NATO STANDARD

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NON-BALLISTIC TEST METHODS AND EVALUATION CRITERIA FOR COMBAT HELMETS

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NORTH ATLANTIC TREATY ORGANIZATION

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NATO LETTER OF PROMULGATION

6 February 2019

1. The enclosed Allied Engineering Publication AEP-2902, Edition A, Version 1, NON-BALLISTIC TEST METHODS AND EVALUATION CRITERIA FOR COMBAT HELMETS, which has been approved by the nations in the NATO ARMY ARMAMENTS GROUP, is promulgated herewith. The agreement of nations to use this publication is recorded in STANAG 2902.

2. AEP-2902, 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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RECORD OF RESERVATIONS

CHAPTER	RECORD OF RESERVATION BY NATIONS

Note: The reservations listed on this page include only those that were recorded at time of promulgation and may not be complete. Refer to the NATO Standardization Document Database for the complete list of existing reservations.

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RECORD OF SPECIFIC RESERVATIONS

[nation]	[detail of reservation]
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ABBREVIATION LIST

AEP	Allied Engineering Publication
ASTM	American Society of Testing and Materials
BFD	Back Face Deformation
BHBT	Behind Helmet Blunt Trauma
CoG	Centre of Gravity
CoM	Centre of Mass
DCC	Dismounted Close Combat
DoM	Date of Manufacture
DRI	Detect, Recognise, Identify
EOD	Explosive Ordnance Disposal
FoV	Field of View
g	Acceleration due to gravity
HBS	Head Borne Systems
HML	Head Mounted Load
HIC	Head Injury Criterion
IFF	Identification Friend of Foe
IRR	Infra-Red Reflectance
J	Joules
Kg	Kilograms
MEP	Modular Elastomer Pad
MgCI2I	Magnesium Di-Chloride Iodine
mm	Millimetre
NA	National Authority
NaCl	Sodium Chloride
NATO	North Atlantic Treaty Organisation
NVD	Night Vision Device
NSO	NATO Standardization Office
PPE	Personal Protective Equipment
PTFE	Polytetrafluoroethylene
QR	Quick Response
RFID	Radio-Frequency Identification
s	Second
STANAG	Standardisation Agreement
VA	Visual Awareness

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CHAPTER 1 INTRODUCTION

1.1. NON-BALLISTIC TEST METHODS AND EVALUATION CRITERIA FOR COMBAT HELMETS

1.1.1 Aim

a. The aim of this agreement is to assist in the design and development of NATO combat helmets to provide non-ballistic protection to the wearer (and may also offer ballistic protection, see Section 2).

b. This agreement will establish common test methods, evaluation criteria, standards and performance for the assessment and selection of combat helmets.

c. This will allow NATO nations to specify common elements of helmet design and performance; leading to the procurement of helmets that achieve NATO agreed test methods or performance, and allow interoperability of helmets and associated ancillary (helmet mounted) equipment.

1.1.2 Normative References

a. STANAG 2333 Edition 4 - Performance and Protective Properties of Combat Clothing.

b. STANAG 2920 Edition 3 - Procedures for the Evaluation and Classification of Personal Armour - Bullet and Fragmentation Threats.

c. STANAG 4694 Edition 1 - NATO Accessory Rail.

d. STANAG 2129 / ATP-91 Edition A Version 1 - Identification of Land Forces on the Battlefield and In An Area of Operation.

e. ATP-91 Edition A Version 1 - Identification of Land Forces on The Battlefield and in an Area of Operation.

f. BSI BS 6658:1985 - Specification for Protective Helmets for Vehicle Users.

g. EN 960:2006 - Headforms for Use in the Testing of Protective Helmets (unless otherwise stated).

h. EN 397:2012+A1:2012 - Industrial Safety Helmets.

i. EN ISO 15025:2002 - Protective Clothing - Protection Against Flame - Method of Test for Limited Flame Spread.

j. ASTM D 6413 (2015) - Standard Test Method for Flame Resistance of Textiles (Vertical Test).

k. PSDB Protective Headwear Standard for UK Police (2004) Public Order Helmet.

l. EN 966:2012 - Helmets for airborne sports.

m. EN 13087-4:2012 - Protective Helmets. Test Methods. Part 4: Retention Systems Effectiveness.

n. EN 13087-5 - Protective Helmets. Test Methods. Part 4: Retention Systems Strength.

o. EN ISO 2409:2013 - Paints and Varnishes - Cross-Cut Test.

p. EN 12492:2012 - Mountaineering Equipment - Helmets for Mountaineers - Safety Requirements and Test Methods.

q. ASTM D 3359 (2017) - Standard Test Methods for Rating Adhesion by Tape Test.

r. ECE R22.05 (2002) - Uniform Provisions Concerning the Approval of Protective Helmets and Their Visors for Drivers and Passengers of Motor Cycle and Mopeds.

1.2. SCOPE

a. This document covers aspects of non-ballistic test methods and evaluation criteria required to specify (in-whole of in-part) a combat helmet.

b. A number of helmet design requirements are detailed within this document, with the exception of the following:

(1) Ballistic test standards and methods;

(2) Behind Helmet Blunt Trauma (BHBT) test standards and methods;

(3) Back Face Deformation (BFD) test standards and methods;

(4) Visual pattern or multi-spectral camouflage emissivity.

c. The excluded requirements are included in STANAG 2920 Edition 3, (1-3, above), and National Authority (NA) requirements (4, above).

d. The roles within the scope of this document include:

(1) Dismounted;

(2) Mounted;

(3) Parachutist;

(4) Public order;

(5) Engineering;

(6) Maritime.

e. The roles that are outside of the scope of this document includes:

(1) Mountaineering;

(2) Explosive Ordnance Disposal (EOD);

(3) Aviation;

(4) Quad biking;

(5) Motorcycle;

f. The components of the combat helmet that this AEP covers, includes:

(1) Cover (material, flammability, signature/camouflage);

(2) Shell;

(3) Energy absorbing liner/pad;

(4) Comfort adjustment;

(5) Harness;

(6) Chin straps;

(7) Visor;

(8) Mandible guard;

(9) External mounting/rail accessories.

g. The following table serves to aide in the identification of relevant chapters of this document that are recommended to be followed for the evaluation of role specific helmets:

Chapter	Dismount	Mounted	Parachutist	Public Order	Engineering	Maritime
4 – Blunt Impact Protection						
4.1.1 – Linear Blunt Impact	■	■	■	■	■	■
4.1.2 – Rotational Blunt Impact						
4.1.3 – Visor Blunt Impact	■	■		■		
4.1.4 – Mandible Guard Blunt Impact	■	■		■		
5 – Resistance to Penetration	■	■	■	■	■	■
6 – Musculoskeletal Pain or Injury						
6.2 – Test Method	■	■	■			
7 – Structural Rigidity						
7.2 – Option 1 Test Procedure	■	■	■	■	■	■
7.3 – Option 2 Test Procedure	■	■	■	■	■	■
8 – Retention and Stability						
8.2.1 – Dynamic Loading Method	■	■	■	■		■
8.2.2 – Static Loading Method	■	■	■	■		■
8.3 – Stability	■	■	■	■		■
8.4 – Bucketing						■
8.5 – Ease of Release	■	■	■	■	■	■
9 – Helmet Coverage						
9.2.1 – Full Helmet Shell	■	■	■	■	■	■
9.2.2 – High-Cut Helmet Shell	■	■	■	■	■	■
9.2.3 – Facial Protection	■	■		■		
10 – Helmet Cover						
10.3 – Features	■	■	■	■	■	■
11 – Helmet Mounts						
11.1.1 – Front Shroud/Mount	■	■	■	■	■	■
11.1.2 – Side Rail/Mount	■	■	■	■	■	■
11.1.3 – Hook and Loop	■	■	■	■	■	■
12 – Snag Hazard						
12.2 – General Use	■	■	■	■	■	■
12.3 – Parachuting			■			
13 – Age and Environmental Testing						
13.2 – Heat Distortion	■	■	■	■	■	■
13.3 – Temperature Shock	■	■	■	■	■	■
13.4 – Altitude Test	■	■	■	■	■	■
13.5 – Vibration	■	■	■	■	■	■
14 – Helmet Marking	■	■	■	■	■	■
15 – Flammability Testing						
15.2 – Helmet Flammability Liquid Trap	■	■	■	■	■	■
15.3 – Helmet Flame Test	■	■	■	■	■	■
15.4 – Helmet Cover Vertical Flame Test	■	■	■	■	■	■
15.5 – Helmet Ancillary Flame Test	■	■	■	■	■	■
16 – Primary Blast Durability	■	■				
17 – Combat Identification	■	■	■	■		■
18 – Human Factors	■	■	■	■	■	■
19 – Paint Adhesion	■	■	■	■	■	■

1.3 ACKNOWLEDGEMENTS

a. Thank you to Gentex Corporation for the supply of images and designs, as well as Major Johno Breeze and Colonel Peter Mahoney (Royal Centre for Defence Medicine, UK) for the coverage information; included in ANNEX B and Chapter 9, respectively.

CHAPTER 2 SIGNIFICANCE, USE AND LIMITATIONS

2.1 SIGNIFICANCE AND USE

a. The non-ballistic test procedures, criteria and method of designation described in this document apply to combat helmets and/or components thereof intended for use in the roles stated in 1.2.d.

b. The test procedures described can equally be used for research and development, qualification of materials or designs, and in the procurement of new equipment.

2.2 LIMITATIONS

a. This AEP covers only the non-ballistic test methods and classification of the performance of combat helmets.

b. Ballistic performance, including associated testing of bullets and fragments are detailed in STANAG 2920 Classification of Personal Armour Systems.

c. Where specified, classifications are attributed to helmets under varying environmental conditions. e.g. “hot, wet, cold”. It is strongly recommended that helmets are tested at these conditions, plus extremes that are representative of the likely environment where the combat helmets will be used. The NA will define these conditions.

d. Test methods and conditions are defined and may be used to establish/determine the extent of performance degradation of combat helmets after short time exposure to higher/lower temperatures, wet conditions (ANNEX A), and following mechanical testing.

e. This document does not specify any details of the construction or management of the test facility.

f. The non-ballistic testing of a product may require the use of materials and/or equipment that could be hazardous. This document does not address the safety aspects associated with their use. It is the responsibility of the test facility using this procedure to establish appropriate health and safety practices and to determine the applicability of any regulatory requirements (that may vary between nations) prior to testing commencing.

g. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable national laws and regulations, unless a specific exemption has been obtained.

h. These procedures and criteria may be updated as further data become available.

i. Compliance with this STANAG does not certify the adequacy of helmets to meet regulations for use on public roads or competitive events, by vehicle users.

CHAPTER 3 TEST FACILITY, CALIBRATION AND EQUIPMENT

3.1 OVERVIEW

a. This chapter describes the requirements for the equipment to be used for non-ballistic testing.

b. The equipment shall meet the criteria described in this procedure. Before the start of the testing all equipment used shall be checked (correct function, inspection, calibration status, etc.) and when necessary shall be re-calibrated.

c. The test facility/facilities employed shall provide the equipment necessary to meet the requirements stated in the following chapters.

d. The test facility/facilities will make available, at request, copies of the relevant calibration certification and proof of accreditation to the relevant international test standards.

e. All measurements are in metric units, millimetres (mm) and grams (g), unless otherwise stated.

3.2 TEST EQUIPMENT

a. Table 1 summarises the equipment and ancillary measurement devices required by test facilities for each test applicable criterion.

Test	Equipment	Comments
Blunt Impact (Helmet)	EN 960:2006 Uni-axial accelerometer FMVSS No 218, S12.6.1	Headforms
Blunt Impact (Helmet)	BSI BS 6658:1985 Appendix F test equipment EN 397:2012+A1:2012 test equipment ECE R22.05 test equipment FMVSS No 218, S7.1.8	Drop tower and supporting assembly
Blunt Impact (Visors)	Hemispherical steel impactor of radius 25 mm and mass of 1 kg	
Resistance to Penetration	BSI BS 6658:1985 Appendix G	
Impactors/anvils	Flat, hemispherical, spherical, kerb stone	
Flammability test	EN ISO 15025:2002 ASTM D 6413 (2015) PSDB Protective Headwear Standard for UK Police (2004) Public Order Helmet	
Snag test	EN 966:2012	
Retention System Effectiveness	EN 13087-4:2012	
Dynamic and Static Loading	EN 13087-5:2012	
Paint adhesion	EN ISO 2409:2013 ASTM D 3359 (2017)	Mechanical resistance Tape adhesion

Table 1 - Equipment List

3.3 PRE-CONDITIONING EQUIPMENT

a. The means to pre-condition helmets shall be available. The tolerance of the conditioning temperature shall be within ±2°C throughout the zone in which the helmets are kept and remain within the temperature and relative humidity margin specified in ANNEX A. The actual readings shall be recorded manually or by an electronically produced log.

b. For the optional temperature shock test (see Chapter 13) a circulating air oven or freezer is required.

c. Temperature and relative humidity values (conditioning equipment, test facility) shall be measured with equipment with an accuracy of ± 1ºC for temperature and ± 3% for relative humidity.

3.4 SAMPLE SIZE

a. Recommended sample size testing should be conducted for tender assessment and research and development activities.

b. The minimum recommended sample size is stated for each criterion, where and if appropriate, but may be amended by the NA.

3.5 ACCEPTANCE TESTING

a. All helmet designs must pass acceptance testing to meet this specification, or specific tests and chapters thereof.

b. A recommended sample size is provided for each criterion of each chapter.

c. Not all test criteria will require the level of confidence as recommended in each chapter. NA's are invited to modify the sample size and confidence levels if they wish, but must assess at least the recommended sample size.

3.6 FINISHING

a. The finished helmet and its fittings are to be free from the following defects:

(1) Burrs, sharp and ragged edges;

(2) Surface imperfections;

(3) Contaminants and foreign matter;

(4) Unfinished edges or seams;

(5) Too loose, too tight, unsecured, broken and single stitching.

3.7 DEFINITIONS

a. Comfort Pads - User configurable comfort system. Is not required to mitigate the effects of blunt impact (not part of the mitigation system).

b. Cover - Removable assembly designed to protect the shell and adapt it to the operational environment, including all means to attach the cover to the shell.

c. Helmet - Assembly of shell, suspension system, retention system, shroud, side rails and cover.

d. Impact Liner - Innermost material (usually fixed and rigid) to the helmet shell, providing impact absorption to the head under dynamic blunt impact events. Can be used in conjunction with pads.

e. Impact Pads - Innermost material to the helmet shell, comprising numerous detachable and user (location) configurable pads, providing impact absorption to the head under dynamic blunt impact events. Can be used in conjunction with an impact liner to provide comfort and additional impact protection.

f. Retention System - The complete assembly, by means of which the helmet is maintained in position on the head, including any devices for adjustment of the system to the dimensions of the head to enhance the wearer's comfort or helmet stability, including the means for attaching it to other components of the helmet (e.g. bolts etc).

g. Shell - The hard part of the helmet that provides the general outer form of the protective headwear and whose primary purpose is to distribute the impact load and to resist penetration. The shell includes the paint and or coating applied to it and when applicable the rim used to seal and to protect the edge (excluding helmet cover).

h. Shroud and Side Rails - Means for mounting head-mounted equipment to the helmet, located on the shell, including the means for attaching it to other components of the helmet (e.g. bolts etc).

i. Suspension System - Complete assembly serving as an interface between the shell and head designed to mitigate impact load and distribute the helmet weight including devices for adjusting fitting to the head, including the means for attaching it to other components of the helmet (e.g. bolts etc).

CHAPTER 4 BLUNT IMPACT PROTECTION

4.1 OVERVIEW

a. Blunt impact protection focuses on relatively low energy collisions of the helmeted head from incidents such as road traffic accidents, falls, training and operational impacts. These are commonly referred to in the literature as ‘bump’ or ‘blunt’ impacts.

b. Blunt impact tests and evaluation criteria are provided and specified for the head (helmet), visor and mandible guard.

c. Generally, bump injuries result from blunt or angular threats such as the flat roof of a vehicle interior or the corner of a wall. These are considered separately to hostile events which include ballistic impact from bullets or fragments (BHBT or BFD). Hostile threats are dealt with in STANAG 2920.

d. Protection of the head is important given the crucial role of the brain in controlling both voluntary motion and essential organ function. However, the effects of acceleration on the brain are complex and not well understood or agreed. Therefore, for blunt impact protection to the head, a number of agreed categories of bump tests are suggested for the consideration of NA’s. This is due to variability in:

- Impact values for concussion vs death threshold;
- Different impact scenarios, which arise from different risk assessments, relating to different operational scenarios and approaches.

e. Pre-conditioning of helmets and ancillary protection should take place as per ANNEX A.

f. If a helmet fails/performs poorly, the test cannot be repeated with a substitute helmet. The result must be declared.

