP-97.

18. PACKAGING AND STORAGE – CAPABILITY OF WITHSTANDING TRANSPORTATION

18a. NATO ammunition shall be produced from materials and using processes which assure a long shelf life. Ammunition shall be packaged in waterproof containers sufficiently rugged to withstand service use.

18b. Ammunition will not be specifically tested to assess these features. However, when NATO ammunition is assessed for compliance with transportation and rough-handling requirements, the assessment shall be of ammunition in its complete tactical pack.

19. MARKING

NATO ammunition and its packaging shall be marked in accordance with AOP-2.

20. QUALIFICATION OF OTHER DESIGNS

This standard is structured to ascertain an ammunition's design in order for it to be interchanged on the battlefield among NATO and Partner Member Forces. While this standard is only structured for conventional cartridges, however, other designs may also be submitted for NATO Qualification Approval. These designs will only be assessed to the requirements described within the standard but upon successful qualification will allow the NATO Member Forces to apply the NATO Symbol of Interchangeability to these other ammunition designs thereby increasing the logistical stockpile available in theater. However, should it be determined by higher NATO authority that an additional requirement should be pursued, the NATO body implementing this standard will formulate appropriate requirements and tests to assess suitability of the design to those new requirements.

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ANNEX A - 5.7 mm x 28 STANDARDIZATION DRAWINGS

A.1. SHEET 1 – 5.7 mm x 28 CARTRIDGE & CASE DIMENSIONS

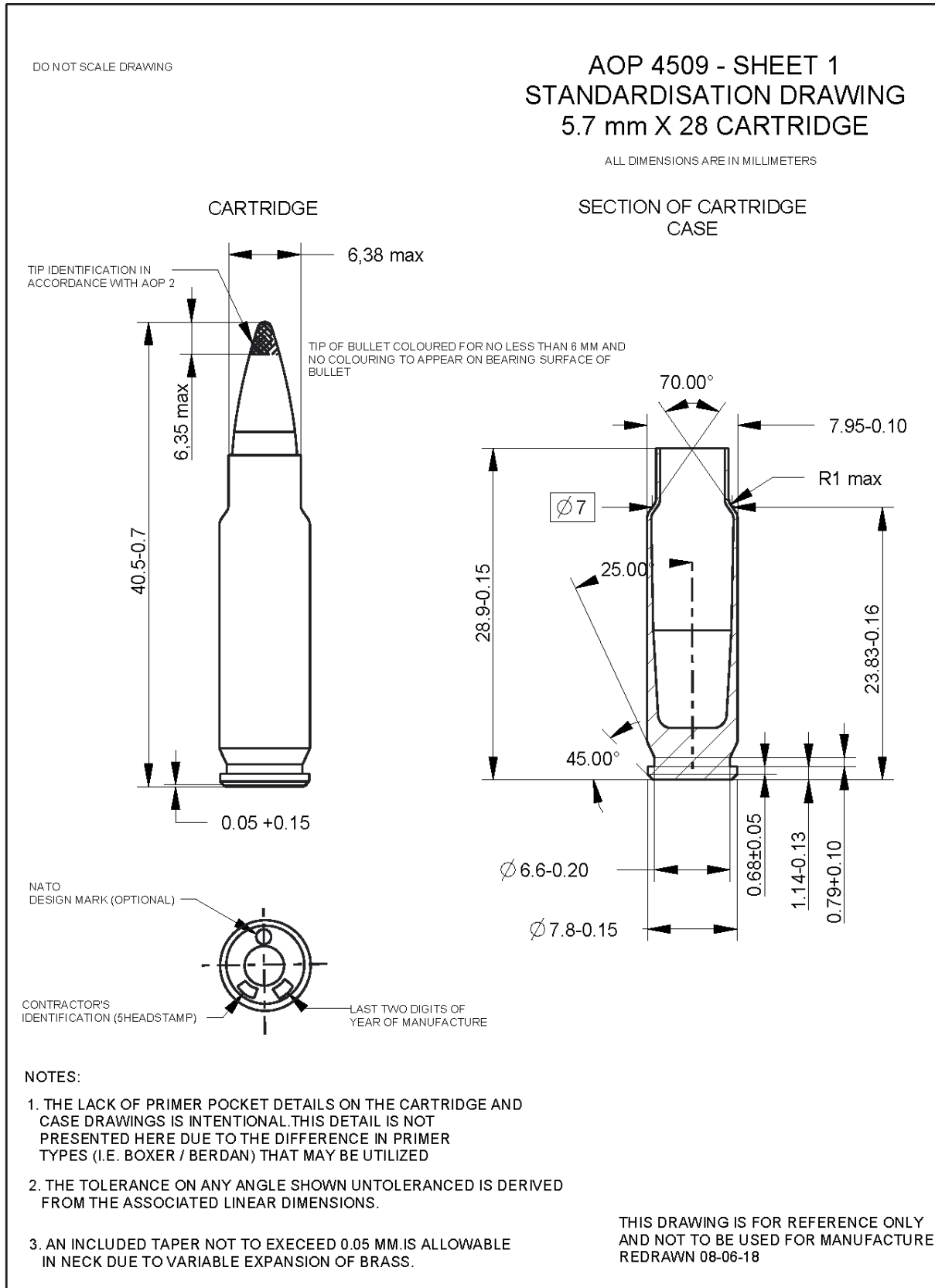
A.2. SHEET 2 – 5.7 mm x 28 PROOF WEAPON CHAMBER & BARREL

