Appendix 1 – Test conditions and projectiles

Table A1.1 – Test conditions and projectiles summary for KE and artillery threat

Level	Ammunitions	Supplier / Specific test ammunitions	V_{proof}* (m/s)	Azimuth	Elev.	V_{proof} (m/s)	Azimuth	Elev.
		KE Threat				Artillery Threat (FSP 20mm)		
5	25 mm x 137 APDS-T, PMB 073	Oerlikon-Contraves, 121.5 g W alloy core (150 g with sabot)	1258	±30°	0°	960	0 – 360°	0° – 90°
4	14,5 mm x 114 API/B32	CIS, Chicom, ARL Drawing number 32000 (Figure C.7.), 63.4 g steel core	911	0 – 360°	0°	960	0 – 360°	0° – 90°
3	7,62 mm x 51 AP (WC core)	Bofors Carl Gustaf FFV AP M993 or AP8 Nammo, 8.4 g W alloy core	930	0 – 360°	0° – 30°	--	0 – 360°	0° – 30°
3	7,62 mm x 54R B32 API	Barnaul Machine Tool or CIS Russia, AP 7N13, 10.0 g	854	0 – 360°	0° – 30°	--	0 – 360°	0° – 30°
2	7,62 mm x 39 API BZ	Chicom, CIS State arsenals, 7.77 g steel core	695	0 – 360°	0° – 30°	--	0 – 360°	0° – 22°
1	7,62 mm x 51 NATO ball	Ball M80, copper jacket, 9.65 g lead core or C21, 9,5 g, DM41 with tombac jacket and lead core, projectile weight: 9.45 g	833	0 – 360°	0° – 30°	--	0 – 360°	0° – 18°
1	5,56 mm x 45 NATO SS109	SS109, 4.0 g, M855, DM11, tombac jacket, steel and lead core, projectile weight: 4 g	900	0 – 360°	0° – 30°	--	0 – 360°	0° – 18°
1	5,56 mm x 45 M193	M 193, Ball 3.56 g	937	0 – 360°	0° – 30°	--	0 – 360°	0° – 18°

*V_{proof} = Figures are mean values: tolerance of striking velocity for individual shot is ± 20 m/s

Table A1.2 - Accepted test projectile and characteristics

| Level	Name	Material	Core Weight (g)	Comment
5	Oerlikon-Contraves	W alloy core	121.5 (150 with sabot)	Unique supplier
4	CIS XXXX-xx	Steel core		
	Chicom yyy.xyyy	Steel core		
	ARL Drawing number 32000	Steel core	63.4	Surrogate without incendiary. Fig C.7.
3 (7.62 x 51 mm)	Nammo AP8	W alloy core	8.4	Present day available product
	Bofors Carl Gustaf FFV AP	W alloy core	8.4	Denomination under previous supplier
	M993	W alloy core	8.4	US designation of the same round
3 (7.62 x 54R)	CIS Russia, AP 7N13	Steel core	10.0	
	Barnaul Machine Tool xyz.zyx	Steel core		
2	CIS State arsenals xyz	Steel core	7.77	
	Chicom	Steel core		
1 (7.62 x 51 mm)	Ball M80	Lead core, copper jacket	9.65	US designation for the 7.62 x 51 NATO ball
	C21	Lead core, copper jacket	9.5	Canadian designation for the 7.62 x 51 NATO ball
	DM41	Lead core, copper jacket	9.45	German designation for the 7.62 x 51 NATO ball
1 (SS109)	SS109	Steel and lead core, copper jacket	4	
	M855	Steel and lead core, copper jacket	4	US designation for the 5.56 x 45 NATO SS109
	DM11	Steel and lead core, copper jacket	4	German designation for the 5.56 x 45 NATO SS109
1 (M193)	M193		3.56	
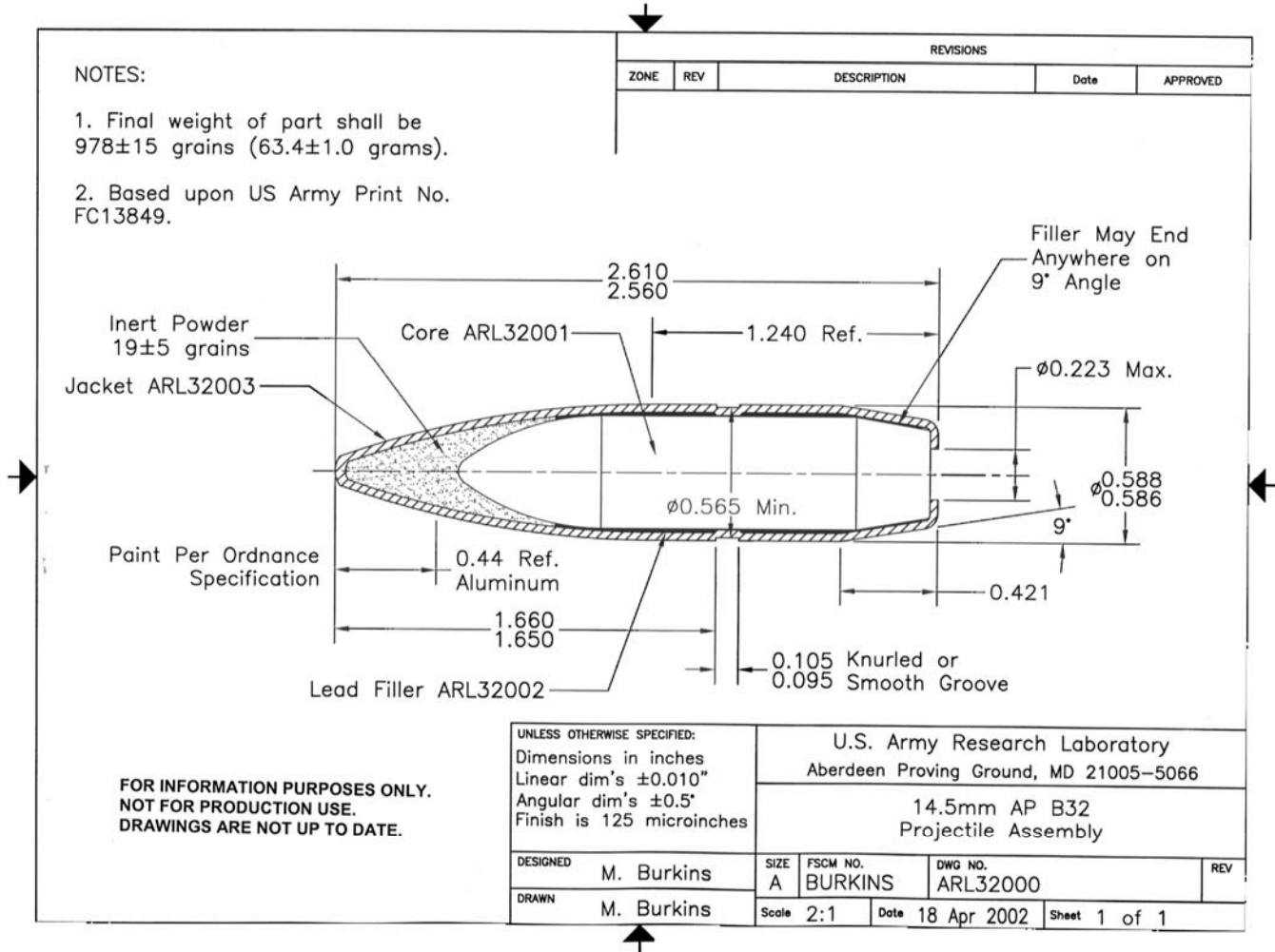
Figure C.7 - Drawing of Protection Level 4 threat (ARL Drawing 32000)