4.1.1 Linear Blunt Impact

a. Table 2 provides a list of accepted linear blunt impact test methods and criteria.

b. NA's are encouraged to adopt the method(s) and acceptance criteria most appropriate to their nation's risk assessment.

c. ANNEX C defines the helmet drop locations relative to external landmarks of the head.

4.1.1.1 Test Method

	Drop 1								Drop 2						
NBI Test Method	**First Drop Peak Deceleration Limit (g)**	**First Drop Peak Force Limit (kN)**	**First Drop HIC (-)**	**First Drop Height (m)**	**First Drop Velocity (m·s^{-1})**	**First Drop Anvil Impact Energy (J)**	**First Drop Impact Location(s)**	**First Drop Anvil(s)**	**Second Drop Deceleration Limit (g)**	**Second Drop HIC (-)**	**Second Drop Height (m)**	**Second Drop Velocity (m·s^{-1})**	**Second Drop Impact Locations**	**Second Drop Anvil(s)**	**Reference to civilian standard**
Method A - Helmet Drop	400	-	-	-	6.50	-	Crown Front Rear Side	Flat	-	-	-	-	-	-	BS 6658:1985 Appendix F
Method B - Helmet Drop	400	-	-	-	6.50	-	Crown Front Rear Side	Flat	400	-	-	3.0	Crown Front Rear Side	Corner Kerb Hemi	BS 6658:1985 Appendix F
Method C - Helmet Drop	300	-	-	-	6.50	-	Crown Front Rear Side	Flat	300	-	-	3.0	Crown Front Rear Side	Corner Kerb Hemi	BS 6658:1985 Appendix F
Method D - Helmet Drop	300	-	-	-	10.30	-	Crown Front Rear Side	Flat	300	-	-	3.0	Crown Front Rear Side	Corner Kerb Hemi	BS 6658:1985 Appendix F
Method E - Anvil Drop	-	5	-	1	-	49	Crown	Hemi	-	-	-	-	-	-	EN 397:2012+A1: 2012 Paragraph 6.6
Method F - Helmet Drop	<150 to <250	-	-	-	4.75	30 to 55	Crown Front Rear Side	Flat	-	-	-	-	-	-	None (See details below)
Method G –Helmet drop	275	-	1000	-	4.40	-	Crown Front Rear Side	Flat	275	1000	-	4.4	Crown Front Rear Side	Flat	ECE R22.05 The headform as in EN 960 (575 mm),
Method H – Helmet Drop	<150[1]	-	-	-	3.05	-	Crown Front Right Left Rear Right Nape Left Nape	Hemi	<150[a]	-	-	3.05	Crown Front Right Left Rear Right Nape Left Nape	Hemi	FMVSS No. 218 (TP-218-06)

[1] Probability of Under Limit (P(uL)) criteria with 90% Lower Confidence Level (LCL) calculated using the Clopper-Pearson method.

Method I – Helmet Drop	Mean <150	-	-	-	4.31	-	Crown Front Right Left Rear Right Nape Left Nape	Hemi	<300[2]	-	-	4.31	Crown Front Right Left Rear Right Nape Left Nape	Hemi	FMVSS No. 218 (TP-218-06)

Table 2 - Liner blunt impact methods

a. Table 2 captures performance criteria and references to international civilian standards that state the test methods (with the exception of Method F).

b. There are currently two main methods used for testing helmet protection against blunt impact:

(1) A helmet may be dropped from a height via guided freefall on to an impact surface to represent tripping/falling (referred to as ‘Helmet Drop’).

(2) An anvil may be dropped on to the helmet in a guided freefall to represent the helmet being struck by another object (referred to as ‘Anvil Drop’).

c. The shape of the anvil varies with differing test methods, including: flat, hemispherical (hemi) and kerbstone (kerb).

d. The helmet configuration should represent the as worn condition, or worse case limits of adjustability as decided by the NA.

e. It is recommended that any permanently attached accessories are to be left in-place during testing. e.g. NVG Mount, Combat ID Mount, Side Rails, helmet cover and tested as worn for general service. This should be decided by the NA.

4.1.1.2 Sample Size

a. Method A

(1) Nine helmets in total are required.

(2) For drop one, three helmets of each condition (hot, wet, cold), each dropped at each impact location (crown, front, side (1), rear).

[2] Probability of Under Limit (P(uL)) criteria of 90% with 90% Lower Confidence Level (LCL) calculated using the Clopper-Pearson method.

b. Method B, C, D

(1) Nine helmets in total are required.

(2) For drop one, three helmets of each condition (hot, wet, cold), each dropped at each impact location (crown, front, side (1), rear).

(3) The same nine helmets will then be re-dropped (drop two) in each of the three conditions (hot, wet, cold), testing three helmets per condition, each helmet per condition assessed against a corner, kerb or hemispherical anvil, dropped at each impact location (crown, front, side (1), rear).

c. Method E

(1) Three helmets in total are required.

(2) For one drop, one helmet of each condition (hot, wet, cold) will be tested on the crown, only.

d. Method F

(1) Seven helmets are required for dismounted combat helmet and four for parachutist role.

(2) Each helmet is to be impacted once on the crown and at four other sites (rear, front and both sides) in order determined by test facility.

(3) Helmets to be conditioned at Ambient (3 samples), hot (2 samples) and cold (2 samples). The sample size for parachutist is 2, 1 and 1, respectively.

(4) The average pass/fail criteria are:

	Dismounted	**Parachutist**
Crown	< 150G @ 55 Joules	< 250G @ 90 Joules
Sides	< 150G @ 30 Joules	< 250G @ 65 Joules
Front/Rear	< 150G @ 30 Joules	< 250G @ 65 Joules

Table 3 - Method F Performance Criteria

e. Method G

(1) Five helmets in total are required.

f. Method H

(1) Six helmet samples of each size (small, medium, large, and extra-large) are required: two each size for testing after exposure to each of three environmental conditions.

(2) The environmental conditions shall be ambient, cold and hot (in accordance with ANNEX A).

(3) Helmets shall be conditioned for a minimum of 12 hours prior to test. Hot and cold impacts shall be conducted within five minutes after the helmets are removed from the environmental conditioning chamber.

(4) Helmet shall be fitted to the appropriate size DOT (FMVSS 218) headform (B, C, and D).

(5) Impact locations are front, rear, left side, right side, left nape, right nape, and the crown. The headform shall be oriented as described in Table 4 for each particular impact site.

Impact site	Headform Base Orientation
Front	40-45 degrees off vertical
Rear	5-30 degrees off vertical
Left / right side	10-30 degrees off vertical
Crown	± 35 degrees off vertical
Left / right nape	Zero degrees off vertical, rolled 15 to 35 degrees left or right

Table 4 - Headform orientation for blunt impact testing

(6) Two successive impacts shall be made at each location. The second impact shall be made no sooner than one minute and no later than 5 minutes after the first.

(7) Each helmet shall be tested with the suspension system arranged standard inside the finished helmet.

(8) The pass fail criteria are:

Conditions	LCL (P(uL) / Confidence)[3]		Impacts Over 150g Allowed	
	1st Impact	2nd Impact	1st Impact	2nd Impact
Aggregate	90/90	80/90	11	26
Size	81/90	73/90	4	7
Environment	81/90	75/90	6	9
Location	79/90	69/90	2	4

Table 5 - Method G Performance Criteria

g. Method I

(1) Six helmet samples of each size (small, medium, large, and extra-large) are required: two each size for testing after exposure to each of three environmental conditions.

(2) The environmental conditions shall be ambient, cold and hot (in accordance with ANNEX A).

(3) Helmets shall be conditioned for a minimum of 12 hours prior to test. Hot and cold impacts shall be conducted within five minutes after the helmets are removed from the environmental conditioning chamber.

(4) Helmet shall be fitted to the appropriate size DOT (FMVSS 218) headform (B, C, and D).

(5) Impact locations are front, rear, left side, right side, left nape, right nape, and the crown. The headform shall be oriented as described in Table 4 for each particular impact site. Additionally, Figure 4 shows the orientation of all locations except the left and right nape.

(6) Two successive impacts shall be made at each location. The second impact shall be made no sooner than one minute and no later than 5 minutes after the first.

(7) Each helmet shall be tested with the suspension system arranged standard inside the finished helmet.

[3] Probability of Under Limit (P(uL)) criteria with 90% Lower Confidence Level (LCL) calculated using the Clopper-Pearson method.

(8) The average of all first impacts must be less than or equal to 300g. Second impacts must meet a Probability of Under Limit (P(uL)) criteria of 90% with 90% Lower Confidence Level (LCL) calculated using the Clopper-Pearson method (in other words for second impacts no more than 11 impacts over 150g are allowed).

4.1.2 Rotational Blunt Impact

a. The contribution that the rotational component of impact may make to the severity and/or frequency of blunt head injury is not fully understood.

b. There are currently no internationally accepted defined limits or established published methods for capturing metrics of rotational blunt impact injury risk for different helmet types.

c. At this point, it is not possible to define a test method or ‘pass/fail criteria’ to reliably control the risk from rotational blunt impact. It is expected that this will be included in future versions of AEP 2902.

d. However, NAs may wish to monitor developments of CEN TC158, specifically the development of oblique test methods for recreational and sport helmets.

4.1.3 Visor Blunt Impact

a. This test is performed to ensure that a known impact to the visor will not cause deformation that may contact the wearer’s face and cause subsequent injury.

4.1.3.1 Test Method

a. **Equipment**

(1) Free fall drop system with velocity sensors;

(2) Helmet and associated visor;

(3) Impactor with hemispherical steel impactor of radius 25 mm (±1 mm) and mass of 1 kg (±0.02 kg);

(4) Rigidly mounted headform with metal nose;

(5) Device for measuring contact time, e.g. oscilloscope or timer module.

a. Equipment capable of measuring the velocity of the impactor within 60 mm of the surface of the visor with an accuracy of 0.1 $m \cdot s^{-1}$ shall be used.

b. The measuring device circuit shall be connected to the copper strip and the metal nose. The measurement device shall be able to record contact times of 0.1ms and above.

b. **Impactor**

(1) The test nose shall be manufactured from a suitable conductive material that will withstand an impact of 50 J without deformation.

(2) The test nose shall be of conical design and of a suitable size to give a measurement from the Mid Coronal Plane to the tip of the test nose of 119 ±3mm.

(3) The test nose shall be mounted 20 ±2mm below the basic plane of the head along the mid-sagital plane.

c. **Headform**

(1) The headform of appropriate size, according to EN 960:2006, shall be securely mounted to a block with a minimum mass of 250 kg and with the metal test nose orientated upwards in line with the central axis of the impactor.

d. **Preparation and Conditioning**

(1) The visor shall be mounted on a helmet body of appropriate size for the test headform and secured as described in the helmet manufacturer’s instructions.

(2) A suitable length of 25 mm (±5 mm) wide and 1 mm (±0.5 mm) thick copper conductive tape shall be attached to the inside face of the visor in line with the central axis of the impactor.

(3) Visors in the hot, wet, cold and ambient condition (ANNEX A) should be tested.

e. **Mounting**

(1) Mount the test sample on the headform and securely fasten as described in the helmet manufacturer's instructions.

(2) Additional support may be provided to the underside of the helmet to ensure the helmet cannot move during the test.

f. **Test Procedure**

(1) The visor and helmet system shall be preconditioned prior to testing (ANNEX A).

(2) Align the helmet and headform such that the impactor is in the same vertical axis as the rigid nose, or as determined by the NA.

(3) Raise the impactor in the drop system, to a height of 1m from the surface of the visor to the bottom of the impactor.

(4) Release the impactor allowing it to free-fall.

(5) Record the duration of any contact between the visor and test nose and the velocity of the impactor.

g. **Criterion**

(1) The test sample has passed if the recorded contact time between the visor and test nose is ≤1ms in duration.

4.1.3.2 Sample Size

a. It is recommended that a sample size of six systems (helmet and visor) per condition (hot, cold, wet and ambient) is undertaken.

4.1.4 Mandible Guard Blunt Impact

a. Impact mandible guards (which may also offer ballistic protection) can be added to helmets primarily for personnel in top cover sentry, static sentry, and open architecture vehicles, to provide impact protection to the face. The mandible guard should provide front and side coverage and be light weight and easily removable. The mandible guard design should not obscure vision and allow for clear verbal communication. These are defined further in Chapter 19.

4.1.4.1 Test Method – Option 1

a. Minimum requirements:

Headform	EN 960:2006 metal half head
Method	Guided free fall
Instrumentation	Uni-axial accelerometer
Anvil	Flat
Conditioning	Hot, wet, cold
Impacts	3 per mandible guard
Sample size	Three mandible guards per condition, three impacts per mandible guard – front, left, right (nine mandible guards in total)
Principal Criteria	< 300 G peak for impacts at 45 Joules; < 225 G average No Fractures
Restitution time	No less than three minutes / no longer than five minutes apart
Site selection	Sites for each series shall be equally spaced

4.1.4.2 Impact Requirements

45 Joules (Minimum)				
	Flat Anvil		Flat Anvil	
Test sequence	FRONT CENTRE		LEFT AND RIGHT	
	Temperature	Evaluation Criteria	Temperature	Evaluation Criteria
Mandible Guard *3 Samples*	Ambient	< 300 G Peak < 225 G Average No Fractures	Ambient	< 300 G Peak < 225 G Average No Fractures
Mandible Guard *2 Samples*	Cold Extreme	< 225 G Average No Fractures	Cold Extreme	< 225 G Average No Fractures
Mandible Guard *2 Samples*	Hot Extreme	< 225 G Average No Fractures	Hot Extreme	< 225 G Average No Fractures

Table 6 – Mandible Guard Blunt Impact Test Criteria

4.1.4.3 Evaluation Method

a. The mass of the falling assembly must be 5 kg ±0.1kg, and must include the headform and supporting structure, but does not include the mass of the helmet/mandible guard being tested.

b. The uni-axial accelerometer is mounted at the centre of gravity of the headform and shall be aligned to within 1° of the direction of impact. The measurement transducer shall be capable of withstanding a shock of 2000 G without damage.

c. Data from the transducer shall be sampled at a minimum sampling rate of 10,000 Hz using an analogue filter conforming to Channel Frequency Class 1000 filter as per SAE J211 revision December 2003.

d. The operation of the instrumentation shall be verified prior to and following each test series by dropping a spherical calibration impactor three times from a height of 0.75 m, onto a calibrated modular elastomer pad (MEP) pad at 75s±15s intervals.

4.1.4.4 Sample Size

a. It is recommended that a sample size of nine mandible guards per condition (each tested in the hot, cold and ambient condition) is undertaken.

4.1.4.5 Test Method – Option 2

a. EN 960 headforms, guided drop at 1.52 meters per second onto a hemispherical anvil.

b. No breaking allowed, no headform (centre) accelerations greater than 150 G allowed, and mandibular deformations constrained at the limit established by distance from mandible guard to the 99th percentile chin structure on the service population.

c. One drop per mandible guard, three temperature conditions (hot, cold, and ambient).

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CHAPTER 5 RESISTANCE TO PENETRATION

5.1 OVERVIEW

a. In order to prevent penetrating injuries to the head from a sharp object, the helmet should be resistant to penetration. This may be the result of an incident such as rock fall during mountaineering or from impact during a fall or vehicle accident.

5.2 METHOD – Option 1

a. The helmet is placed on a headform with an electrical contact. A metal striker is raised to a specified height, and dropped onto the helmet. If contact (completing an electrical circuit) is made between the striker and the headform, the helmet fails the test.

b. The method is described in BSI BS 6658:1985 Appendix G.

c. A total of 12 helmets should be assessed, three in each hot, wet, cold and ambient condition.