Please note the following:

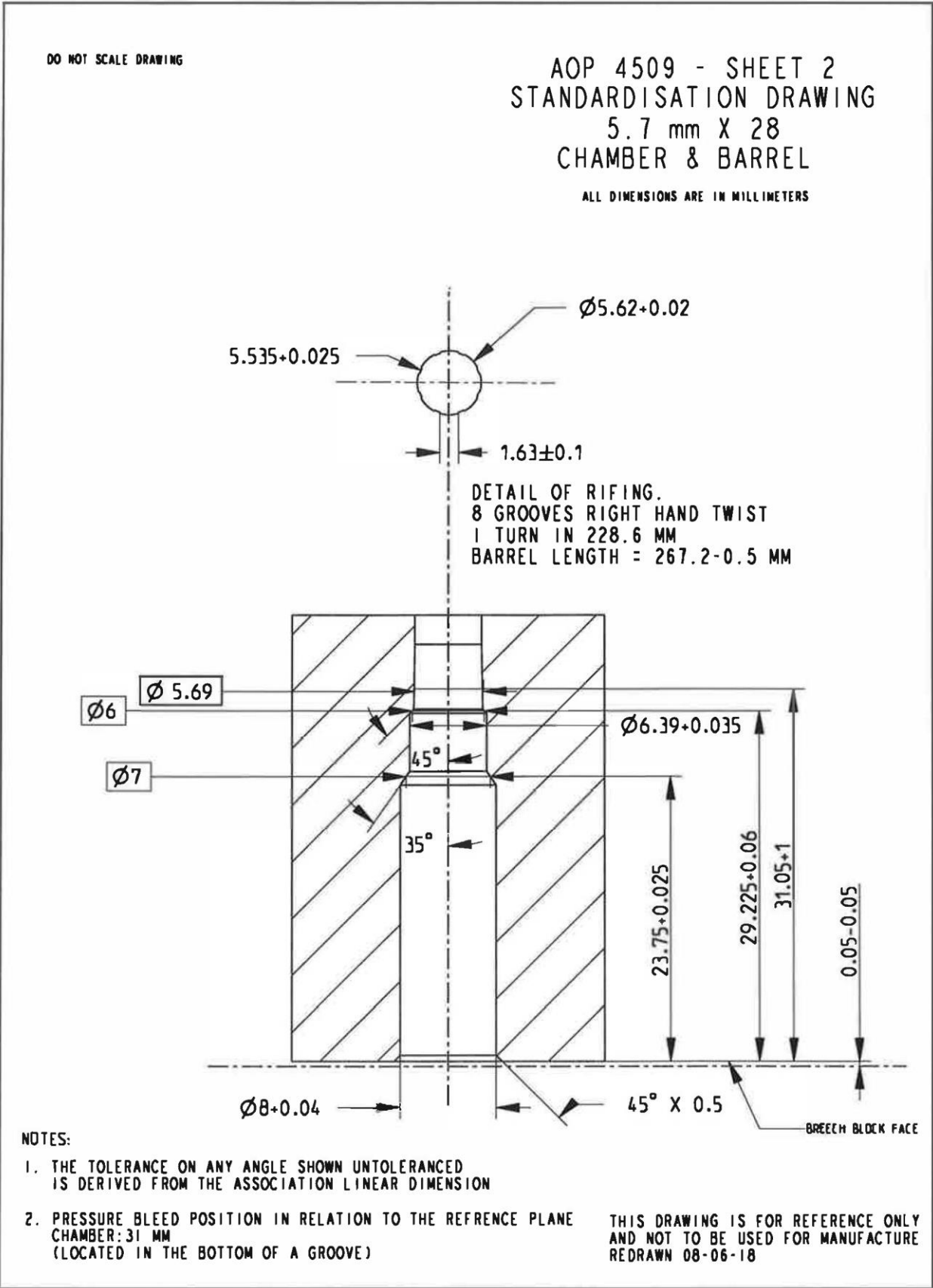
Note 1: The drawings are for reference only and are NOT to be used for manufacture, dimensions are for guidance only. Please refer to drawing published in AEP-97, Volume 6 – NATO Test Equipment and Visual Standards.