Appendix 2 – Multiple Hit Testing

A2.1   General

The capability of the armour system under evaluation to with stand multiple impacts (multi-hit requirement) from the specified test projectiles is included as part of the Phase 2 Vproof ballistic assessment process.

The application of multi-hit conditions to armour component ballistic testing require a number of geometric parameters be defined in order to obtain a reproducible and fair evaluation.   These parameters and qualifying comments are as follows:

1. **The distance between the centres of individual shot impacts.**   The specified shot patterns / separation distances have been determined from the results analysis of realistic live fire test scenarios or ballistic trials experience.   Alternative patterns are allowed for transparent armour as described below.
2. **The impact accuracy tolerance.**   The values for individual rounds are based on National Authority technical expert experience of the weapons and projectiles concerned.   National Authorities may at their discretion demand tighter impact accuracy tolerances than those stated herein.
3. **The EZ.** The minimum specified distance that the ballistic assessment impacts shall be separated from component panel edges, to avoid testing within a SWA.
4. **Component target size effects. T**o address case where target size is small compared to test multi-hit test pattern area a shot pattern with reduced number of shot is allowed.

This Appendix specifies the multi-hit assessment requirements for opaque and transparent armour components for Protection Levels 1 to 5.

In addition, alternative multi-hit assessment requirements are provided for transparent armour for Protection Levels 1 to 3.   Evaluations carried out under these test conditions will be accorded a [PARTIAL] nomenclature.

It is a requirement for multi-hit testing that all ballistic impacts shall attempt to exploit the localised weak areas (LWA) of the armour target where present or suspected.

A2.2   Multi-hit requirements for Protection Levels 1-3

For Protection Levels 1 to 3, the multi-hit procedure is based on an ambush scenario where an individual with personal weapon attacks an immobile vehicle for the equivalent of 4.5 seconds per occupant.   The derived multi-hit pattern is two pairs of impacts repeated at a prescribed distance.

The multi-hit parameters that shall be respected for ballistic assessments conducted with the projectiles specified for Protection Levels 1, 2 and 3* are defined in Table A2.1, and illustrated in Figure C.8.

Table A2.1 – Shot separation and impact tolerances for Protection Levels 1, 2 and 3

Dimension definition	Value	Size (mm)
Distance between shots pairs (#1 & #2, #3 & #4)	N	25
Distance from midpoint of shots #1 and #2 to shot #3	L	100
Maximum tolerance on shot impact position	T	-0 / +20
EZ (Minimum distance to component target edge / boundary)	E	25
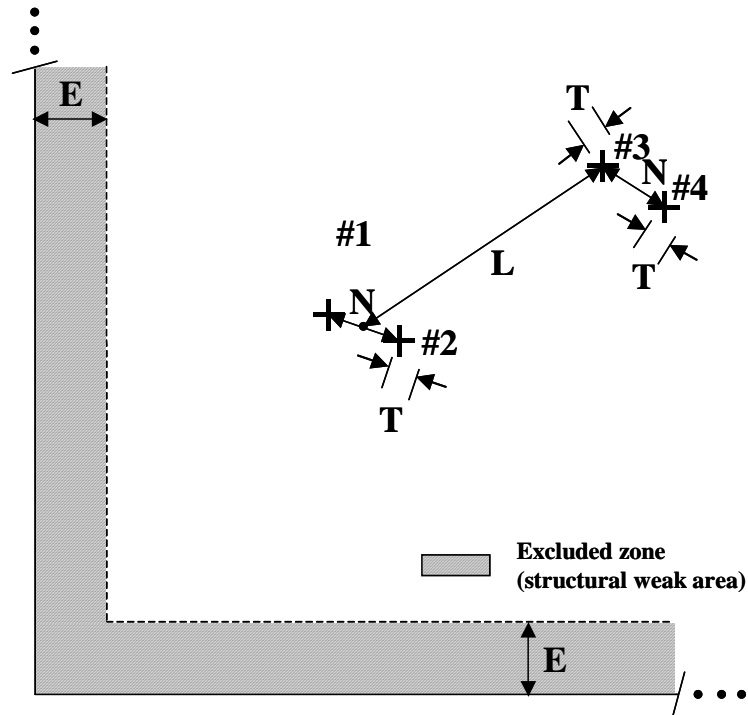
Figure C.8 – Example of multi-hit shot pattern for Protection Levels 1 - 4

Any vehicle successfully assessed using the requirements specified above shall be classified as compliant with "NATO STANAG 4569 KE Level X".

A2.3   Multi-hit procedure for Protection Levels 1-3

The detailed procedure for multi-hit assessment is described below with reference to the drawings (a-h) within Figure C.9.

Shot #1: The first projectile (# 1) is fired at the chosen aim position, which should be LWA if present (Figure C.9 a); the actual impact should be within a ± 10 mm zone of this point.