5.2.1 EVIDENCE BASE AND RATIONALE FOR TEST

a. A specification for motor vehicle helmets, BS 6658:1985, includes a test for resistance to penetration, presumably to ensure that the head is protected during a collision with a surface other than flat road and protected from sharp objects that may strike the helmet during a combat vehicle mishap. This test is also included in the specification for mountaineering helmets, in which the head may be struck by sharp falling objects or may strike a jagged cliff face.

b. These documents both use the same test method; however the test parameters chosen are different. The mountaineering test, EN 12492:2012, uses a 5 kg striker dropped through 1 m, giving impactenergy of 49 J. In the case of vehicle helmets, a 3 kg striker is used which may fall through 3 m or 2 m depending on the classification of the helmet (Type A, competitive, or Type B, ordinary use). This gives impact energies of 88 J or 59 J respectively.

c. The vehicle Type B helmet standard is recommended as the standard for resistance to penetration.

5.3 METHOD - Option 2

a. The alternate method described in ANSI Z89.1-2009 uses a 1 kg carbon teel tip striker which strikes the helmet at a velocity of 7.0 meters per second on the crown, front, side, rear, and any perimeter location above the dynamic test line as defined in the standard.

b. This provides an impact energy of 24.5 Joules.

CHAPTER 6 MUSCULOSKELETAL PAIN OR INJURY

6.1 OVERVIEW

a. Adding helmet-mounted equipment further increases the risk of musculoskeletal pain or injury. The predominant factor in increasing risk in the lower neck is the increase in angular momentum. Angular momentum is more dominant in the directions that create a flexion or lateral bending movement. UK Defence Standard 00-251 recommends “Any required external attachments should not restrict the users head or shoulder motion required for the performance of any tasks”. It also states that “with the trunk balanced upright, the head is best held in balance when the work is in an area between 23° and 37° below a horizontal plane through the eyes when standing and between 15° and 45° below the horizontal when sitting”. Outside of these limits, neck strain occurs and work capacity is reduced. The weight of protective helmets will further exacerbate this problem.

6.2 TEST METHOD

a. This test method will be developed in future versions of AEP 2902.

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CHAPTER 7 STRUCTURAL RIGIDITY

7.1 OVERVIEW

a. The helmet shell is to be subjected to cyclic loading, as detailed below, to ensure that its structure is free from defects and weaknesses which may lead to delamination or cracking.

b. This chapter consists of two test options. It is for the NA to decide which test option is most applicable to their nation's requirement.

7.2 OPTION 1

7.2.1 Test Procedure

a. Six helmet shells (or at least one of each size) are to be tested in the hot condition (See ANNEX A) after a period of no less than 3 hours.

b. The force is to be applied by means of a hemispherical steel loading nose with a radius of 25 mm.

c. Shells are to be supported diametrically opposite the point of application of the force over an area not exceeding 160 mm^2.

d. The deflection of the loading nose is to be limited to 50 mm, measured from its position in contact with the shell at zero load.

e. The loading nose is to be moved towards the support opposite until the force required reaches 900 N or the deflection is 50 mm and then moved to the original position, or until the residual force is zero.

f. The shell is to be subjected to 100 deflection cycles over a period not exceeding 24 minutes. The maximum velocity of the loading nose is to be 50 $mm \cdot sec^{-1}$.

g. The shell is to be tested as above in two positions, the first from side to side, the second from front to rear.

7.3 OPTION 2

7.3.1 Test Procedure

a. **Conditioning and Set-up**

(1) Six helmet shells (or at least one of each size) will be subjected to the compression testing procedure outlined below. The samples shall be tested at extreme hot temperature condition (see ANNEX A) with two helmet shells tested in each of the three orientations specified in Figure 1 to Figure 3: front-to-back, side-to-side, and top-to-bottom.

(2) Pre-condition all helmet shells at ambient temperature for a minimum of 6 hours. Measure the pre-test maximum helmet width (side-to-side, front-to-back, and top-to-bottom, measured to the outside edge). For the lateral (side-to-side) and longitudinal (front-to-back) compression testing, if any edging is present, it shall be either fully removed or cut away at the contact points with the compression testing device or any measuring device.

(3) Place the helmet shell on a rigidity tester. For lateral (side-to-side) and longitudinal (front-to-back) compression testing, a foam block shall be placed between the crown of the test sample and a fixed surface on the compression testing device to prevent any helmet movement during the cyclic test. Laterally position the sample and the stops such that the support foam as seen in Figure 1 and Figure 2 is flat against the fixed surface and just touching the crown of the sample. Firmly lock down the stops and slide in a sheet of Teflon® (PTFE) to compress the support foam. Geometry: 0.32 cm thick and approximately 10 cm wide x 10 cm long, a quantity of 4 are required for testing (±1%).

(4) The support foam will be Plastazote LD15 Foam 15 $kg \cdot m^3$ and 45 kPa @ 25% deflection (as per ISO 7214). The geometry should be approximately 3.8 cm thick x 10 cm wide x 10 cm long. The block is to be replaced after each test. The device that supports the foam located at the crown of the helmet should permit vertical translation of the foam but restrict movement about other degrees of freedom.

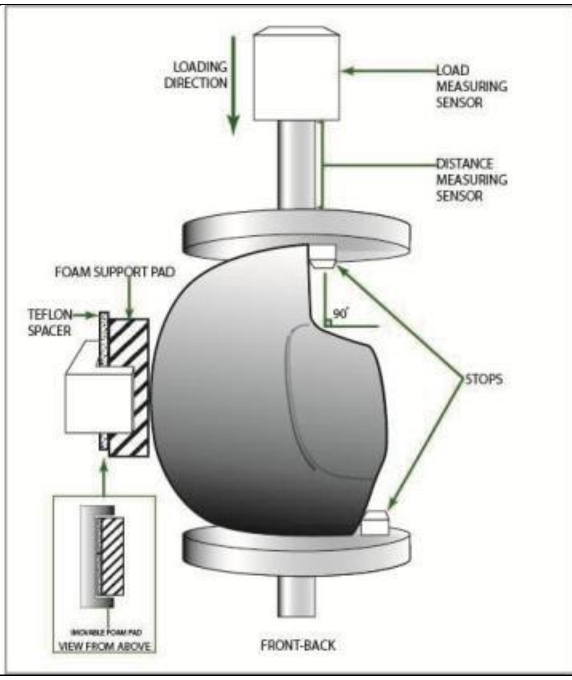

Figure 1 – Front-Back

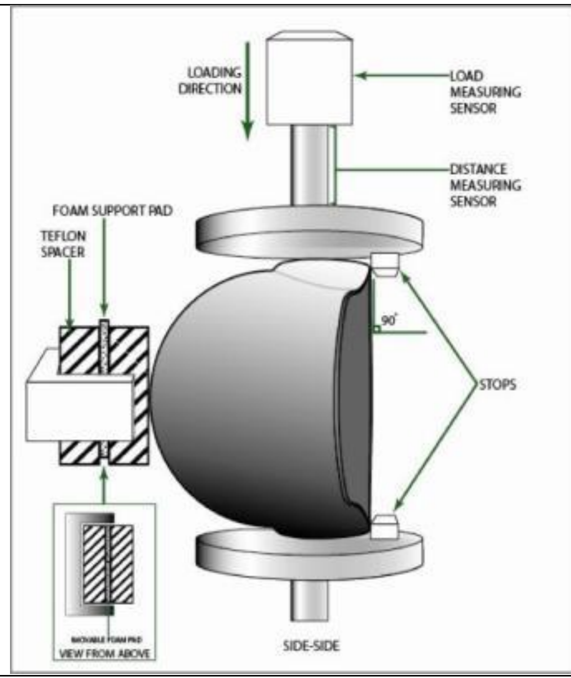

Figure 2 – Side-Side

(5) For vertical (top-to-bottom testing, Figure 3), each of the two bottom edges (at the ear cup) of the helmet shell shall be supported by a steel distribution plate and two layers of anti-friction material as shown in Figure 3. Attempts should be made to centre the sheets of steel and Teflon® on the lower edge of the test sample. If the helmet sample is stable with an applied load, while sitting on the rigidity tester, then no additional support is required. Should the helmet not be stable, then a support of appropriate material and size shall be added under the front brim of the test sample to provide support. The steel distribution plate shall be low carbon steel, precision ground both sides. Geometry: 0.635 cm and approximately 7.5 cm wide x 15 cm long, a quantity of 2 are required for testing. The anti-friction sheets shall be Teflon® (PTFE). Geometry: 0.32 cm and approximately 7.5 cm wide x 10 cm long, a quantity of 4 are required for testing (±1%). Any amendments to the above fixing methods/materials must be authorised by the NA.

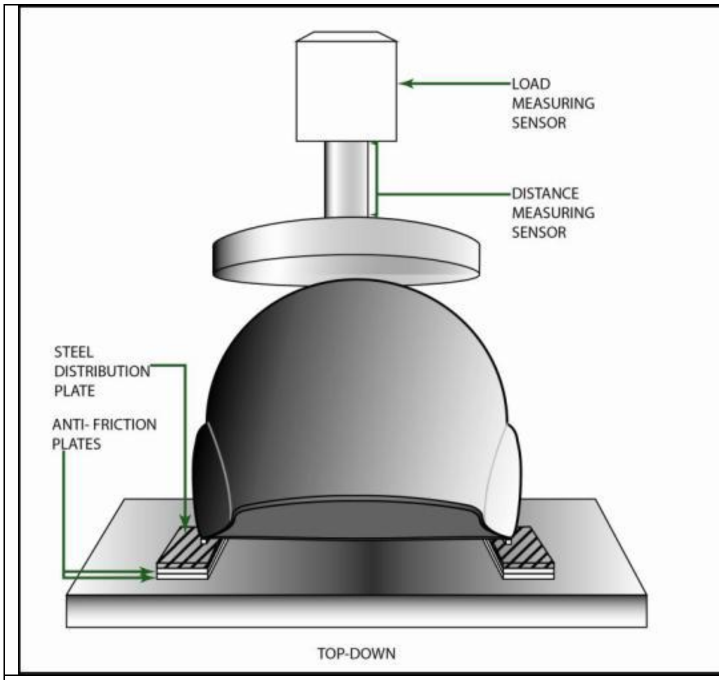

Figure 3 - Top-Bottom

b. **Compression Cycling**

(1) Apply a force at maximum width (side-to-side, front to back, or top to bottom as required) until a 25 N pre-load is reached. Measure the width, **A***, of the helmet to the outside edges of the shell (side-to-ear, front-to-back, or top-to-bottom as appropriate to the test configuration).

(2) Compress the test sample at a rate of 100 mm^{-2} until a load of 1100 N (for side-side and front-back) or a load of 1500 N (for top-bottom) is reached while recording the force/displacement curve. The sampling rate for recording the force/displacement curve shall be a minimum of 10Hz (10 force displacement readings per second). Reduce the compression load to 25 N and repeat until all cycles are completed. Samples in each orientation will be subjected to 45 cycles. During the final cycle, measure the helmet width **B*** with the helmet under maximum load. Reduce the load to 25 N for the final time and measure the helmet width **C***.

(3) The total test duration (after removal from the conditioning chamber to measurement **C***) shall not exceed 30 minutes. In order to complete the testing in as short a period as possible, there is to be no dwell

time at either the full load or the 25 N load for any one of the cycles to be completed on the test sample.

(4) Remove the helmet from the test frame. Measure the final unloaded helmet width, **C**, one and a half (1½) hours after removal from the conditioning chamber. After 24±1 hour, re-measure the final helmet width **D**.

c. **Compression Measurements**

(1) Calculate the following deformation values:

- Maximum deformation under load (**B*- A**)
- Permanent deformation under preload (**C*- A***)
- Permanent deformation unloaded (**C-A**)
- Restitution value after a 24 hour recovery period (**D-A**)

(2) All measurements shall be to the nearest 0.1 mm. Visual inspection should note any delamination, ply separation, or prominent buckling at the conclusion of the test sequence. The measured values shall be verified against Table 7.

Deformation Limits - Compression	**Side-Side (mm)**	**Front-Back (mm)**	**Top-Bottom (mm)**
Maximum Deformation Under load (B*- A)	24	24	6
Permanent Deformation Unloaded (C- A)	8	8	2
Restitution Value After 24 hours (D - A)	5	5	1

Table 7 - Compression Deformation Limits

7.4 PASS CRITERIA

a. This is additional pass criteria for Option 1 and Option 2.

b. All signs of cracking or de-lamination are to be recorded.

c. When tested as above, any de-lamination or cracking which traverses the thickness of the shell is to constitute a failure.

d. Helmet must return to shape and size ±3 mm.

7.5 SAMPLE SIZE

a. At least six helmets should be tested for structural rigidity.

CHAPTER 8 RETENTION AND STABILITY

8.1 OVERVIEW

a. Retention and stability are key to user comfort, ensuring that the helmet remains in the correct position, and stable.

8.2 RETENTION

8.2.1 Dynamic Loading Method

a. This test examines the behaviour of the retention system under a dynamic high loading rate, resulting from the drop of a heavy mass linked to the chin strap. The aim is to ensure that the helmet does not release under the load.

b. This method is as per EN 13087-5, which specifies the use of a 10 kg drop mass.

c. It is recommended that the mass be dropped from a height of 0.75 m, as specified in BSI BS 6658:2008.

d. A maximum dynamic limit of 30 mm and residual limit of 15 mm (measured 120 s after the drop) of the harness is recommended.

e. The drop mass is suspended below the helmet, which is supported by a hook.

f. It is recommended that 10 helmets are tested.

8.2.2 Static Loading Method – Method 1

a. This test assesses the behaviour of the retention system under a slowly increasing (quasi-static) load. The method is in accordance with EN 13087-5.

b. This test specifies that the helmet be mounted onto a headform with a simulated jaw (modelled as two rollers, over which the chin strap is fastened).

c. It is recommended that an initial load of 50 N is applied, gradually increased to 900 N with a fixed loading rate as specified in EN 13087-5.

d. After a load of 900 N is achieved, the system is held at this load for 120 s and then a measurement of the extension of the retention system is taken.

e. An extension limit of 25 mm is recommended.

f. It is recommended that 10 helmets are tested.

8.2.3 Static Loading Method – Method 2

a. This method forgoes the headform and clamps the helmet directly to better simulate the chin strap loading for a blast or similar event that may pull at the helmet without full head engagement. The helmet shall be rigidly attached to the testing machine base with either a clamp or headform device. The retention system shall be attached to a grip that simulates the jaw. The grip shall consist of freely moving cylindrical rollers, each 6.35 mm radius, and rigidly spaced 76.20 mm apart (centre-to-centre) with a length of approximately 38.10 mm to accommodate the retention system chin-cup by the edge.

b. Load is applied after removal of the slack by moving the loading mechanism at a rate of 25.4 mm per minute until a load of 667.23 N is achieved.

c. The retention system is allowed to stretch but not slip (or loosen). The load is held for one minute, breakage prior to one minute is a failure.

d. NAs may wish to establish a mandatory breakage criteria (e.g. must hold for one minute at 668 N but must break prior to 1335 N) to ensure that the helmet chinstrap can breakaway in case of vertical falls or other events where helmet breakaway may be desirable.

e. It is recommended that 10 helmets are tested.

8.3 STABILITY

a. This test is used to assess whether the displacement of the helmet varies with an applied load.

b. It is recommended that the method described in EN 13087-4 Retention System Effectiveness is used.

c. The helmet is secured to a headform as worn. A hook is attached to the rear edge, which is linked to a 10 kg mass set to fall through a guided fall of 0.4 m, as illustrated in Figure 4.

d. The initial and final positions of the front edge of the helmet are to be marked, and the distance between them recorded. It is recommended that the criterion for this is no more than 10 degrees(°).

e. It is recommended that 10 helmets are tested.

Figure 4 - Stability test

8.4 BUCKETING

a. Bucketing refers to the collection of water in the helmet due to submersion of the wearer into water and/or the wearer moving through the water at speed, and the associated force on the wearer's neck/chin.

b. To combat this, the user must be able to undo the chin strap under tension. This can be evaluated via the Ease of Release Test stated in Section 8.5.

8.5 EASE OF RELEASE

a. The aim of ease of release testing is to determine the minimum pressure required to activate the helmets retention system release system, when the retention system is under load

8.5.1 Test Method

a. A Hybrid III 50th percentile male head-form is to be rigidly fixed to a retention test apparatus such that it's Y-Z plane is inclined 30° forward of vertical.

b. The intersection of the Y-Z plane and the base plane of the head are in line with the support plate of the stirrup (see Figure 5), which is used to simulate the lower jawbone structure.