Note 2: Deviations are allowed if all other requirements of AEP-97 (incl. functioning in the NATO Nominated Weapons) are met.

A.1. SHEET 1 – 5.7 mm x 28 CARTRIDGE



A.2. SHEET 2 – 5.7 mm x 28 PROOF WEAPON CHAMBER & BARREL



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ANNEX B – 5.7 mm x 28 REQUIREMENTS TABLE

- B.1. SHEET 1 – 5.7 mm x 28 REQUIREMENTS TABLE**
B.2. SHEET 2 – 5.7 mm x 28 REQUIREMENTS TABLE (cont.)
B.3. SHEET 3 – 5.7 mm x 28 REQUIREMENTS TABLE (cont.)

PARA. #	PERFORMANCE REQUIREMENTS	TEMP	VALUES	UNITS	AEP-97 VOL. #
CASE MOUTH PRESSURE					
--	Maximum Corrected Mean Case Mouth Pressure	+21 °C	No Requirement	MPa	12
1ba	Maximum Corrected Mean Case Mouth Pressure + 3 Std Dev	+21 °C	370	MPa	12
1b & 5a	Maximum Mean Case Mouth Pressure Δ from +21° C sample	+52 °C	+40 to -40	MPa	12
1b & 5a	Maximum Mean Case Mouth Pressure Δ from +21° C sample	-54 °C	+40 to -40	MPa	12
--	Maximum Corrected Mean Case Mouth Pressure	+52 °C	No Requirement	MPa	12
--	Maximum Corrected Mean Case Mouth Pressure	-54 °C	No Requirement	MPa	12
1c & 5a	Maximum Corrected Mean Case Mouth Pressure + 3 Std Dev	+52 °C	370	MPa	13
1c & 5a	Maximum Corrected Mean Case Mouth Pressure + 3 Std Dev	-54 °C	370	MPa	13
--	Maximum Corrected Individual Case Mouth Pressure	+52 °C	No Requirement	MPa	12
--	Maximum Corrected Individual Case Mouth Pressure	-54 °C	No Requirement	MPa	12
1d & 5b	Maximum Corrected Mean Case Mouth Pressure + 3 Std Dev	AEP-97	370	MPa	13
1e & 5b	Maximum Δ between Mean of Treated & Untreated Samples	AEP-97	+45 to -45	MPa	13
PORT PRESSURE					
--	Minimum Corrected Mean Port Pressure – 3 Std Dev	+21 °C	No Requirement	MPa	12
--	Maximum Mean Port Pressure Δ from +21° C sample	+52 °C	No Requirement	MPa	12
--	Maximum Mean Port Pressure Δ from +21° C sample	-54 °C	No Requirement	MPa	12
--	Minimum Corrected Mean Port Pressure – 3 Std Dev	+52 °C	No Requirement	MPa	12
--	Minimum Corrected Mean Port Pressure	-54 °C	No Requirement	MPa	12
VELOCITY					
2a & 5a	Maximum Mean Velocity Δ from +21° C sample	+52 °C	+30 to -30	m/s	12
2a & 5a	Maximum Mean Velocity Δ from +21° C sample	-54 °C	+30 to -30	m/s	12
2b & 5b	Maximum Δ between Mean of Treated & Untreated Samples	AEP-97	+20 to -20	m/s	13
ACTION TIME					
--	Maximum Individual Action Time	+21 °C	No Requirement	ms	12
3a	Maximum Mean Action Time + 5 Standard Deviation	-54 °C	2	ms	12
3b & 5b	Maximum Mean Action Time + 5 Standard Deviation	-54 °C	2	ms	13
FUNCTION & CASUALTY					
4 & 5a	The ammunition shall perform satisfactorily in the NATO Nominated Weapons when fired the Function and Casualty firing defects shall not exceed the permitted number defined in the relevant table in AEP-97, Volume 14 for any NATO Nominated Weapon type.	+21 °C - 54 °C +52 °C	per AEP-97	--	11 & 14
LINKED AMMUNITION					
--	NATO Chute ¹	--	No Requirement	--	15
--	Free Hanging ¹	AEP-97	No Requirement	--	14
--	Free Helical Flexibility	+21 °C	No Requirement	--	15
--	Free Fanwise Flexibility	+21 °C	No Requirement	--	15
--	Belt Strength (and Firing)	+21 °C	No Requirement	--	15
--	Free Hinging	+21 °C	No Requirement	--	15
--	Cartridge and Link Extractor Pull	--	No Requirement	--	15
--	Cartridge Stripping	--	No Requirement	--	15
--	Dimensional Characteristics	--	No Requirement	--	15
--	Visual Inspection	--	No Requirement	--	15
--	Salt Corrosion Test	--	No Requirement	--	15
<i>Note ¹ Test is conducted and sentenced as part of the Function and Casualty Test</i>					