Shot #2: The possible positions for the second shot (#2) are then determined by tracing concentric circles of minimum radial distance N and maximum radial distance N+T onto the target (Figure C.9 b). Once shot #2 is completed of the defined zone (Figure C.9 c), the allowed area for the third shot (#3) can be defined.

Shot #3: Two concentric circles centred on the midpoint between shots # 1 and #2, of minimum radial distance L and maximum radial distance L+T can be traced on the target. From the midpoint, an angle of ±60° is traced in the directions perpendicular to shot #1 and to shot #2. The zone formed by the concentric circles and the angles is the allowed area for shot #3 (Figure C.9 d). (Figure C.9 e).

Shot #4: The fourth shot shall be aimed in the zone formed by concentric circles at distances of N and N + T from the impact point #3, but not closer to the midpoint of shots #1 and #2 than the distance L, as illustrated in Figure C.9 f.

On completion of shot #4 (Figure C.9 g), the resultant four shot pattern is as illustrated in Figure C.9 h.

a)

b)

c)

d)
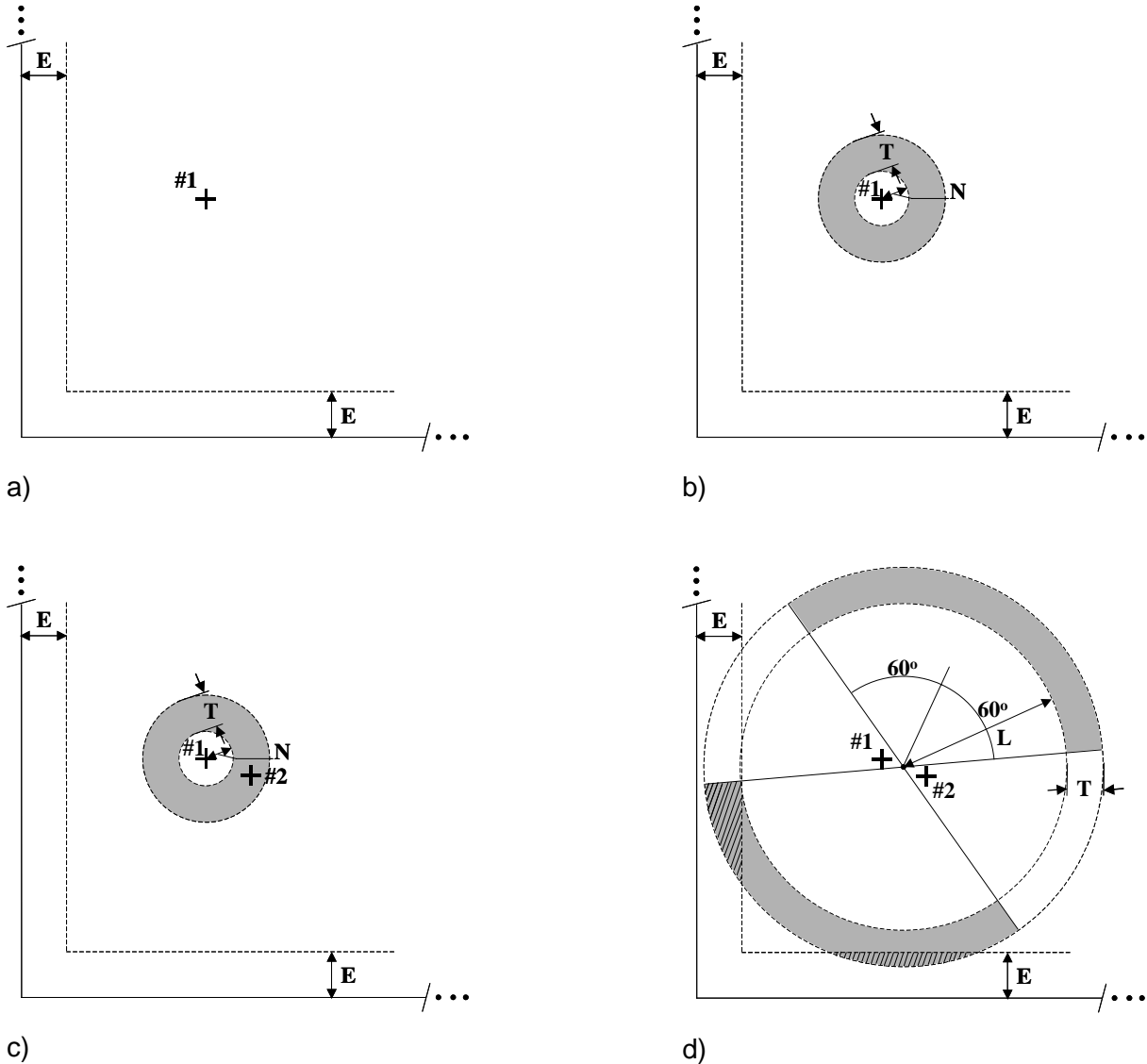
Figure C.9 – Multi-hit sequence for Protection Levels 1-4
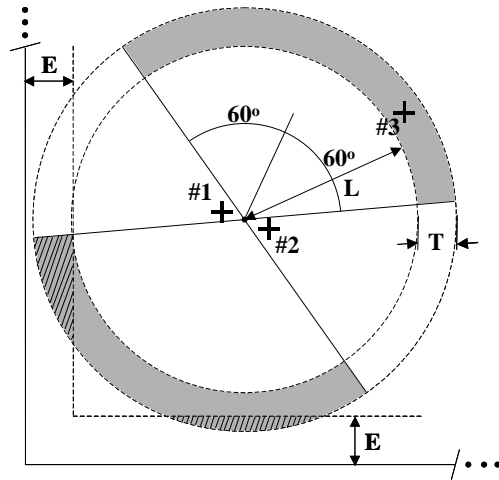
e)
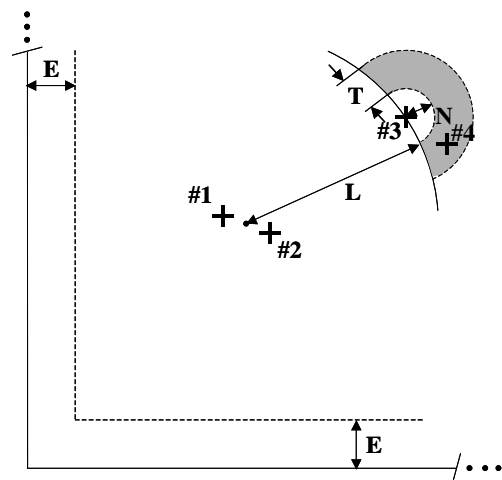
g)
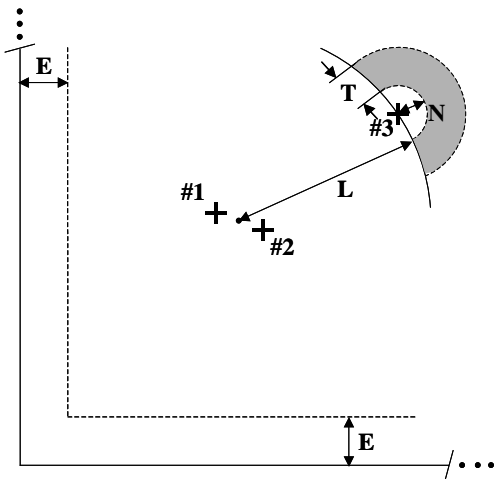
f)
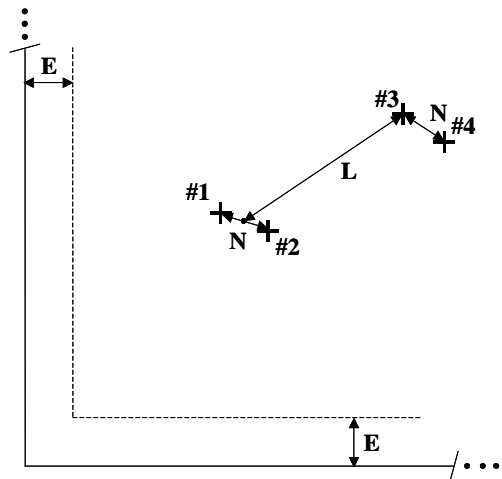
h)