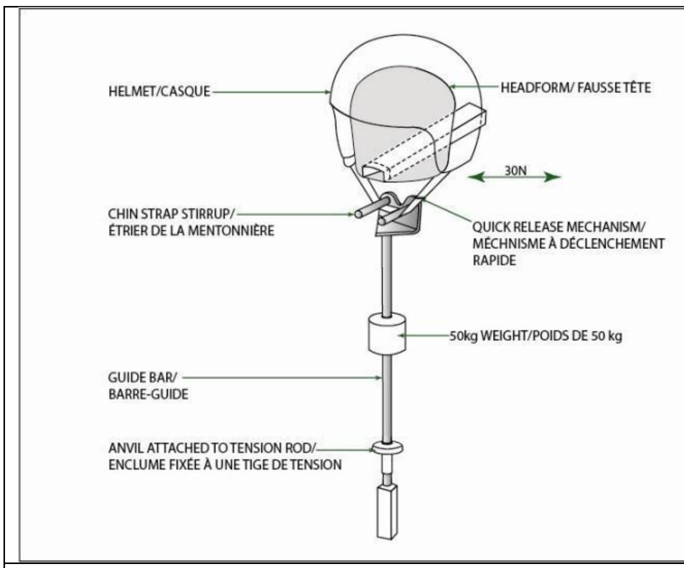

Figure 5 – Overview diagram

c. Extending below the stirrup is a guide bar that carries a free-sliding mass of 50 kg.

d. The helmet shall be positioned on the head-form in accordance with manufacturer's instructions.

e. The chin strap shall be passed around the stirrup, buckled, and then drawn up until the position of the stirrup approximates the position of a wearers jaw.

f. An appropriate mass will then be lowered such that the tension on the chin strap system shall be 500 ± 10 N.

g. In the ambient condition, a force of 30 N will be applied by an extensometer, indentometer or other suitable force-loading device onto the release mechanism.

h. The release mechanism passes if the release mechanism activates with ≤30 N force.

i. A total of six helmet systems should be assessed against this test.

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CHAPTER 9 HELMET COVERAGE

9.1 OVERVIEW

a. A helmet is a piece of Military Personal Protective Equipment (PPE) designed to protect the brain and brain stem from external threats. The potential medical effectiveness of a helmet can be predicted by how much coverage it provides to the brain and brain stem. External anatomical landmarks can be used as a proxy to predict coverage of these structures. This is a less suitable approach when considering elevated angles of attack other than horizontal angles. Additional items of Military PPE can attach to a helmet, such as a visor, nape protector and mandible guard. Although their requirement is coverage of the face and neck, they also potentially provide coverage of the brain and brain stem from certain angles of attack.

b. The aim of this chapter is to identify, by means of anatomical landmarks, the minimal coverage to be specified by a full and high-cut helmet, a visor and mandible guard.

c. There is a requirement for an objective method of comparing the coverage of different helmet designs for the coverage they offer. Ideally, an assessment of coverage should take account of protection provided to critical vulnerable structures, for representative angles of attack.

9.2 Coverage

a. Coverage assessments should take into account the amount of coverage provided to critical vulnerable structures, for representative angles of attack.

b. Surface landmarks are one method of relating the coverage provided by a helmet to the underlying brain and brainstem. The use of bony landmarks instead of soft tissue landmarks reduces variability between measurements. Two easily identifiable anatomical landmarks are the nasion (the point of depression between nose and forehead) and the external auditory meatus (exit of the ear canal). Both the nasion (anterior landmark) and external auditory meatus (lateral landmark) can be related to the margins of the brain, but must not be thought of as the margins of the brain per se. The internal auditory meatus is a closer representation to the margin of the brain than the external, but it cannot be palpated. The internal and external auditory meati do not always correlate in vertical position to one another.

c. The identification of a posterior bony landmark is more problematic, as no recognised anatomical landmarks exist and none are easily palpable. It has been proposed that the superior nuchal line is used; this can be palpated as the point at which the trapezius muscle inserts into the occipital bone.

d. Commercially available coverage (cuts) are illustrated in Figure 9.

9.2.1 Full Helmet Shell

a. The following images represent and identify external anatomical landmarks for providing coverage to the brain and brainstem against a (representative) full coverage helmet shell.

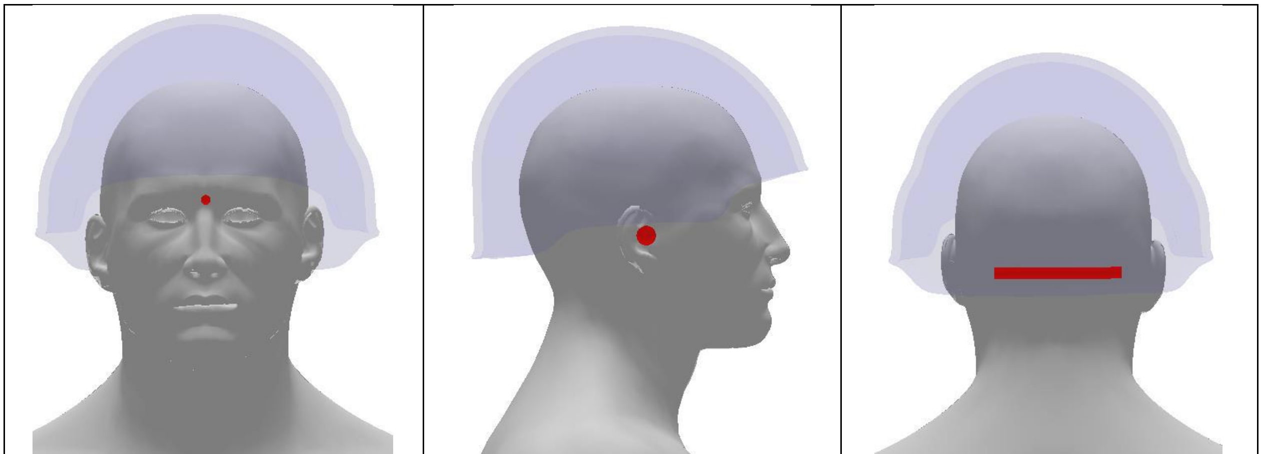

Figure 6 - Surface anatomical landmarks can be related to the coverage required of a full helmet, from left to right they are the nasion, external auditory meatus and superior nuchal line

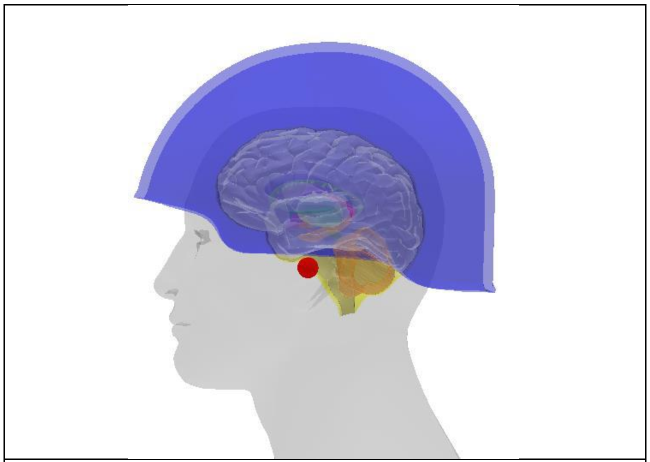

Figure 7 - Example of how brain and brainstem (yellow/green/orange) is covered from horizontal angles by an illustrative helmet. The external auditory meatus marker (red dot) is also included for reference.

9.2.2 High-Cut Helmet Shell

a. The following images represent and identify sub-optimal (not providing full coverage of the brain and brain stem) external anatomical landmarks for providing coverage to the brain and brainstem against a (representative) half (high-cut) coverage helmet shell.

b. It is recommended that as much coverage of the brain and brain stem is provided, with human factors and situational awareness also considered.

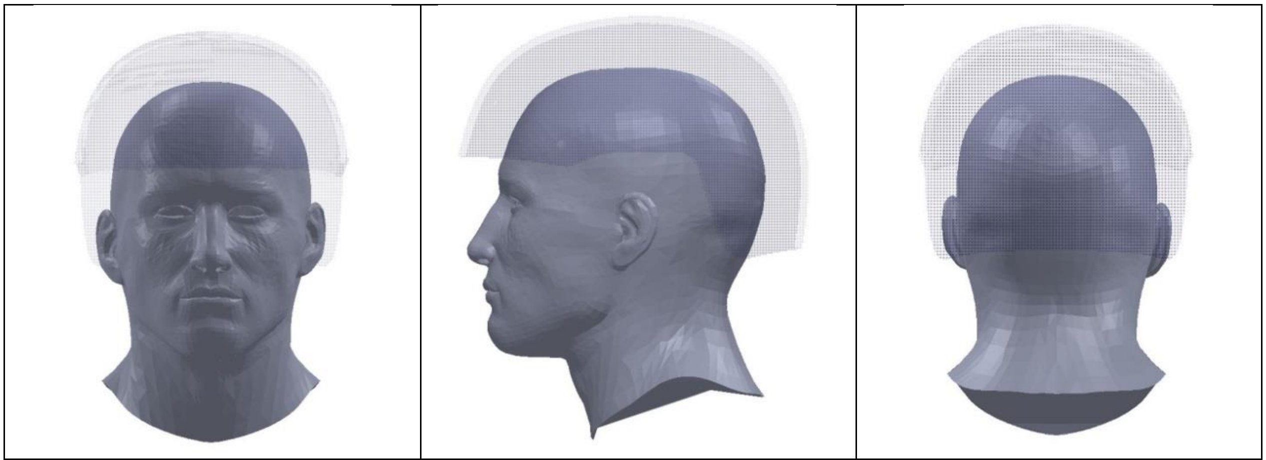

Figure 8 - Demonstration of the anatomical coverage provided by a commercial high-cut helmet.

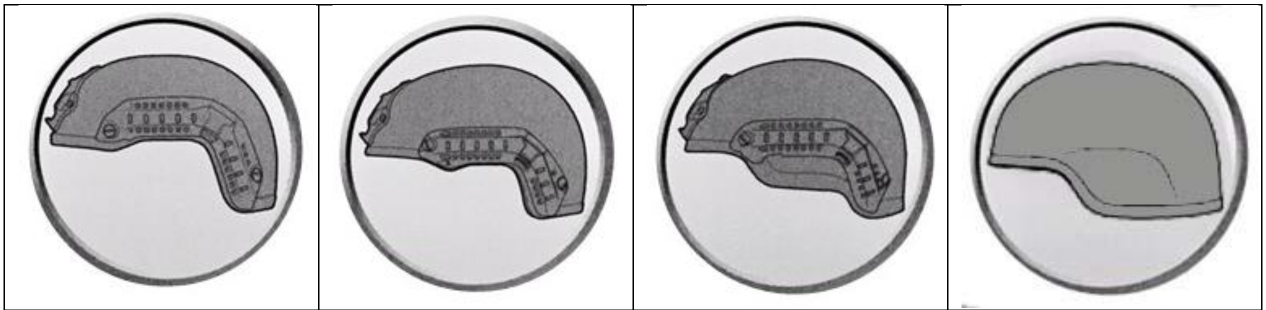

Figure 9 – Demonstration commercially available (left to right) Super High-Cut, High-Cut, Mid-Cut, Low-Cut helmets

9.2.3 Facial Protection

a. In terms of protection of the face, divisions should ideally be made in terms of coverage of individual structures. Consensus of surgeons has determined that order of priority for coverage should be the following order: eyes, nose, lips and ears. In the absence of such a capability, then coverage of the face can be defined by dividing it into thirds.

b. The upper face is demarcated from the middle face by the nasion. This is the same landmark as used for helmet coverage. Behind the upper face is the brain. Coverage of the upper face is by a helmet, and a visor if worn. The upper landmark of visor coverage should therefore be the lower border of the helmet.

c. The demarcation between middle face and lower face is the subnasale. A visor may cover the middle face alone (Figure 10), or both the lower and middle face. A mandible guard generally covers just the lower face. The lower border of the lower facial third is the lower border of the mandible.

d. Figures 9-11 provide a visual demonstration of coverage provided by commercial systems.

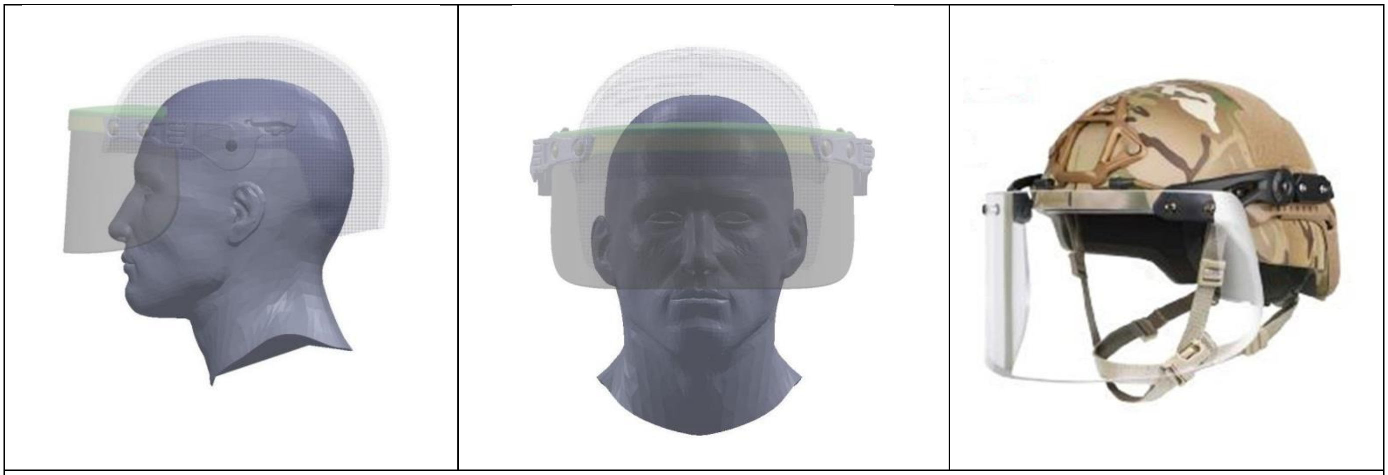

Figure 10 - Demonstration of the anatomical coverage provided by a commercial half visor worn with a helmet.

Figure 11 - Demonstration of the anatomical coverage provided by a commercial full visor worn with a helmet.

Figure 12 - Demonstration of the anatomical coverage provided by a commercial helmet in conjunction with a mandible guard.

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CHAPTER 10 HELMET COVER

10.1 OVERVIEW

a. The helmet cover is (generally) a textile product made to cover some, or all, of the helmet shell surface. Helmet covers can provide a crucial role in a Head Borne System by fulfilling a number of functions. Helmet covers must not interfere with retention system functionality.

b. The following provides recommended features that helmet covers may provide. It does not prescribe specific tests to validate these features, with the exception of textile material characteristics (this is addressed in STANAG 2333) and flame retardance (Chapter 15).

10.2 KEY FUNCTIONS

a. A helmet cover should provide the following functionalities, depending on design:

(1) Infra-Red Reflectance (IRR) (Optional)

(2) Environmental concealment (both in printed visual pattern and ability to add natural foliage) (Optional).

(3) Equipment mounting (rails, hook and loop fastener and/or webbing loops) (See Chapter 11) (Optional).

(4) Helmet shell protection.

10.3 FEATURES

a. A helmet cover must have the following features to provide full functionality:

(1) Sufficient sizes to fit the range of helmet shell sizes.

(2) Fit securely to the helmet.

(3) Pattern must have IRR/emissivity levels as determined by the NA. (Optional)

(4) Be available in multiple environmental colours and/or patterns i.e. arctic white or desert tan, based on a nation's operational

requirements and geography, and be simple to change without tools or modifications to the helmet.

(5) Be tear, abrasion and fade resistant in accordance with STANAG 2333 (as determined by the NA).

(6) Flame resistant, as determined by the NA (See Chapter 15).

CHAPTER 11 HELMET MOUNTS

11.1 OVERVIEW

a. The helmet attachment mounts allow the fitting of ancillary head-mounted equipment, and should be of a universal design wherever possible to enhance interoperability of equipment.

b. This chapter prescribes the design of the front and side helmet mounting points, as well as hook and loop.

c. All design drawings are provided in ANNEX B.

11.1.1 Front Shroud/Mount

a. The front shroud or mount is the unitary mount on the front of the helmet and must be compatible with the universal adapter.

b. See ANNEX B.1.