B.1. SHEET 1 – 5.7 mm x 28 REQUIREMENTS TABLE

B.2. SHEET 2 – 5.7 mm x 28 REQUIREMENTS TABLE (cont.)

PARA. #	PERFORMANCE REQUIREMENTS	TEMP	VALUES	UNITS	AEP-97 VOL. #
BARREL EROSION					
6	Ammunition with all metal bullets, excluding tracer ammunition, shall be free from design features which render barrels unserviceable because of erosion in less than 5000 rounds while meeting both the bullet yaw criteria and the velocity drop criteria.				
6a	Bullet Yaw Exceeding 15° @ 25 m (Less than 20 % of bullets in any 100 round group of consecutive shots show keyholing)	+5°C to +30°C	≤ 20%	--	16 - ANNEX B
6b	Velocity Drop of 60 m/s or less @ 25 m (An average velocity drop of 60 m/s or less below the initial velocity level obtained at the start of the test)	+5°C to +30°C	≤ 60	m/s	16 - ANNEX B
FOULING					
7	The ammunition shall be designed to avoid excessive fouling. Satisfactory functioning in the Barrel Erosion Test on prolonged firing and in the Function and Casualty Test in the NATO Nominated Weapons shall be used as a criterion.	per AEP-97	--	--	14 & 16
SMOKE AND FLASH					
8	The ammunition shall be designed to avoid excessive smoke and flash. Observation of these features will be performed during the Barrel Erosion Test and the Function and Casualty Test in the NATO Nominated Weapons.	per AEP-97	--	--	17
PRECISION					
5.7 mm All Metal bullets @ 100m					
9	Horizontal Standard Deviation	+21 °C	≤ 40	mm	18
9	Vertical Standard Deviation	+21 °C	≤ 40	mm	18
5.7mm Tracer bullets @ 100m					
9	Horizontal Standard Deviation	+21 °C	≤ 50	mm	18
9	Vertical Standard Deviation	+21 °C	≤ 50	mm	18
TERMINAL EFFECTS					
10	A projectile containing inert materials shall completely perforate six (6) mild steel plates (1 mm thickness) @ 100 m from the muzzle. At least one splinter shall perforate a 0.5 mm witness plate 300 mm behind the mild steel plate.	0°C to +35°C	≥ 90%	--	19
10a	Muzzle Energy @ the muzzle (For Info Only)	+21 °C	Min: 430	J	12
--	Muzzle Energy @ 24m from the muzzle (For Info Only)	+21 °C	Min: 381	J	12
--	Bullet Mass	--	No Requirement	g	12
TRAJECTORY MATCH					
Mean Point of Impact (MPI) @ 50 m					
11a	MPI Δ Vertical from NATO Ref MPI	+21 °C	≤ 30	mm	20
11a	MPI Δ Horizontal from NATO Ref MPI	+21 °C	≤ 25	mm	20
Mean Point of Impact (MPI) @ 100 m					
11b	MPI Δ Vertical from NATO Ref MPI	+21 °C	≤ 70	mm	20
11b	MPI Δ Horizontal from NATO Ref MPI	+21 °C	≤ 50	mm	20