Figure C.9 – Multi-hit sequence for Protection Levels 1-4 (continued)

A2.4 Alternative multi-hit procedure for Protection Levels 1-3 (Transparent armour only)

Achieving the specified Level 1-3 multi-hit ballistic resistance requirements for transparent may be impractical due to weight, geometric or human factor constraints.

Accordingly, if a lower multi-hit ballistic resistance is acceptable to National Authorities, the following alternative testing protocol may be used for transparent armour only. Any vehicle successfully assessed using the alternative requirements specified shall be classified as compliant with "NATO STANAG 4569 KE Level X [PARTIAL]".

The multi-hit test protocol for transparent armour requires three impacts in an equilateral triangle with a separation of 120 mm between impacts. The tolerance distances is-0 + 20 mm. The distance from the edge shall be at least 50 mm. The pattern is illustrated in Figure C.10.

Table A2.2 – Alternative shot separation tolerances for transparent armour (Protection Levels 1, 2 and 3)

Dimension definition	Value	Size (mm)
Distance between shots (equilateral triangle)	N	120
Tolerance on shot impact	T	-0+20
EZ (Minimum distance to component target edge / boundary)	E	50

N + T = 120mm -0+20mm

E

E = 50mm

Excluded zone (structural weak area)
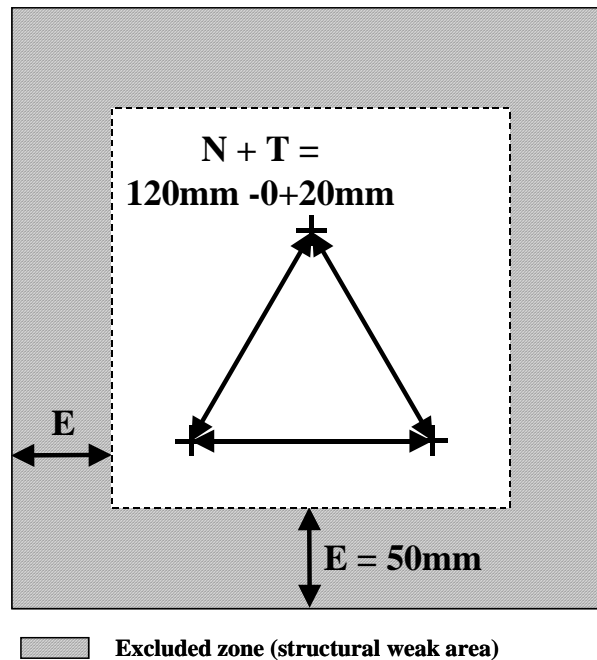
Figure C.10 – Multi-hit pattern for Protection Levels 1-3 PARTIAL (transparent armour).

A2.5   Multi-hit Procedure for Protection Level 4

For Protection Levels 4, the multi-hit procedure is based on an ambush scenario where a fixed heavy machine gun attacks an immobile vehicle with a five rounds burst. The derived multi-hit pattern is two pairs of impacts repeated at a prescribed distance as described for Protection Levels 1 to 3.

The assessment procedure is the same as for Protection Levels 1 to 3 as illustrated in Figure C.9, but with the shot spacing and impact tolerance parameters as presented in Table A2.3.

Table A2.3 – Shot distance and tolerances for Protection Level 4

Dimension definition	Value	Size (mm)
Distance between shots of a pairs	N	50
Distance from centre of shots #1 and #2 to shot #3	L	200
Maximum tolerance on shot impact position	T	-0 + 50
EZ (Minimum distance to component target edge / boundary)	E	50

A2.6   Multi-hit Procedure for Protection Level 5

For the Protection Level 5, the multi-hit procedure is based on a unique two shot pattern per target sample as illustrated in Figure C.11 and the shot spacing and impact tolerance parameters as presented in Table A2.4.