11.1.2 Side Rail/Mount

a. Rails on the side of the helmet will conform to one of two possible standards:

- Side rail;
- STANAG 4694 Edition 1 - NATO Accessory Rail.

b. See ANNEX B.2 and B.3.

11.1.3 Hook and Loop

a. Hook and loop (external to the shell) will be provided on the helmet and/or helmet cover where necessary, and is recommended to be in compliance with (one colour of) the IRR specification of the helmet cover, as defined by the NA.

b. It is suggested that areas are reserved for the left, right and rear of the helmet covers for the application of Identification Friend or Foe (IFF) patches, in accordance with ATP-91/STANAG 2129 – Identification of Land Forces on The Battlefield and In An Area of Operation.

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CHAPTER 12 SNAG HAZARD

12.1 OVERVIEW

a. In order to reduce the hazard of snagging from materiel (vehicles, tree branches and parachute risers, etc.) all external helmet edges are required to be smooth and rounded.

12.1.1 General Use

a. A user trial, utilising representative scenarios, should be conducted to identify any hazardous snag points of the helmet with obstacles, vest, other head-born systems, load carriage, and weapon(s).

12.1.2 Parachuting

a. Any permanent external projection from the helmet shell/cover will be ≤5 mm and be smoothly tapered to the adjacent surface.

b. It is recommended that EN 966:2012 Paragraph 5.3 is specified.

c. It is further recommended that NAs consult with airworthiness teams to identify further mitigations.

12.1.3 Sample Size

a. It is recommended that at least 6 individuals perform dry testing to confirm that the helmet and its ancillaries do not snag on external materials.

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CHAPTER 13 AGE AND ENVIRONMENTAL TESTING

13.1 OVERVIEW

a. Whilst manufacturers are likely to provide a limited warranty of their product(s), users/authorities are often unable (in many circumstances) to trace the use of systems through life.

b. The following tests are intended to assess the durability of systems, assessing materials in a variety of expected circumstances and conditions.

13.1.1 Helmet Life

a. Helmet life is defined as the operational life in operational use and training.

b. The minimum **storage life** that a helmet must offer is 10 years. Storage life is the time for which a helmet, in specified storage conditions (by the NA), may be expected to remain safe and suitable for service.

c. The minimum **service life** that a helmet must offer is 5 years. Service life is the time for which a helmet, when stored in a specified storage environmental conditions and then subsequently used in its specified operational and/or training conditions, may be expected to remain suitable for service. Service Life is the sum of Storage and Operational Life.

13.2 HEAT DISTORTION

a. The helmet shell is to be subjected to high temperature, as detailed below, to ensure that it does not undergo excessive distortion on exposure to heat.

13.2.1 Test Method

a. Measure the shell front to back length, and side to side width, marking datum points.

b. Place the helmet shell, crown down, on a cork ring inside a circulating air oven maintained at 72 ± 2°C. The oven is to be large enough so that the inner surfaces do not touch the shell.

c. Remove the shell after one hour and within 3 minutes, re-measure front to back and side to side between the datum marks used at step 1, and record the dimensions.

d. The dimensions before and after exposure to heat must not vary by more than 2% from the original dimension.

13.2.2 Sample Size

a. At least six helmets of each size should be tested for heat distortion (e.g. small, medium, large).

13.3 TEMPERATURE SHOCK (OPTIONAL)

a. All helmet components of the finished helmet, including the finished shell, pad/suspension system, retention system, and hardware, shall exhibit no structural, visible, or operational degradation, or physical damage when subjected to temperature shock, hot to cold, and cold to hot, as per ANNEX A temperature levels.

b. The finished shell shall exhibit no cracking, delamination, separation of plies, distortion, softening, or other deterioration. If the helmet shell exhibits these visual defects, helmets shall be ballistic tested to determine if the helmet has been operationally degraded. The NA must prescribe a shot pattern that includes 50% of impacts occurring on degraded regions.

c. The retention system shall be operable (webbing slides, retention system can be securely fastened, etc.) and shall have no cracked or damaged components, or other deterioration. The absorption/suspension system shall not have suffered any degradation or damage.

13.3.1 Testing

a. The finished helmet, clean and free of dirt or other foreign matter, shall be exposed to standard ambient conditions for a minimum of 24 hours. The finished shell shall be subjected to an initial conditioning of 24 + 1 hours at the Hot condition in a conditioning chamber. The test specimen shall then immediately be put in a conditioning chamber at the Cold condition for a minimum of 24 hours (±1 hour). A second finished shell shall be subjected to an initial conditioning of 24 ± 1 hours at the Cold condition in a conditioning chamber. The test specimens shall then immediately be put in a conditioning chamber at the Hot condition for 24 ± 1 hours.

b. The test specimen(s) shall be removed from the conditioning chamber and allowed to return to room temperature. The finished shell shall be assessed against the requirements of Chapter 7.2 or 7.3.

c. Failure to meet the requirements (13.3b) of this test shall constitute a test failure.

13.4 ALTITUDE TEST (OPTIONAL)

a. The finished shell helmet, clean and free of dirt or other foreign matter, shall be exposed to standard ambient conditions for a minimum of 24 hours (±1 hour) and measured in accordance with Paragraph 4.5. Place the finished shell in an ambient air pressure chamber and vary the pressure in the chamber. Starting at ambient pressure, lower the pressure to simulate a 12,192 m (±91.44 m) (40,000 ft (±300 ft)) altitude and hold the pressure for a minimum of one hour. Then raise the pressure to simulate a 4,572 m (±91.44 m) (15,000 ft (±300 ft)) altitude. Hold the pressure for a minimum of one hour. Then pressurise the chamber. The change rate of the air pressure is 4,572 m/min (1,500 ft/min) to 609.6 m/min (2,000 ft/min). The finished shell shall be visually examined against the requirement of Section 13.4.1. Failure to meet the requirements of this test shall constitute a test failure.

13.4.1 Testing

a. All helmet components of the finished helmet, including the finished shell, the pad suspension system, retention system, and hardware, shall exhibit no structural, visible, or operational degradation, or physical damage when subjected to altitudes from sea level to 4,572 m (15,000 ft) equivalent pressure and 12,192 m (40,000 ft) equivalent pressure. The test temperature at the 12,192 m (40,000 ft) equivalent pressure should be approximately -50°C (±2°C).

b. The finished shell shall exhibit no cracking, delamination, separation of plies, distortion, softening, or other deterioration. The retention system shall be operable (webbing slides, retention system can be cinched down, etc.) and shall have no cracked or damaged components, or other deterioration. The suspension system (pads and hook disks) shall not have suffered any degradation or damage.

13.5 VIBRATION (OPTIONAL)

a. This test is designed to ensure that the primary helmet structure remains sound and that ancillary items remain intact and functional when the helmet system is exposed to vibrations typical of exposure during transport and operation.

b. Helmets in operational use or during storage and transport via wheeled vehicle, rail, air, or ship may experience vibration that loosens or causes de-bonding and fracture between attachment points or mechanical interfaces. Key interfaces potentially affected by vibration include but are not limited to:

(1) Nut and bolt interfaces;

(2) Edge trim to helmet bond interfaces,;

(3) Exterior layer (e.g., polyvinyl chloride or carbon fibre caps) to interior layer bonding interfaces;

(4) Suspension system attachment mechanism interfaces;

(5) Mandible guard or visor attachment mechanism interfaces; and

(6) Integration fixture or adaptor (e.g., integrated night vision device mounting, rail accessories; or supplementary protection interfaces).

c. It is recommended that vibration testing be conducted to assess vibration risk and ensure vibration cannot cause operationally relevant damage to finished helmets.

13.5.1 Test Configuration

a. The helmet should be tested in the as worn condition. The as worn condition is a finished shell configured with a suspension system, retention system, and any other operationally relevant features that are integral to the use of the helmet and that are procured with the helmet.

b. If a particular feature (e.g. a night vision mounting bracket assembly or a helmet cover) is not procured with the helmet, that feature may be excluded from the test at the discretion of the testing authority. In such cases, a vibration test with that excluded feature should be conducted during procurement of the excluded feature.

13.5.2 Testing

a. The helmet should be tested in accordance with MIL-STD-810, Method 514.6G(1), Procedure II (Loose Cargo Transportation) or equivalent standardised test methods, including:

(1) Def Stan 00-035 Environmental Handbook for Defence Materiel Part 3 Environmental Test Methods Issue 5.

(2) STANAG AECTP 400 Ed 3 method 401. Pages 5 – 82.

(3) MIL-STD-810G – Part 16 (Vibration) Method 514.6, Procedure II.

(4) BS EN 60068 series of vibration tests.

b. The vibration test chosen should approximate the various environments to which the helmet shall be subjected.

13.5.3 Criteria

a. When subjected to vibration, no finished helmet components including the finished shell, suspension system components, retention system, and hardware shall exhibit structural, visible, operational degradation or physical damage.

b. There should be no damage that renders the helmet unserviceable by the established criteria for the independent helmet components such as peeling, fracturing, separation, delamination, or fraying.

c. Minor coating and edging scuffing, marring, or wear marks are acceptable.

d. No helmet parts shall become loose or disassembled when subject to vibration. “Loose” shall be defined as not meeting the original adhesion, tightness, or torque (as applicable) as when manufactured or assembled.

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CHAPTER 14 HELMET MARKING

14.1 REQUIREMENT

a. Helmet marking will be provided in the form of a durable label, bonded securely to the surface of the inside of the helmet shell, easily accessible, in accordance with the drawing listed in Figure 13.

b. The labels are to be clearly and indelibly marked with the information listed in Figure 13, with a minimum of 2 mm high characters:

[HELMET NAME]

Size:
Origin:
DoM:
NATO STOCK No:
CONTRACT No:
SERIAL No:
BATCH No:

Figure 13 - Helmet Label Marking

c. The location and dimensions are to be determined by the NA.

d. In addition to, or in lieu of, a QR code or RFID can be applied.

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CHAPTER 15 FLAMMABILITY TESTING

15.1 OVERVIEW

a. These tests are performed to ensure that there are no liquid traps on the exterior of the helmet and that the helmet material or finish is self-extinguishing within the defined period of time.

b. The tests must be conducted with the helmet worn as in general service. e.g. shrouds, rails, helmet cover, etc.

15.2 HELMET FLAMMABLE LIQUID TRAP

a. This test is performed to ensure there are no liquid traps on the exterior of the helmet and helmet cover, and that the helmet is self-extinguishing within the defined period of time. The helmet must be tested with the helmet cover in-place.

b. Test procedure: Test in accordance with PSDB Protective Headwear Standard for UK Police (2004) Public Order Helmet. Publication Number 21/04 paragraph 8.

15.3 HELMET FLAME TEST

a. This test is performed to determine the flammability properties of the helmet shell/finish.

b. Test procedure: Test in accordance with PSDB Protective Headwear Standard for UK Police (2004) Public Order Helmet. Publication Number 21/04 paragraph 9.

15.4 HELMET COVER VERTICAL FLAME TEST

a. In accordance with EN ISO 15025:2002 or ASTM D 6413 (NA decision), a specimen of the helmet cover material is positioned vertically above a controlled flame and the bottom edge posed for a specified period of time.

b. The flame is then removed, and the after flame time and afterglow time are measured.

c. Char length is measured under a specified force and any evidence of melting or dripping is noted.

15.5 HELMET ANCILLARY FLAME TEST

a. In accordance with EN 13087-7, the shell, shroud and rails shall not emit a flame after a period of 5 s has elapsed from removal of the burner.

b. The burner shall be applied for a period of (5 ± 1) s to the component as mounted on the helmet.

15.6 SAMPLE SIZE

a. A total of three helmets/covers for each FR test must be performed.

b. Helmets/covers may be reused as long as the area of previous damage does not interfere with the area being tested.

CHAPTER 16 PRIMARY BLAST DURABILITY

16.1 OVERVIEW

a. This chapter defines two primary blast integrity/durability test options to ensure that the helmet and associated systems remain usable after a survivable primary blast event. The NA is encouraged to select the most appropriate based upon role.

b. This test does not assess the survivability of an individual from primary blast, but assesses the integrity of the equipment to ensure that it remains in place to ensure that it affords suitable protection.

16.1.1 Option 1 - Test Description

a. A charge size of 0.5 kg (±10 g) PE4 (hemispherical) will be surface emplaced onto LBF sand.

b. A mannequin of representative mass (~75 kg) will be dressed in representative combat equipment and/or Military Personal Protective Equipment (PPE) for assessment.

c. The following positions and distance from the charge are recommended:

1. Prone (1 m from visor);
2. Kneeling (1 m from toe);
3. Standing (1 m from toe).

d. Up to four mannequins will be emplaced at 90° increments from the charge, allowing NAs to utilise high speed video, blast pressure gauges, etc., for additional recording if required.

e. The Military PPE and combat equipment will be inspected post blast for durability and integrity. Scoring will be based upon visual inspection involving the following criteria:

1	Failure / detachment and fails to provide full protection
2	Remains attached but fails to provide full protection
3	Failure / detachment but appears to provide protection
4	Remains attached and appears to provide protection

Table 8 - Assessment of CPE Scoring

16.1.2 Option 2 - Test Description

a. A charge size of 5.0 kg (±10 g) PE4 (hemispherical) will be surface emplaced onto LBF sand.

b. A mannequin of representative mass (~75 kg) will dressed in representative combat equipment and/or Military PPE for assessment.

c. The following positions and distance from the charge are recommended:

1. Prone (5 m to visor);
2. Kneeling (5 m to toe);
3. Standing (5 m to toe).

d. Up to four mannequins will be emplaced at 90° increments from the charge, allowing NAs to utilise high speed video, blast pressure gauges, etc., for additional recording if required.

e. The Military PPE and combat equipment will be inspected post blast for durability and integrity. Scoring will be based upon visual inspection involving the following criteria:

1	Failure / detachment and fails to provide full protection
2	Remains attached but fails to provide full protection
3	Failure / detachment but appears to provide protection
4	Remains attached and appears to provide protection

Table 9 - Assessment of CPE Scoring

16.1.3 Failure Criteria

a. It is recommended that any article of Military PPE/combat equipment achieving a score of 1 or 2 is deemed as unacceptable.

16.2 SAMPLE SIZE

a. At least six articles of combat equipment/Military PPE will be assessed against Table 8/Table 9.

CHAPTER 17 COMBAT IDENTIFICATION

17.1 OVERVIEW

a. A hook and loop system shall be available for passive visual/IR patches to be applied to the front, rear and sides of the helmet. Active combat identification methods i.e. IR strobes, can be mounted using hook and loop or side rails.

b. It is recommended that the helmet has the ability to accept a hook and loop patch on each side, rear, crown and in front above the shroud.

c. Minimum size for the IR patches is 40 x 40 mm and they are to be mounted one on each side, front and crown. The hook and loop patches on the helmet must be of size that could accommodate both IR path and an IR strobe at the same time.

d. Figure 14 below, are recommend locations for helmet mounted combat ID.

Figure 14 - Helmet IR combat ID locations

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CHAPTER 18 HUMAN FACTORS

18.1 OVERVIEW

a. In addition to the protection and platform capability of a helmet, there are a range of human factors requirements including that the helmet can fit the soldier and is stable on the head whilst allowing the soldier to conduct their mission-essential tasks. Ergonomic attributes such as the fit, comfort, stability and integration of the helmet with other clothing and equipment systems affect operational performance and overall acceptability by the user population. This procedure aims to define ergonomic evaluation by establishing objective and subjective criteria that can be taken into consideration in the process of technical evaluation of tenders.

b. The helmet is a product system with the components, the shell, retention system, and suspension system, working together to provide the soldier with the required capability. The system is comprised of many interdependencies and relationships. For example, stability is affected by the fit of the helmet and, in turn, comfort is affected by both the fit and the stability. Therefore, although each human factors attribute is discussed individually below, the testing regime should be considered in a holistic approach.

c. Specific test methods are recommended but it should be noted that after a regime of testing, it is useful to conduct focus groups with the sub-set of users to allow further exploration of the human factors issues and to provide an opportunity for the subjects to provide more information on the fit, form and function of the helmet system.

18.2 HEAD SIZE

a. Anthropometric measurements of the head are required to assign helmet sizes to users based on the manufacturer's sizing criteria, to then assess if the sizing of the helmet range is appropriate for the population and to identify where problems relating to fit or discomfort may exist. The head measures relate to the sizing and fit of both the helmet shell/suspension system as well as the retention system/chin strap.