B.3. SHEET 3 – 5.7 mm x 28 REQUIREMENTS TABLE (cont.)

PARA. #	PERFORMANCE REQUIREMENTS	TEMP	VALUES	UNITS	AEP-97 VOL. #
TRACER PERFORMANCE					
<i>Trace Distance</i>					
--	The tracer shall be dim or invisible from the muzzle to at least 13m.	+21 °C	No Requirement	--	21
12a	The tracer shall be visible by 20 m.	+21 °C	≥ 80%	--	21
12a	The tracer shall maintain continuous visibility between 20 m and a minimum of 150 m.	+21 °C	≥ 80%	--	21
5b & 12c	After the ammunition has been subjected to Climatic Conditioning the minimum percentage of the treated sample that shall meet the Trace Distance requirements	+21 °C	≥ 70%	--	21
<i>Trace Quality</i>					
12b	The tracer ammunition tested shall exhibit a continuous trace of satisfactory quality throughout its visible range. The requirement applies to daylight visibility conditions in which it is reasonable to expect satisfactory observation of trace.	+21 °C	≥ 80%	--	21
5b & 12c	After the ammunition has been subjected to Climatic Conditioning the minimum percentage of the treated sample that shall meet the Trace Distance requirements	+21 °C	≥ 70%	--	21
RESIDUAL STRESS					
13	Brass cased ammunition shall be free from harmful residual stress.	+21 °C	0 Splits 0 Cracks	--	22
PRIMER SENSITIVITY (with 55 g ball)					
14a	Mean Height (H) + 5 Standard Deviation	+21 °C	≤ 355	mm	23
14b	Mean Height (H) - 2 Standard Deviation	+21 °C	≥ 75	mm	23
BULLET EXTRACTION					
15	The force required to extract the bullet from the cartridge	+21 °C	≥ 200	N	24
PROPELLANT AND PRIMER MIX COMPOSITION					
16	NATO does not specify the chemical composition for propellant or primer composition contained in ammunition submitted for NATO qualification. Once acceptability of an ammunition design is established and the design is qualified, then all subsequent production of that ammunition design, which bears the NATO Symbol of Interchangeability on the basis of that qualification, must contain the same propellant and primer composition as were identified in the Qualification Approval sample.	--	National Requirement	--	25
WATERPROOF					
17	The ammunition shall be considered to have met the waterproof requirement if not more than 15 % of the cartridges tested display leaks.	+21 °C	≤ 15%	--	26
5b & 17	After the ammunition has been subjected to Climatic Conditioning the maximum permitted percentage of the treated sample displaying leaks of any type.	+21 °C	≤ 15%	--	26
PACKAGING AND STORAGE – CAPABILITY OF WITHSTANDING TRANSPORTATION					
18a	NATO ammunition shall be produced from materials and using processes which assure a long shelf life. Ammunition shall be packaged in waterproof containers sufficiently rugged to withstand service use.	--	National Requirement	--	--
18b	Ammunition will not be specifically tested to assess these features. However, when NATO ammunition is assessed for compliance with transportation and rough-handling requirements, the assessment shall be of ammunition in its complete tactical pack.	--	National Requirement	--	--
MARKING					
19	NATO ammunition and its packaging shall be marked in accordance with AOP-2.	--	National Requirement	--	--

AOP-4509(A)(1)