Table A2.4 – Shot distance and tolerances for Protection Level 5

Dimension definition	Value	Size (mm)
Distance between shots of a pair	N	150
Maximum tolerance on shot impact position	T	-0 + 50
Minimum distance to component target edge / boundary	E	50

Figure caption text in figure:

$$N + T = 150mm\ -0+50mm$$

$$E$$

$$E = 50mm$$

Excluded zone (structural weak area)
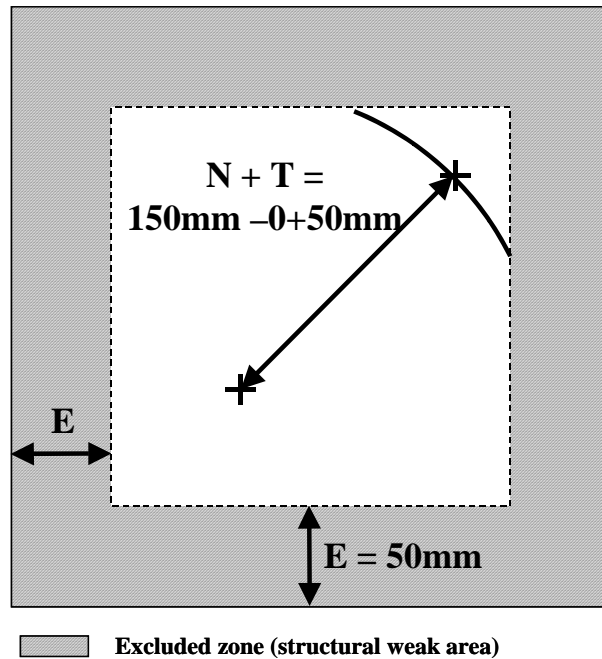
Figure C.11 – Multi-hit pattern for Protection Level 5

A2.7 Multi-hit tests – target numbers and size

Sufficient MA targets should be made available to perform the Vproof multi-hit ballistic assessments required for each Protection Level.

The number of targets required will be dependent on several factors:

- The number of accepted shots required for the assessment as described in Table 3.3.
- The multi-hit shot pattern demanded as described in Tables A2.1–A2.4 above.
- The actual size of the target component.
- Allowance for contingency.

For Level 1-4 multi-hit assessments, testing shall be performed with the four-shot patterns described. However, where the total number of rounds is not a multiple of four, testing may conclude with a pair of shots to finish a series, and these can be on a separate target. For example, after shooting five panels

of four shots (twenty shots), the last two shots required by Table 3.3 to reach the twenty-two shot total could be fired in a single pair without completing another four-shot pattern.

The influence of the size of the component on the multi-hit test procedure is described in Section 5.3.

Appendix 3 – Artillery threat

The details of the artillery threat and protection requirements in terms of the HE shell type, Protection Level, protection ranges and attack elevations were included in STANAG 4569 for reference purposes mainly, to provide advisory information for military commanders on vehicle spacing during operations.

The performance data presented is empirically based upon 155mm shells attacking Rolled Steel armour plate assessed in arena trials and encompasses the two following important points:

- The attack elevation quoted for Levels 1 though 3 in the STANAG 4569 Annex A were derived assuming shell detonation occurred at heights up to 30 m above ground level. For Levels 4 and 5 in the STANAG 4569 Annex A, the attack angle is all around the vehicle at a distance of 25 m.
- Protection Levels take into account a 90% chance of surviving a single shell detonation only. (It should be noted that if protection against multiple shell detonations is desired then the probability of occurrence of a closer range detonation and of being struck by a larger fragment both increase).

At the long ranges of artillery engagement appropriate to Protection Levels 1-3, the low obliquity of attack achievable on a vehicle roof coupled with low fragment impact velocity on account of their high drag coefficients leads to the KE projectile threats dominating the armour demand. The chance of impact from a large fragment from a single shell detonation at ranges of 60-100m is also extremely low. Hence, no testing against Level 1-3 fragment threats is required by STANAG 4569, but is optional to the National Authority.

However, for Protection Level 4 and 5 different circumstances apply, as the detonation range is close enough to allow high velocity fragment attack at 90^0 to the vehicle roof. As the KE threats for Level 4-5 are disposed horizontally the artillery threat determines the roof protection requirement, and thus fragment testing of vehicle armour is required to fully comply with STANAG 4569.

The assessment of protection provided from artillery shell fragment threats is to be achieved using gun launched fragment simulating projectiles (FSP) as defined in Figure C.6 of calibre 12.7 mm or 20 mm and at velocities in accordance with the Table A4.1 below. The data included for Levels 4-5 is summarised from Table A1.1 of Appendix 1.

Table A4.1 – FSP Velocities for Testing for Protection Levels 1, 2 and 3

Protection Level	Range of burst (m)	12.7 mm FSP V_{proof} (m/s)	20 mm FSP V_{proof} (m/s)
5	25	-	960
4	25	-	960
3	60	560	770
2	80	420	630
1	100	310	520

A reduced amount of single impact FSP testing compared with the KE threats is demanded as indicated in Table 3.3. No multi-hit testing is required reflecting the wide dispersion of shell fragments in real situations even at 25m range of detonation. Testing is however required to assess both the Main and weak armour areas (LWA and SWA).

Appendix 4 – Shatter gap testing

Shatter-gap is a phenomena exhibited by a few projectile/armour material interactions. The classical shatter-gap is exhibited when the projectile core is shattered and thereby defeated by the armour when impacted at relatively high velocities (see Refs. 18, 21 and 22). At lower velocities, the projectile could however defeat the armour because the impact energy is insufficient to break the projectile core. This usually results in projectile/armour combinations having multiple ballistic limit values as shown in Figure C.12. The classical shatter gap phenomenon is most common with ceramic armour systems. Where a shatter gap is suspected, an appropriate test procedure should be employed to explore the possibility of low velocity penetration.