18.2.1 Test Methods

a. Head size measurements will be (in accordance with EN 960:2006 – Headforms for use in the testing of protective helmets)

i. **Head Length**

Description: Distance along a straight line between the glabella and the rearmost point of the skull.
Method: Position of head has no influence on the measurement but to reduce measurement error, subject is positioned in Frankfort plane.
Instrument: Spreading calliper.
Purpose: The head length is used to size the helmet for the individual and to aid the assessment of fit.

ii. **Head Breadth**

Description: Maximum breadth of head above the ears [measured perpendicular to the midsagittal plane].
Method: Position of head has no influence on the measurement but to reduce measurement error, subject is positioned in Frankfort plane.
Instrument: Spreading calliper.
Purpose: Head breadth is used to size the helmet for the individual and to aid the assessment of fit.

iii. **Bizygomatic Breadth (Optional)**

Description: Maximum horizontal distance is measured across the face between the zygomatic arches (cheekbones).
Method: Subject faces straight ahead, in Frankfort plane, with teeth lightly closed but not clenched.
Instrument: Spreading calliper.
Purpose: Bizygomatic breadth is used to size the helmet for the individual and to aid the assessment of fit.

iv. **Face Length (Optional)**

Description: Distance between nasion and menton.
Method: Subject keeps mouth closed with teeth lightly closed but not clenched. Subject looks straight ahead in Frankfort plane.
Instrument: Sliding calliper.
Purpose: Face length is used to size the face/mandible protection for the individual and to aid the assessment of fit.

v. **Head Circumference**

Description: Maximum, approximately horizontal, circumference of head measured above the glabella and crossing the rearmost point of the skull.

Method: Subject is positioned in Frankfort plane. Tape measure is held on the glabella and led around the head so as to pass over the rearmost point of the skull. Hair shall be included in the measurement. Subjects should ensure hair is flat with no plates or braids.
Instrument: Steel tape measure.
Purpose: Head circumference is used to size the helmet for the individual and to aid the assessment of fit.

vi. **Head Arch (Frontal)**

Description: Maximum distance is measured across the skull between both left and right auricular point (hearing channel).
Method: Subject faces straight ahead with teeth lightly closed but not clenched. Hair shall be included in the measurement. Subjects should ensure hair is flat with no plates or braids.
Instrument: Steel tape measure.
Purpose: The Bitragion Coronal Arc is used to help determine required adjustments to the suspension system and aid the assessment of fit.

vii. **Head Arch (Sagittal)**

Description: Maximum distance is measured across the skull between Glabella and the Inion.
Method: Subject faces straight ahead with teeth lightly closed but not clenched. Hair shall be included in the measurement. Subjects should ensure hair is flat with no plates or braids.
Instrument: Steel tape measure.
Purpose: The Head Arch is used to help determine required adjustments to the suspension system and aid the assessment of fit.

viii. **Glabella to Vertex Height**

Description: Distance along a straight line between the glabella and the vertex (highest point of the head).
Method: Subject faces straight ahead in Frankfort plane with teeth lightly closed but not clenched.
Instrument: Sliding calliper.
Purpose: Glabella to Vertex Height is used to identify if the helmet is sitting at the correct height relative to the brow bone. The brow bone is often used as a reference point by manufacturers to ensure fit and coverage.

ix. **Bitragion Chin Arc**

Description: Maximum distance is measured under the bottom of the chin between left and right tragion.
Method: Subject faces straight ahead in Frankfort plane with teeth lightly closed but not clenched.
Instrument: Steel tape measure.
Purpose: The Bitragion Chin Arc is used where there are different options of retention strap length and to aid assessment of fit issues related to the retention strap.

b. **Helmet size**

i. Helmet sizes are required to accommodate the entire intended population of users whilst ensuring satisfactory fit for each individual within the population. The military population have a range of head shapes, varying in length, breadth and circumference. Although possible, it is not financially viable to manufacture a bespoke helmet system for each individual. Therefore, helmet systems are manufactured in a limited number of sizes based on head circumference. Each size is adjustable to accommodate for a small range of circumferences, as well as individual variability in head breadth and length.

ii. Once the range of sizes is defined, the fit of the helmets must be assessed across the population of interest, the user community. This is to ensure that the vast majority of individuals can wear the available helmet sizes. It is important that fit is consistent so that each user has the same level of protection and coverage, with the same level of impact on their ability to conduct their role.

iii. NAs should use their own anthropometric data to devise helmet sizes, but in the absence the following information from EN 960:2006 is recommended:

Helmet	**EN 960:2006 Head Circumference (mm)**	**Head Length (mm)**
Extra Large	625	200-220
Large	605	190-210
Medium	575	180-200
Small	545	160-180
Extra Small	525	<160

Table 10 - Head Dimensions

18.2.2 Test Methods

a. Helmet fit is assessed through subjective measure of fit (Section 18.1) and subjective feedback on comfort (Section 18.4). Testing should be conducted on users whose head measurements represent an anthropometric spread across the intended user population. Additionally, size and fit will also affect the protective coverage of the helmet. These factors will need to be balanced across the full assessment of a helmet system.

b. Equally, stability of a helmet will also be influenced by the fit and should be considered when comparing helmet systems and different sizes (Chapter 8 and Section 18.2).

c. The overall time/duration of testing will be determined by the NA.

18.3 FIT AND ADJUSTMENT

a. The overall fit of a helmet is affected by the shell shape, the shell size, the suspension system, the retention system, the position of the helmet, the required stand-off and the head shape and size of the user. If the helmet is too loose then it will not provide the function of stabilising the helmet, yet if it is too tight then it can cause problems with discomfort, pain, and headaches. Therefore, tests of stability (Section 18.2) and discomfort (Section 18.4) can be used as an indicator of problems with fit.

b. Irrespective of the number of helmet sizes produced, it is unlikely that a helmet is going to fit a user perfectly when they first put it on and so adjustability is required. As the helmet shell is a rigid structure which is not designed to dynamically conform around different shapes of head; the material, coverage, thickness and adjustability of the suspension system and the retention systems are key to fitting different head shapes.

18.3.1 Test Methods

a. In order to assess the fit and adjustment of a helmet, a sub-set of users should be sized and fitted for a helmet using the manufactures guidelines. Subjects should then perform a number of dynamic movements and then be asked questions. Use of a rating scale, similar to the 5-point scale presented below, to determine if the fit and level of adjustability is adequate is recommended.

b. NAs must define suitable and appropriate dynamic activity/functional activity.

c. How acceptable was it to fit the helmet?

Totally acceptable	Acceptable	Neutral	Unacceptable	Totally Unacceptable
O	O	O	O	O

b. Questions should include asking participants to rate the following (additional questions may be added by the NA):

i. The overall fit of the helmet.
ii. The range of adjustment provided on the retention system to fit the helmet.
iii. The position, comfort and fit of the suspension system pads.
iv. The position of the chin strap.
v. The position of the chin strap buckle.
vi. The position of the retention straps (front).
vii. The position of the retention straps (rear).
viii. The position of the retention strap buckles.

c. Part of the assessment of fit should be to ensure that any coverage requirements are met (Chapter 9).

d. Helmet fit should be assessed with just the helmet alone and also with the helmet and all other items of face/head-borne equipment such as ocular and hearing protection.

18.4 STABILITY

a. Stability refers to the ability of the helmet to remain in a constant orientation once it has been subject to dynamic movement and exposed to loads, such as NVDs and other helmet-mounted equipment. The fit, the retention system, the suspension system, the mass properties, the users head shape, hair and skin can all affect the stability of the helmet.

b. Any instability can, in turn, affect comfort and also be a cause of distraction to the user. Instability is also exacerbated when additional load is added. This is especially problematic when NVDs are in use as the helmet movement can cause the NVDs to move out of alignment with the eye and affect the user’s visual awareness of the operational environment.

c. Instability can be indicative of problems with fit and may introduce issues with comfort. Therefore, tests of discomfort can be used as an additional indicator of stability problems.

18.4.1 Test Methods

a. The stability of the helmet can be measured subjectively and objectively. Objective measures include the test detailed in Chapter 8.

b. Subjective measures should be administered to a sub-set of users who have worn the helmet whilst conducting representative, dynamic military tasks. Subjects should be asked questions similar to the below:

c. How stable did the helmet feel?

Very stable	Slightly stable	Neutral	Slightly un-stable	Very un-stable
O	O	O	O	O

d. Qualifying questions can be asked to ascertain the cause of the instability.

e. Test methods for stability with NVDs are presented in ‘Integration with NVDs – Test Methods’ (Section 18.12.1)

18.5 EASE OF USE

a. In addition to the actual fit, the ease and time required to don and fit the helmet is of importance. When issued with a new helmet, or any item of equipment, there is a period of time required to perform the required adjustments to ensure that the item is correctly fitted and configured for the user. These adjustments can be carried out without time demands.

b. However, the fastening and adjustments that must be conducted every time a combatant dons the helmet, or has to don/doff hearing protection, need to be easy and quick as they may be performed in a time critical situation.

c. Ease of use is, therefore, ensuring that fastening and adjustments can be conducted easily and quickly as they may be performed in a time critical situation, potentially whilst the combatant is wearing patrol or cold weather gloves. Factors such as the type of adjustment mechanisms, the number of adjustments, and the wearing of gloves contribute to the ease of use.

18.5.1 Test Methods

a. A sub-set of users should conduct integration trials where helmet donning, fastening, adjusting and doffing are conducted in all possible types of gloves as well as with bare-hands.

b. Questions can be administered to determine the ease and acceptability of the participant to conduct the tasks whilst wearing different glove conditions. A scale of ease-difficulty can be administered as well as a scale of acceptability.

c. How easy was it to fit the helmet with gloves?

Very easy	Easy	Neutral	Difficult	Very difficult
O	O	O	O	O

d. If valid, then testers can specify a time in which the helmet should be able to be donned, fastened and adjusted. This time may be associated with specific operational scenarios. Subjects can then perform timed trials.

18.6 PHYSICAL COMFORT

a. The physical comfort, or discomfort, of the helmet is affected by a number of factors related to the HBS; retention system, suspension system, fit, stability, mass, CoM, and position of the helmet. It is also affected by history, emotional state, aesthetics, duration of wear, and overall user acceptance. Discomfort can cause headaches, lead to distraction, affect user acceptance and ultimately affect cognitive and physical performance.

18.6.1 Test Methods

a. Comfort is a psychophysical factor and so is measured subjectively. A sub-set of users should wear helmets, which have been properly sized and fitted to ensure correct fitment and stability, and conduct a number of representative military tasks for a sufficient period of time. Questions on physical comfort can then be administered.

b. The most effective method of obtaining data on physical comfort is to use a body diagram (in this case a head diagram) that divides the body into segments and have users indicate the location, the level, and the type of discomfort experienced. The head diagram should include front, rear, side and top views. The level of discomfort can be recorded using a rating scale such as the Borg CR-10 pain scale or another scale of discomfort such as that indicated in Table 11.

1	Neutral/No discomfort
2	Minor fatigue
3	More fatigue
4	Mild discomfort
5	Moderate discomfort
6	Ache
7	Minor pain
8	Pain
9	Severe pain
10	Extreme pain

Table 11 - Pain Scale

c. Common types of discomfort associated with helmet use are pressure, pain, headaches/migraine, neck strain, neck fatigue, ache, rubbing, and skin inflammation.

d. As some level of discomfort is to be expected, a qualifying question asking how acceptable subjects found the level of discomfort is useful.

18.7 THERMAL COMFORT

a. When a combat helmet is worn a microclimate between the inside of the helmet and the skin surface is formed which reduces the transfer of heat from the skin. This microclimate has the potential to increase the thermal burden placed on the wearer by affecting thermoregulatory mechanisms involved in maintaining thermal balance. Elevation in core temperature can lead to heat strain which will impair cognitive and physical performance as well as leading to heat illness.

b. Thermal comfort is an important aspect of thermal burden which can also impair cognitive and physical performance. In addition to the external environment and work rate, the shell, suspension system, fit of the helmet and the overall mass have been identified as factors which influence the thermal comfort felt by a person wearing a helmet. Skin wettedness, sweat accumulation, skin temperature and thermal sensation all influence thermal comfort.

c. It is important to note that it is not the helmet alone that causes problems but the combination of all the clothing and equipment, including a helmet, that a soldier must wear that can impede the ability of the body to loose heat.

18.7.1 Test Methods

a. Thermal burden should be assessed during rest and a range of operationally relevant exercise activities. The heat stress applied should represent both compensable[4] and uncompensable[5] heat stress. There are a number of objective measurements that can be used for such assessments; the exact measurements used will depend on the activity that the individual is conducting due to constraints with the measurement techniques (for example if the activity is laboratory or field based) and the design of the helmet. Objective measurements may include core temperature, skin temperature, heart rate, sweat rate (total sweat rate or continuous sweat rate) and hydration status.

b. Thermal comfort of the helmet is subjectively assessed using scales for thermal sensation, thermal comfort and skin wettedness as well as questionnaires which include head diagrams. The questions should represent how the wearer feels overall as well as targeting particular locations that are subject to hot spots.

c. As with physical comfort, a qualifying question asking how acceptable subjects found the level of discomfort is useful.

18.8 MASS

a. Excessive mass carried on the head is detrimental to operational performance, may lead to increased risk of musculoskeletal injury, and is likely to be unacceptable to users. It therefore needs to be minimised, within the constraints imposed by other protection requirements, such as coverage and ballistic performance.

b. The requirements for minimising mass carried on the head are not universally defined, since the ability to operate effectively depends on numerous factors. These factors include: the task being carried out and the environmental conditions, as well as individual physical fitness, history of and propensity to musculoskeletal injury and the level of fatigue created by the mass burden. It is likely that users will reject a future system that increases perceived physical burden, unless it offers significant functional improvements.

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[4] Thermoregulation is able to compensate for the heat load. Core temperature will reach a steady state albeit at a higher level than at rest.

[5] Thermoregulation is unable to compensate for the heat load. Core temperature will continue to rise.

c. The mass of the helmet alone is not the only consideration. The combined mass of the helmet plus helmet mounted items such as NVDs needs to be considered. It is recommended that the weight distribution of helmet mounted items should be balanced to avoid or minimize neck strain, fatigue, and helmet movement relative to the operator's head.

d. In order to mitigate against injury to the cervical spine, whilst still providing adequate protection to the head, it is important to consider the mass that can be safely borne on the head without causing undue strain or discomfort. Thus, it is important that a safe weight limit and distribution around the centre of mass is better defined within the DCC domain and be included in any future version of this STANAG.

e. It is recommended that 1.5 kg is the upper threshold for user acceptance of a helmet.

18.8.1 Test Methods

a. Helmet mass can be objectively calculated by placing a helmet, individually, on a calibrated scale. Mass will be recorded to the nearest 0.01 kg.

b. Subjective measures can be captured on the acceptability of the overall mass. A sub-set of users should wear the helmet whilst conducting a range of representative military activities for a period of time. The following questions can them be administered along with a scale for rating acceptability.

c. The weight of the helmet was:

Totally acceptable	Acceptable	Neutral	Unacceptable	Totally Unacceptable
O	O	O	O	O

d. Such testing should be conducted with a slick helmet and with helmet-mounted equipment attached such as NVDs.

e. Data on discomfort and fatigue that may be associated with the helmet mass are addressed in ‘Physical Discomfort’ (Section 18.4).

18.9 CENTRE OF MASS/CENTRE OF GRAVITY

a. The head has a natural Centre of Mass (CoM) and any changes to the weight distribution of the head, such as the addition of a helmet, causes a change in the CoM[6]. This change is further exacerbated with the addition of helmet-mounted equipment such as NVDs.

b. CoM is a quasi-static measurement that describes the biomechanical effect of gravitational forces on the head mounted load (HML) which result in flexion or extension and/or lateral bending. The further the resultant CoM moves away from the head's natural CoM results in greater fatigue of the neck muscles, increased stress to the neck muscles, higher levels of discomfort, and increased potential for damage. CoM can, therefore, have an indirect effect on operational performance secondary to the fatigue of the neck muscles and the associated discomfort. A helmet with a forward, low CoM is preferable.

18.9.1 Test Methods

a. There are number of different methods for objectively measuring the CoM of the head/helmet system.

b. Subjective measures can be captured on the acceptability of the overall CoM. A sub-set of users should wear the helmet whilst conducting a range of representative military activities for a period of time. The following question can then be administered along with a scale for rating acceptability.

c. The balance/weight distribution of the helmet was:

Totally acceptable	Acceptable	Neutral	Unacceptable	Totally Unacceptable
O	O	O	O	O

d. Such testing should be conducted with a slick helmet and with helmet-mounted equipment attached such as NVDs.

e. Data on neck fatigue and neck strain that may be associated with increased CoM are addressed in 'Physical Discomfort' (Section 18.6).

f. This test should also be repeated with ancillary equipment, such as NVDs.

18.10 INERTIA

a. Whereas mass and CoM are considered static measures when related to a helmet, inertia represents a dynamic measure of mass. Inertia is a physical property of the helmet that determines the resultant torque on the cervical

[6] Centre of Mass and Centre of Gravity are used interchangeably.

spine when moving the head. The larger the inertia, the more muscle activity is required to generate sufficient torque to move the head toque required to move the head and more muscle activity is required to stop the head from moving.

b. Similar problems with increased neck muscle activity causing fatigue and resultant discomfort and pain are seen with an increase in inertia as they are with an increase in CoM. The increase in inertia can reach a point where the torque created is more than the neck muscles can control.

c. Increase in inertia can have a direct effect on operational performance in the form of delayed head movements which could cause a deficiency in performance of tasks include tracking and sighting of targets. Indirect effects of increased inertia are caused by neck muscle fatigue and discomfort.

18.10.1 Test Methods

a. There are number of different methods for objectively measuring the inertia of the head/helmet system.

b. To subjectively assess inertia, a sub-set of users should conduct military representative activities and then be administered questions similar to those below.

c. Did you experience problems with slowed head movements?

d. Did you find it difficult to stop your head from rotating when looking left/right?

e. Data on neck fatigue and neck strain that may be associated with increased inertia are addressed in ‘Physical Discomfort’ (18.6).

18.11 SITUATIONAL AWARENESS

a. On the battlefield, the dismounted combatant must be aware of what is going on around him/her. This is known as Situation Awareness (SA) and it is critical to operational effectiveness and survivability. SA involves perceiving cues, comprehending information and projecting future actions. The cues in the environment are detected through different senses. As the head is the centre for all senses except touch, addition of equipment such as a helmet to the head can degrade a combatant’s ability to perceive cues. The helmet does not have a large impact on the combatant’s ability to comprehend the information or project future actions. The helmet, therefore, mostly affects the ability to perceive cues which can directly affect operational performance.

b. The perception of cues is broken into visual awareness/field of view (FoV), auditory awareness, and speech intelligibility (SI).

18.11.1 FIELD OF VIEW

a. The visual requirements for a dismounted combatant are to maintain a full, unrestricted FoV and ability to scan his/her surroundings to enable perception of visual cues. The ability for a soldier to view their team, their equipment, and their surroundings is paramount.

b. Factors such as the shape, cut, fit, position, suspension system and retention system of a combat helmet can impede the combatant's FoV. Visual awareness is not just related to the helmet system but is a factor that must be considered when additional components such as ocular protection (glasses & goggles), maxillofacial protection, and respirators are used, as vision must be maintained when these are employed with the helmet.

c. It is suggested that a combination of methods is utilised to provide a better overall indication of VA.

18.11.1.1 Test Method 1

a. The test methods currently related to assessing visual awareness (VA) are associated with determining a delta between a helmet and no-helmet condition (or between different helmet conditions).

b. Adaptations of the Goldman Perimeter test can be conducted with a helmet to measure angle of detection. This is an objective measure of the visual field which utilises a headform and helmet. The headform is fitted with two lightbulbs in the centre of each eye position and is placed on the Goldman Perimeter spherical peripheral vision tester which resembles a large down placed on its side. The standard visual area is plotted on a 360º chart and the visual area illuminated when the helmet is placed on the headform is then recorded on the chart to enable identification of the delta in FoV between the no-helmet and the helmet condition.

c. Real users can also be used to capture both objective and subjective data on VA. Two measuring tapes can be affixed to a wall, one vertically and horizontally and subjects indicating the most right and left lateral, vertically high and low points that they can see. This is achieved by a researcher, starting outside the subject’s FoV, holding a marker on the tape measure and slowly walking the marker down the length of the tape towards the centre. The point at which the subject sees the marker can then be recorded by the researcher and can be translated into an angular delta between a helmet and no-helmet condition. It is important to ensure that the head remains in the same location and at the same angle for both tests for all users conducting the test.

18.11.1.2 Test Method 2

a. Objective data collection with users is that a sub-set of users can conduct a series of weapon handling drills where they are required to sight moving targets which enter the visual field from a variety of positions. Time to sight the targets can be recorded in a no-helmet and helmet condition and the timing delta calculated. These drills should be conducted in different postures. These results can provide a more operationally relevant measure of VA.

b. After conducting a series of representative military scenarios, participants can be asking to subjectively rate their FoV and peripheral vision whilst wearing the helmet on a scale such as that indicated below.

c. The FoV/peripheral vision was:

Totally acceptable	Acceptable	Neutral	Unacceptable	Totally Unacceptable
O	O	O	O	O

18.11.1.3 Test Method 3

a. EN 13087-6:2012 can be used to assess the field of vision.

b. Guidelines and requirements in accordance with EN 13087-6:2012, Test methods, Part 6: field of vision, should be followed.

c. The required Field of View is required to be at least: Horizontal: left/right +/- 90°, Vertical: up: 40° / down: 40°.

18.11.2 AUDITORY AWARENESS (Optional)

a. The auditory requirements for a dismounted combatant are to maintain auditory awareness of the battlefield to enable detection, identification and localisation of a sound(s). Localisation involves determining both the distance and direction of a sound source and uses both monaural (one ear) and binaural (both ears) cues. Helmets are more likely to affect sound localisation rather than sound detection.

b. As well as perceiving sounds, auditory cues can also be the absence of a noise or signal. Auditory cues are often the first indication that there have been changes in an environment because hearing functions through a full 360˚.

c. The aural sensory perception of a combatant can be impeded by the thickness, material, helmet rim and shape/cut (degree to which the ear and ear canal are occluded) of a helmet. The suspension system can also affect auditory localisation by impacting monaural and binaural localisation cues. Directional errors can also be introduced by the use of a helmet.

d. Limitation: Auditory awareness, and the associated outcome measures, are relevant to helmet without the use of hearing protection. There are many issues surrounding the use of hearing protection but these are not addressed in this STANAG.

18.11.2.1 Test Methods

a. ANSI S12.6-2016 (American National Standard Methods for Measuring the Real-Ear Attenuation of Hearing Protectors) uses a measure of real-ear attenuation (REAT) that can be utilised to assess the impact of helmets on sound attenuation.

b. Sound detection can also be assessed by presenting different sounds, at different decibels (dB), from different locations (spanning in front, behind, to the side, and above the subject) and recording the dB at which the subject detects the sound. This test should be conducted on a sub-set of users from the intended population and it is important to conduct a hearing assessment of each subject at the outset of the testing in order to identify any hearing deficiency which may affect the outcome of the assessment. Such tests have previously been conducted in a sound booth, anechoic chamber and reverberant environment.

c. Sound localisation can be assessed by presenting different sounds, at different decibels, from speakers in a wide variety of locations and having participants indicate the direction/location of the sound. The sounds and background noise can be made military specific, i.e., the sound of gun shots. The indication can be made by the subject in a number of ways including verbally or via a laser pointer. Metrics for sound localisation include mean localisation error (difference between actual and report location), percentage of errors/percentage of correct location identification (both for total and as a percentage of correct side), and angular error.

d. Subjective measures of perceived problems with sound detection and localisation can also be gathered from a sub-set of users conducting representative military tasks.

18.11.3 SPEECH INTELLIGIBILITY (Optional)

a. In addition to auditory awareness, operational success is dependent on combatants to have high levels of speech intelligibility (SI) i.e. to hear and understand verbal and transmitted communications. There are three requirements of SI; clear speech by the talker (speech articulation), non-restrictive transmission/distorted channel (speech transmission), and good hearing/speech comprehension by the listener (speech recognition).

b. There are a number of factors that can affect SI. A helmet can impact speech articulation and speech recognition through impairment caused by components such as the retention system, visor or mandible protection.

c. NAs may dictate the noise environment that these tests are conducted.

18.11.3.1 Test Methods

a. Under the topic of SI, MIL-STD-1472 G (2012) recommends that the modified rhyme test (MRT) as described in ANSI/ASA S3.2 (American National Standard Method for Measuring the Intelligibility of Speech over Communication Systems) is used. The MRT measures the communication performance of military communication systems and can be applied to the measurement of SI.

b. MIL-STD-1472 G (2012) also recommends that the articulation index (AI) and/or speech transmission index (STI), which is a measure of speech transmission quality, should be used as a predictive estimator of intelligibility. MIL-STD-1472 G (2012) provides a table of intelligibility criteria.

c. SI tests should be conducted in different noise environments including acoustic shock (loud, impulsive sounds).

18.12 COMPATIBILITY AND INTEGRATION

a. Helmet design must incorporate an ability to be compatible with or integrate with current and potential future soldier system equipment such as weapons, night vision devices (NVD), communications and personal protective equipment such hearing protection, ballistic eyewear and body armour. Failure of a helmet to allow for proper integration may be cause for a soldier to reject wearing of the helmet.

b. When considering integration and compatibility with HBS there are two factors to consider: an item of equipment must not impact the ability of the HBS to be worn in the prescribed position and the HBS must, in turn, not impede the ability of the other item of equipment to be worn/used properly. For example, when wearing ballistic glasses, both the HBS and the glasses should be able to be worn in the prescribed position. Similarly, when using a weapon system, the HBS should allow for the user to achieve a sight picture without any impediment and subsequence effect on performance whilst the HBS remains in the prescribed position. All issues with integration and compatibility have the potential to impact the operational performance or protection of the dismounted combatant.

18.12.1 Integration with NVDs – Test Methods

a. Helmet mounted NVDs are designed such that the display is positioned in front of the eyes, resulting in most of the weight being located anteriorly on the head. This can add extra flexor moment to the head-neck complex unless effectively balanced, compounding the work required of the posterior neck muscles to control head movement. The ergonomic recommendation is to choose NVD systems which produce the smallest overall moment of inertia with respect to the neck joints, allowing for symmetric balance. They should have a small mass, be symmetrically balanced, and aligned to the head's centre of mass and close to the head. Nevertheless, additional loads from the helmet and NVDs are only likely to increase muscle fatigue.

b. Wearing NVDs also reduces peripheral vision, so is likely to increase head movements and thus accelerate the onset of fatigue. CoG and Centre of Mass (CoM) will also be affected by choosing a monocular design over binocular NVDs: the monocular may be lighter, but any asymmetrical distribution may also increase strain on specific muscles and increase neck pain.

c. It is recommended that NVDs are also worn when conducting the stability test described in Chapter 8.

d. In addition to the added mass, increased CoM, and flexor moment caused by the addition of NVDs, the soldier must be able to position the NVDs such that the optical axes align with their line of sight whilst ensuring that correct eye relief is obtained. The NVDs must also remain stable for the duration of use, including when soldiers' are conducting highly dynamic movements.

(1) Position and eye relief - the horizontal, vertical, and tilt of the NVDs should be able to be altered through adjustments in the NVDs and the NVD mount. Subjects should conduct positioning tests and be asked whether there was sufficient adjustment to allow them to align the optical axes with their line of sight and whether they could obtain adequate eye relief.

(2) Balance - prior to conducting dynamic movements subjects should attached NVDs and counterweights. Subjects should then be asked to rate the balance of the helmet. This provides an indication of how well the design of the helmets accounts for the additional forward weight of the NVDs.

(3) Stability - subjects should conduct representative tasks in no-light conditions, using the NVDs and then be asked a number of questions to ascertain the stability of the NVDs. Subjects should be asked questions similar to the below:

a. Was there any movement of the NVDs? Answer options are - No movement / A little movement / A lot of movement.
b. Did the NVDs detach from the helmet at any point?
c. How acceptable was the stability of the NVDs?

Totally acceptable	Acceptable	Neutral	Unacceptable	Totally Unacceptable
O	O	O	O	O

18.12.2 Integration With Common Equipment – Test Methods

a. Compatibility and integration can be broken into several categories to enable identification of potential integration problems and relevant assessment methods. The following list of equipment must integrate with the helmet:

(1) **Body Armour Vest** - Helmets typically do not have any direct integration with body armour PPE when a soldier is in the standing position but consideration has to be given to incidents of integration that can occur upon change of posture of the soldier. Integration issues can include helmets being tipped forward in the prone position from body armour or tactical vests, movement of the helmet from load carriage while on the run and other tactical situations. A sub-set of users should conduct trials that incorporate representative operational tasks. Questions should be administered to identify any integration issues, and the effect they have on effective completion of the tasks.

(2) **Eye Wear** - Helmets must allow for comfortable use of ballistic eye wear either in glasses or goggle format. This can include ensuring pressure points are minimized and retention straps can be utilized. A sub-set of users should conduct integration trials in addition to conducting representative tasks. Questions should be administered to identify any issues with integration, the extent of the issue(s), and the effect of such issues.

(3) **Hearing Protection** - The correct fitting, appropriate use and protection afforded by hearing protection must be allowed when wearing the helmet. A sub-set of users should conduct integration trials in addition to conducting representative tasks. Questions should be administered to identify any issues with integration, such as sealing, physical integration and discomfort. Qualifying questions can be administered to ascertain the level of integration issue and the effect.

(4) **Oxygen Masks (Airborne)** - (Optional) Helmets should allow the use and fitting of oxygen masks. A sub-set of users should conduct integration trials in addition to conducting representative tasks. Questions should be administered to identify any issues with integration, such as sealing, snagging, or task completion. Questions should be administered to identify any integration issues, and the effect of such issues, between the helmet and the mask.

(5) **Respirators** - (Optional) Helmets must allow the rapid donning and correct fit of respirators to ensure that a seal is made. A sub-set of users should conduct integration trials in addition to conducting representative tasks. Questions should be administered to identify any issues with integration, such as sealing, snagging, or task

completion. Questions should be administered to identify any integration issues, and the effect of such issues, between the helmet and the respirator.

(6) **Visors** - (Optional) Helmets should allow the correct fitting of visors. A sub-set of users should conduct integration trials in addition to conducting representative tasks. Questions should be administered to identify any issues with integration, such as snagging, or task completion. If integration issues exist then qualifying questions can be administered to determine the extent of the problem, the cause and the effect.

(7) **Vehicles** - It is recommended that the users wearing helmets and associated systems are assessed for integration into specific and relevant mounted, maritime and air platforms. A sub-set of users should conduct ingress and egress trials in addition to conducting representative tasks within the platform. Questions should be administered to identify any issues with ingress and egress, such as snagging, or task completion.

(8) **Weapons** - Helmets must allow users to use all issued weapon systems without unnecessary modification or adjustment in all firing positions. A sub-set of users should conduct integration trials in addition to conducting representative dry or live firing. Questions should be administered to identify any issues with integration, such as inability to acquire sight picture/sufficient eye relief and obtaining a stable cheek weld. Questions should be administered to identify any integration issues, and the effect of such issues, between the helmet and the weapon system.

(9) **Load Carriage Systems** - Helmets must integrate with issued load carriage systems to ensure interference with the helmet nape area is mitigated. A sub-set of users should conduct integration trials in addition to conducting representative tasks. Questions should be administered to identify any issues with integration, such snagging or physical interference and fouling. Questions should be administered to identify any integration issues, and the effect of such issues, between the helmet and the load carriage system.

(10) **Gloves** - The helmet must be compatibility with gloves and hand protection which a combatant must wear when donning, fastening, adjusting and doffing the helmet. This includes patrol gloves and cold weather gloves. Any impediment may affect the ability of the

user to don/doff the helmet in a time critical situation. A sub-set of users should conduct integration trials and questions should be administered to identify any issues with the use of gloves. If issues are reported then qualifying questions can be administered to ascertain the extent and the effect.

(11) **Eating and Drinking** - The ability to eat and drink should not be impeded.

18.13 USER ACCEPTANCE

a. Every feature, component and attribute of a helmet system has the potential, in some way, to impact upon acceptance of the item by the user. Low user acceptance is associated with equipment rejection through misuse or disuse. Acceptance will vary depending on the user (including role and rank), the type of equipment/clothing, the environment, the mission, and the duration of wear.