Comprehensive testing to explore the possibility of shatter gap vulnerability requires a large number of tests at various reduced velocities. Such investigations are at the discretion of the National Authority and do not fall within the test requirements of this STANAG. Nonetheless armours that are found to have vulnerability to the threat projectile listed in this STANAG but at lower velocities than is specified in this STANAG are considered to fail to meet the requirement.
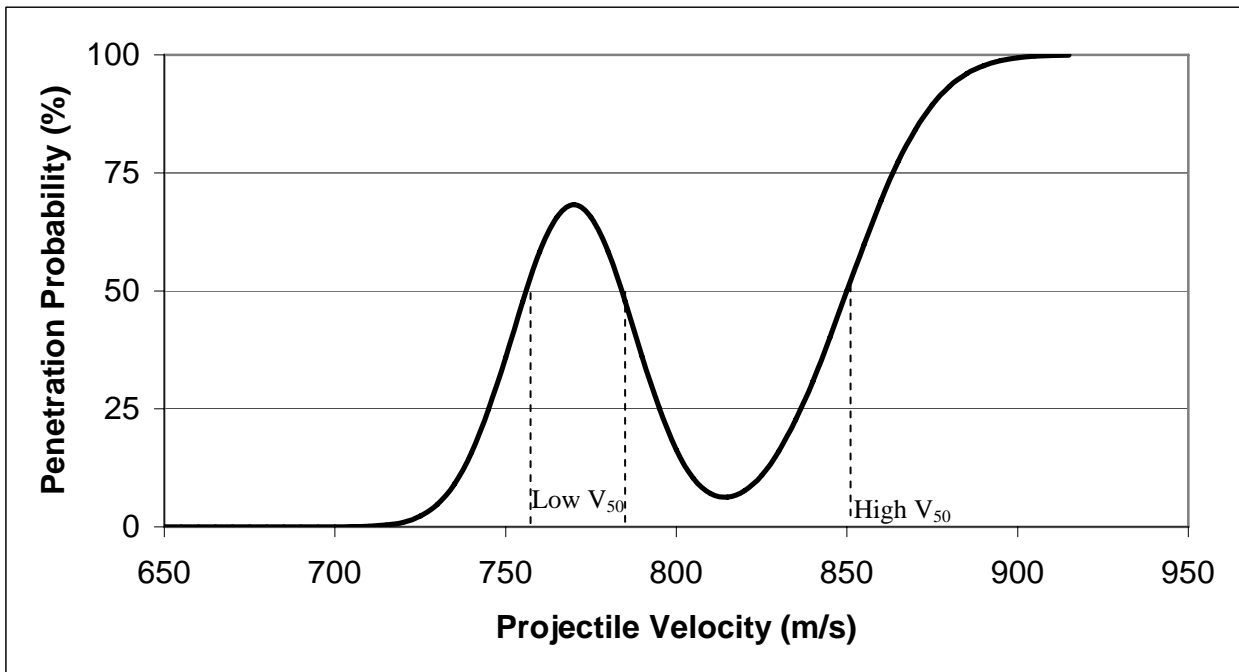

Figure C.12 - Example of shatter gap penetration probability distribution with multiple V$_{50}$.

Appendix 5 – Test equipment issues

A5.1   Velocity correction

No corrections for air drag effect are required for KE projectiles when the striking velocity is measured at a distance of 2.5 m or less from the target (distance **B** in Figure C.5). When projectile velocity is measured at a distance greater than 2.5 m from the target, the striking velocity *Vs* shall then be calculated from the point of measurement to the target. The drag coefficients listed in Table A5.1 could be used with the formula provided below, but measured values for the projectiles used are preferable.

<p align="center">**Table A5.1 – Drag Coefficients for KE threats**</p>

Protection Level	Drag Coefficient
1 - 4	0.33
5	0.165
0.5 in FSP	1.466
20mm FSP	1.500

A common method used for velocity correction is the exponential decay law based on a constant drag coefficient *Cd,* and can be calculated using the following formula:

$$Vs = Vi \cdot \exp(\frac{-X\rho Cd\pi D^2}{8m})$$

where *X* is the distance from the measurement point to the target, ρ is the air density (1.225 kg/m^3 at sea level), *D* is the projectile calibre (excluding sabot), *m* is the projectile mass, and *Cd* is the average drag coefficient for the effective velocity range.

An alternative velocity correction method for air drag is by direct measurement of velocity at multiple distances and extrapolation to the target strike face.

A5.2   Yaw angle characterization

The measurement of projectile impact yaw angle is an important feature of ballistic testing as the yaw value, or even rate of yaw, may determine the ultimate target response and may influence whether a PP or CP results for a given threat / target geometry.

For the ballistic assessments with KE bullets and FSPs described within this Annex, it is necessary to routinely measure indicated projectile yaw for each firing and also to determine precise yaw within a test series as described below.

The use of a yaw "card" is a simple and effective method of assessing projectile yaw. The card material utilised should be suitable in that on perforation a clean hole or signature is produced faithfully recording the presented area of the projectile, but critically without in any way disturbing the onward flight characteristics of the projectile.

Cards should be placed in a series perpendicular to the line of flight with the last card positioned as close to the target surface as practicable (within 150 mm from the target is desirable – closer distances

may result in fragmentation damage). The perforation hole is measured only if a visible observation of the projectile profile signature indicates that yaw is present. When a series of yaw cards (e.g. 7) are positioned at regular measured distances between the weapon and the target, the yaw cycle can be extrapolated to determine precisely the projectile yaw at impact with the target.

When using FSPs, the dimensions *D1*, *D2* and *L* (see Figure C.13) should be measured and recorded. Yaw is then computed by measuring, using an optical device with a magnification factor of at least 5X, the largest dimension (*A*) of the hole caused during perforation of the yaw card. For fragment simulator having no rear skirt, *D1=D2*. The yaw angle (θ) is then determined for cylindrical projectiles using the following formulas:

$$DM = \frac{D1 + D2}{2}$$

$$T = \sqrt{L^2 + DM^2}$$

$$\theta = \alpha - \beta = \sin^{-1}(A/T) - \tan^{-1}(DM/L)$$
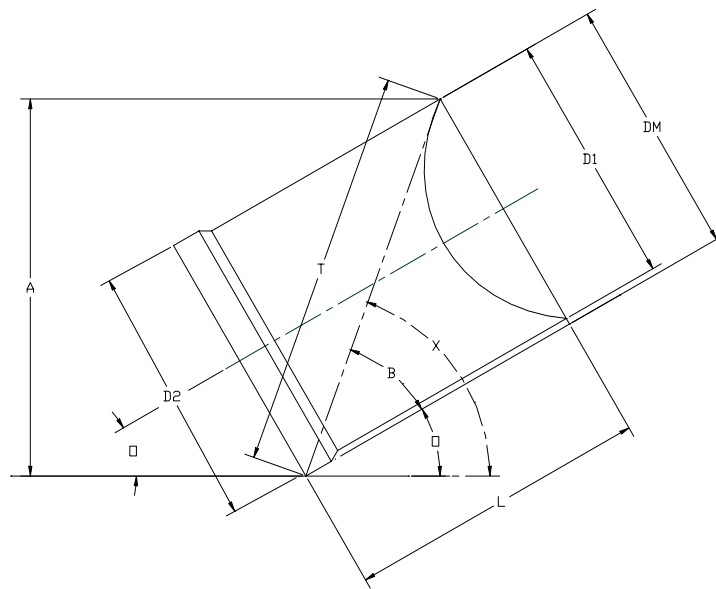
Figure C.13 - Reference dimensions for yaw measurement with FSP

When the hole in the yaw card is a perfect circle no yaw is present in the projectile at the point of measurement.

Photography or flash radiography are alternative methods used for precise yaw measurement. Measurement is required at least once per test series. When using photography or flash radiography, two orthogonal measurement planes shall be used to allow visualisation of yaw in both the horizontal "X" and vertical "Y" directions combined (A*v* and A*h*). With photographic systems, the use of a 45 degrees inclined mirror allows capture of two orthogonal images (actual side view and reflected top view) on a single image. The mirror and camera jig system should be aligned to the flight of the bullet

with an in-bore laser using two pin hole screens to ensure proper alignment with the launcher axis. The images taken should also include a zero degree reference line from which each yaw component will be measured. The total compound yaw (θ) angle can then be computed by applying the following formula:

$$\Theta = \arctan \sqrt{\tan^2 \mathrm{A}v + \tan^2 \mathrm{A}h}$$

Appendix 6 – Flow chart summary of the testing and acceptance process

The sequence of the acceptance test of a component are illustrated in the flow chart presented in Figure C.14, referring to the following note and decision points:

* The minimum number of accepted shots required is shown in parenthesis in Table 3.3.

<u>Decision I</u>: A decision by the National Authority is required:

    A. To stop the component testing after reaching the allowed minimum number of accepted shots (Table 3.3, numbers in parenthesis) when the back damage is confidently judged unlikely to lead to a CP, or;

    B. To continue the component testing.

<u>Decision II</u>: Following the occurrence of a single CP in the test series, the National Authority may decide to:

    A. Declare the component design as failed.

    B. For information, continue testing the component has long as desired, until the maximum number of accepted shots required, as shown in Table 3.3, is reached.

<u>Decision III</u>: The National Authority may decide to:

    A. Accept to declare the component as failed and representing vulnerable area.

    B. Accept to test another component of revised component design if proposed by the manufacturer (re-submission).

<u>Decision IV</u>: Following the occurrence of a single CP, when the maximum number of accepted shots has been reached without subsequent CP, The National Authority may decide to:

    A. Accept to retest the same component design.

    B. Accept to declare the component design as failed.
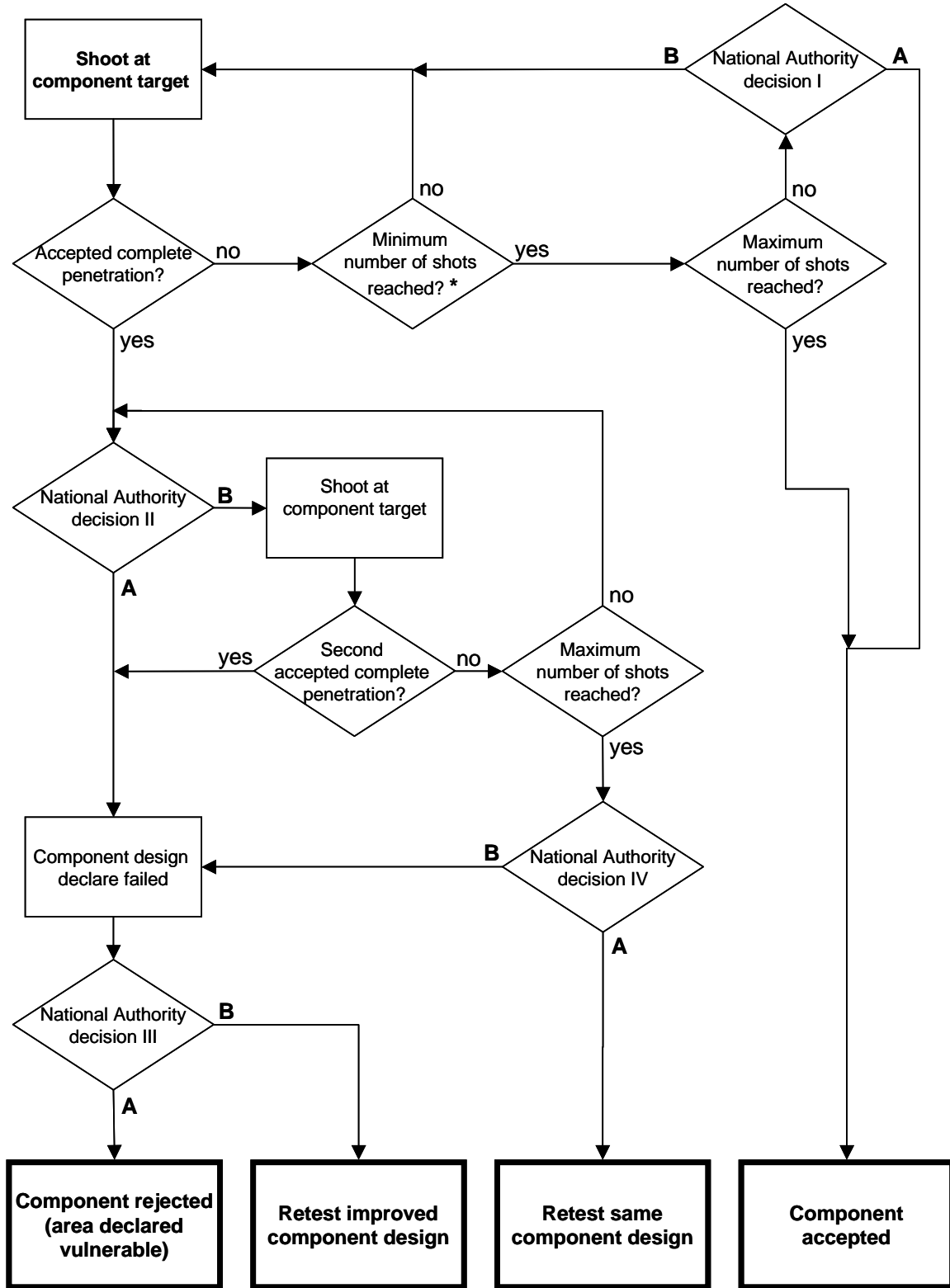
Figure C.14 – Ballistic testing algorithm

Appendix 7 – Options for ballistic performance evaluation

The V_{proof} and V_{50} tests are only two of several types of test to determine the ballistic performance or failure characteristics of armour materials against KE projectile. Other types of tests that may be relevant include:

1. Behind-armour debris test (i.e., fragmentation) arising from penetration of the armour by a KE projectile, or from damage such as back spall produced by a non-perforating projectile.