18.13.1 Test Methods

a. After conducting a series of representative military scenarios, participants can be asking to subjectively rate their overall acceptance of the helmet on a scale such as that indicated below. Collection of data on user acceptance should be conducted as the last component of an evaluation of a helmet.

b. How acceptable, overall, was the helmet?

Totally acceptable	Acceptable	Neutral	Unacceptable	Totally Unacceptable
O	O	O	O	O

CHAPTER 19 PAINT ADHESION

19.1 OVERVIEW

a. Helmet paint (coating, including primer and final finish) shall suffer no degradation or deterioration after *normal* use and/or storage.

b. This chapter proposes two paint adhesion methods: 1) a mechanical resistance test, and 2) a tape test adhesion test.

19.2 METHOD 1

19.2.1 Mechanical Resistance

a. The paint adhesion test is to be carried out in accordance with EN ISO 2409:2013, on helmet shells with the complete paint system.

b. Prior to testing, the shells are to be conditioned ‘Hot’ and ‘Ambient’, as per ANNEX A.

c. The test is to be carried out using a rotary cutting tool with 6 circular blades at 2 mm pitch as specified in EN ISO 2409:2013.

d. The procedure is to be carried out at three sites on each sample.

e. Six helmets will be sampled.

f. The test area is to be classified visually as described in Table 1 of EN ISO 2409:2013 and the results recorded.

g. The paint adhesion is satisfactory if the classification at all three sites across six helmets is 0, 1 or 2.

h. If the classification is 3, 4 or 5 it is not satisfactory.

19. METHOD 2

19.3.1 Tape Adhesion

a. The paint adhesion test is to be carried out in accordance with ASTM D 3359 Method B, on helmet shells with the complete paint system.

b. The Class is to be determined by the NA.

c. It is recommended that Class 5 is used.

d. For coatings having a dry film thickness up to and including 50 μm space the cuts 1 mm apart and make eleven cuts unless otherwise agreed upon

e. For coatings having a dry film thickness between 2.0 mils 50 μm and 5 mils 125 μm, space the cuts 2 mm apart and make six cuts. For films thicker than 125 μm, use Test Method A.

f. The number of helmets tested is to be determined by the NA.

g. Test location to be determined by NA based on helmet shape.

CHAPTER 20 FINAL REPORT

20.1 OVERVIEW

a. The final report shall be dated and signed by an authorised representative of the test facility.

b. The report shall contain reference to the chapters and associated tests conducted, as stated in Table 1, for the selected role that the helmet will fulfil.

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ANNEX A ENVIRONMENTAL CONDITIONS

A.1. Environmental Conditions

a. All pre-conditioning (except water submersion) must take place for at least 6 hours, but less than 24 hours.

b. Wet / immersion testing will submerge the system(s) for at least 24 hours. Prior to testing, immersed systems will be removed from the water and left upright for 15 minutes before testing commences.

c. Wet / immersion testing will fully submerge the system(s), inverted, to a depth not exceeding 1 m. The system(s) will be held in place by a suitable method at that depth.

d. Testing of conditioned equipment must commence within 5 minutes of removal from conditioning (with the exception of 15 minutes for immersed helmets), and be completed within 45 minutes of removal from conditioning.

e. If testing is not completed within the prescribed 45 minute time period, or if subsequent testing is required, articles must be re-conditioned for the original (as a minimum) pre-conditioning duration.

A.1. Pre-Conditions

	Temperature (°C)	**Humidity (%)**
Hot	+50 ±2	40-60
Hot Extreme	+70 ±2	N/A
Cold	-20 ±2	≥90
Cold Extreme	-40 ±2	N/A
Ambient	+20 ±2	40-70
Wet / Immersion	+15 ±5 de-ionised water And/or salt water surrogate (3% NaCl, 0.5% MgCl2l)	N/A

A.2. Test Conditions

a. Range test conditions will be ambient.

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ANNEX B HELMET MOUNTS

B.1. Front Mount

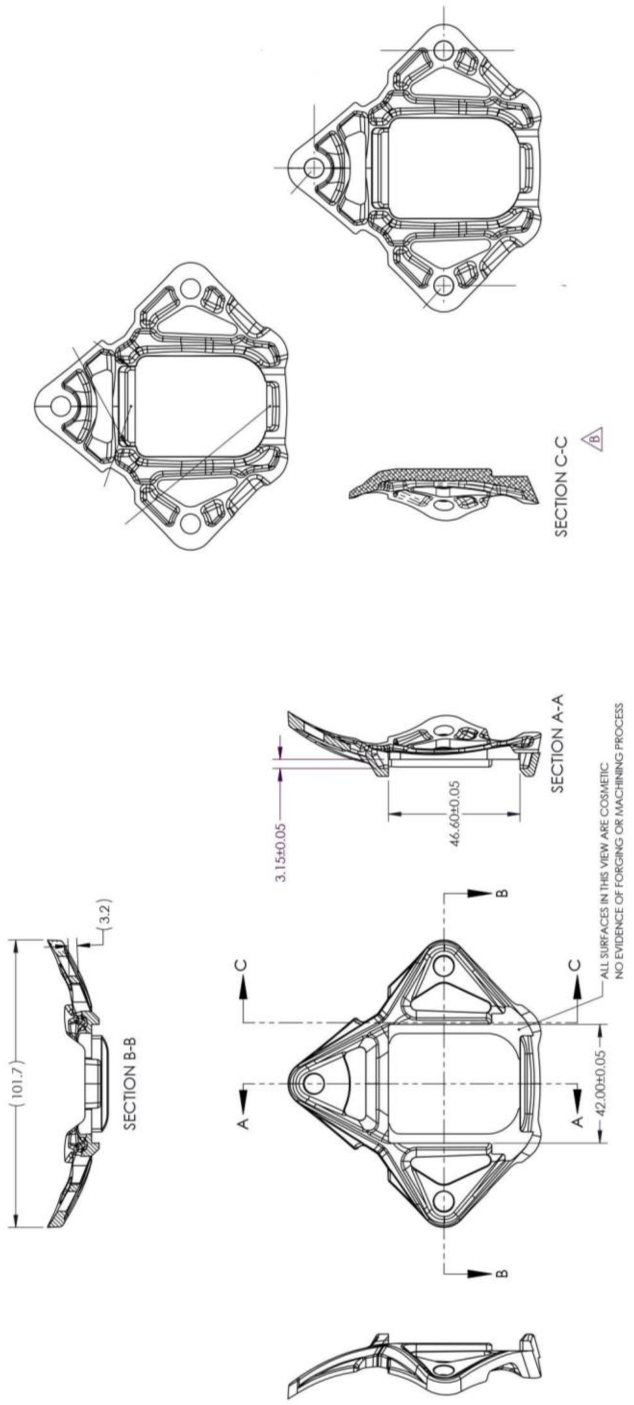

Figure 15 - Front Mount Design

B.2. Side Rail

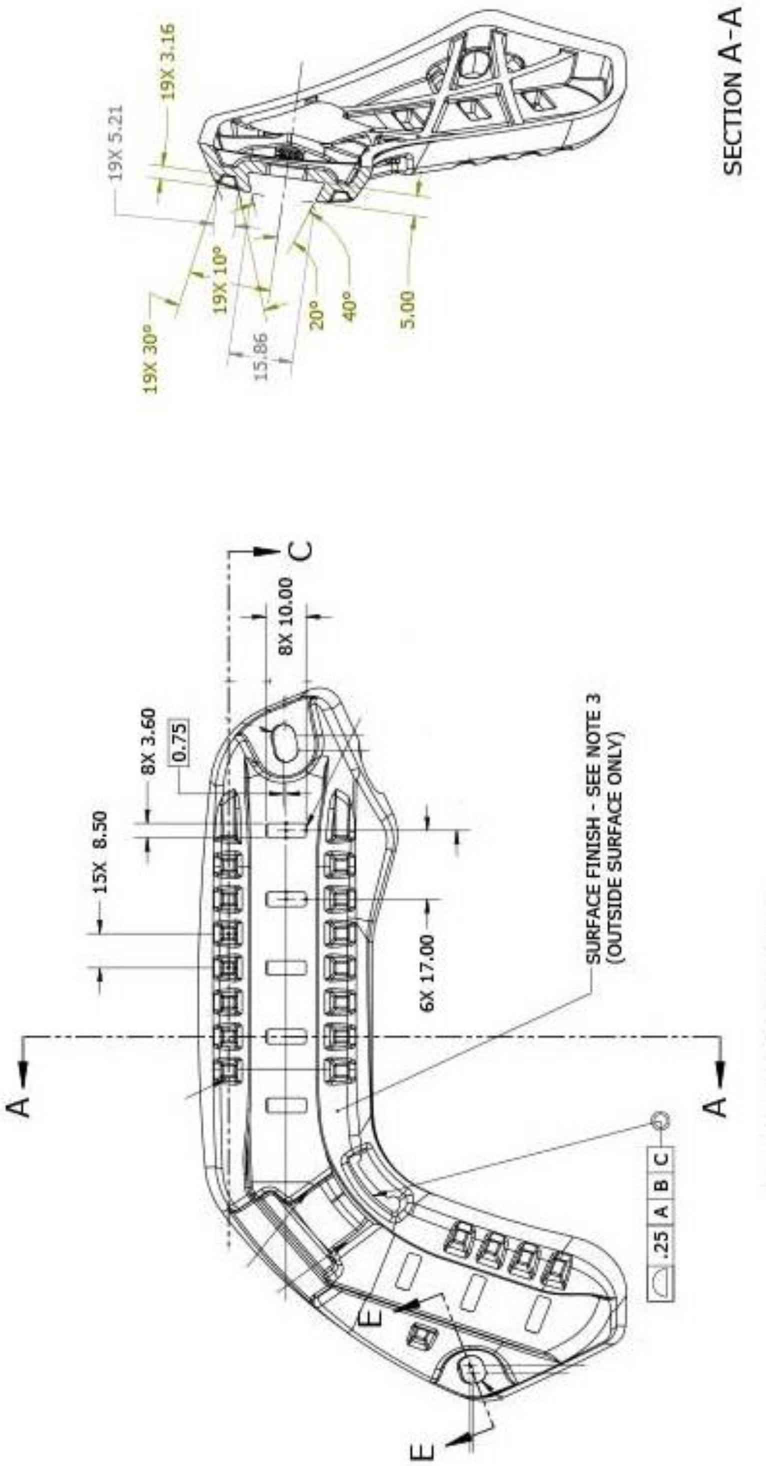

Figure 16 - Side Rail Design

B.3. STANAG 4694 Rail

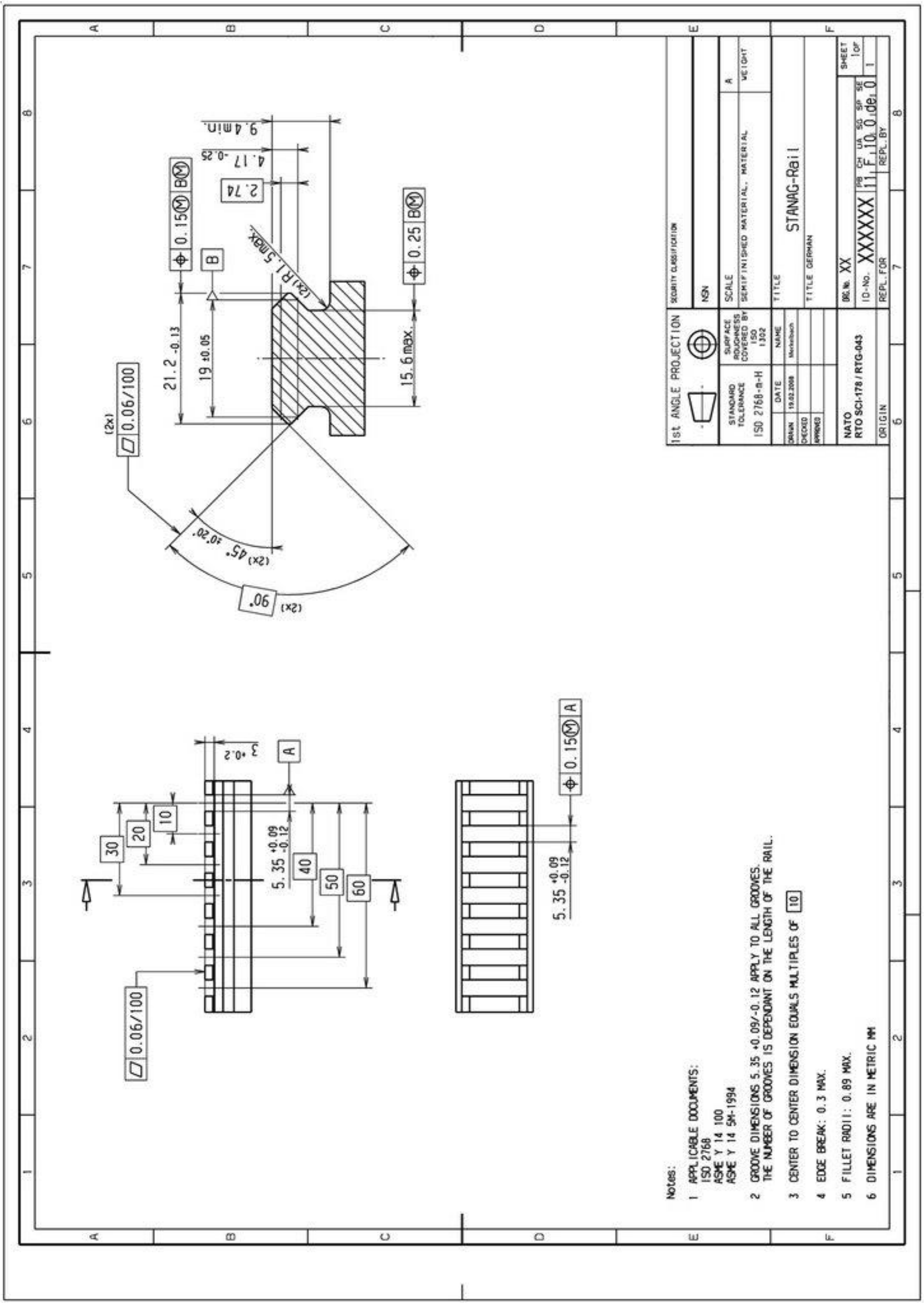

Figure 17 - Side rail design (STANAG 4694)

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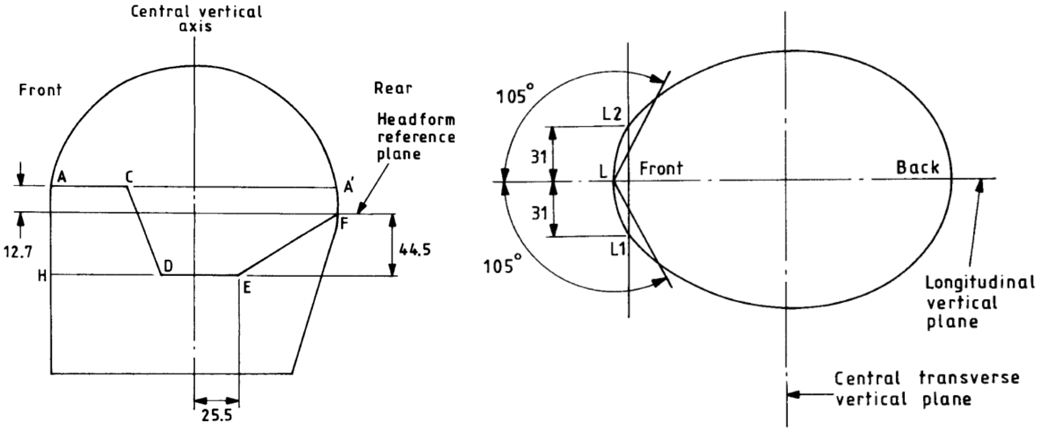
ANNEX C HELMET DROP IMPACT LOCATION

C.1. Drop Impact Locations



Reference planes:

- **Front** – From A to mid-way of A to Central vertical axis.
- **Rear** – From A' to mid-way of A' to Central vertical axis.
- **Side (left and/or right)** – From C to mid-way of C to Longitudinal vertical plane.
- **Crown** – Where the Central and Longitudinal vertical planes meet.
- **Left nape** – Left side, mid-way from Central and Longitudinal vertical planes, between E and F reference planes.
- **Right nape** – Right side, mid-way from Central and Longitudinal vertical planes, between E and F reference planes.

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