2. Critical angle tests where the striking velocity is kept constant throughout a test series but target obliquity is progressively changed to determine the angle at which the KE projectile will be stopped with a given probability level and confidence limit.

3. Critical velocity (V_c) tests based on projectile residual velocity or residual momentum measurements (ballistic pendulum) to determine the armour energy absorbing capability when penetrated (overmatched).

4. Depth of penetration (DOP) test where a homogeneous semi-infinite backing is placed behind a tested component or material target and scoop depth measured.

The tests 1-4 may not be used in place of the ballistic tests prescribed in this document but can be carried out in addition to provide supplementary information.

Appendix 8 – Definitions

For the purposes of the test methods and procedures contained herein, the following definitions apply:

Add-on armour (additional or appliqué armour): An armour system that can be easily installed or removed from a vehicle without adversely affecting its structural integrity or operation. It usually covers the identified vulnerable areas and provides.

Angle of azimuth: The angle in the horizontal plane between the vehicle longitudinal axis and the line connecting the firing point and the rear of the vehicle occupant compartment (see Figure C.1).

Angle of elevation: The angle between the plane of the horizon and a line drawn from the firing point to the point of impact on the target surface (see Figure C.1).

Angle of impact: The angle between the projectile trajectory and the direction perpendicular to the plane tangent to the point of impact on the target sample (see Figure C.15 next page). The angle of incidence and target obliquity may be used with the same meaning. Angle of impact should not be confused with yaw angle nor the angle of azimuth or elevation.

Area of coverage: The area of an armour target that meets or exceeds the ballistic Protection Level requirement to achieve a specified Protection Level.

Areal density (AD): The weight of armour material per unit area. It is usually expressed in kg/m^2 and is the ratio of the mass of the armour material over its area of coverage.

Armour: A shielding material provided for protection against ballistic threats.

Ballistic resistance: The measure of the potential of a protection system component to defeat an impacting projectile or fragment.
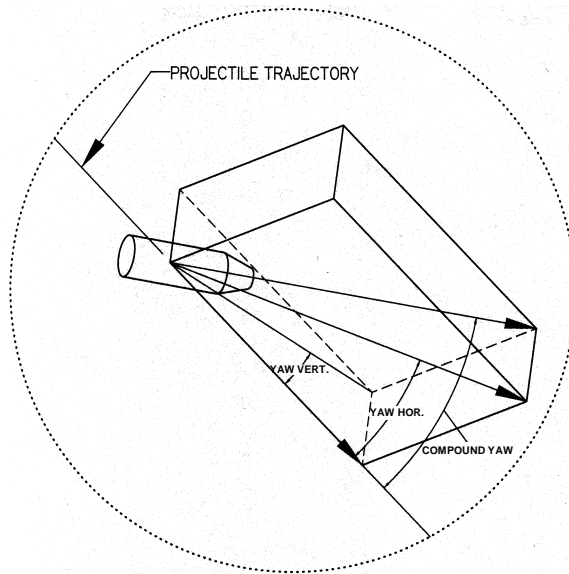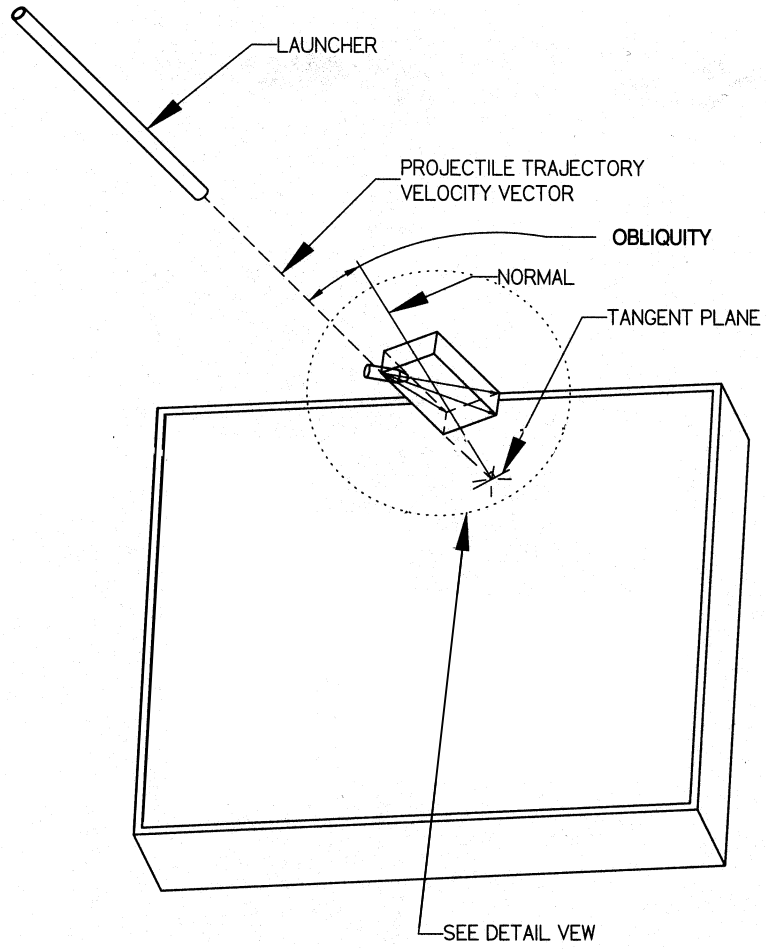
Ballistic retardation: The velocity reduction of a projectile caused by air drag, per unit distance (m/s/m).

Bulge height: The maximum permanent displacement of the back surface of an armour test target caused by projectile impact on the front surface.

Cavity diameter or size: The diameter of the hole made in the armour material measured from the undistorted front and back surface. For a non-symmetric cavity, both the smallest diameter (width) and the largest diameter (length) should be measured and recorded.

Complete penetration (CP): A complete penetration has occurred when an impacting projectile cause the projectile, a piece of the projectile or target debris to pass through the witness plate, i.e., there is at least one perforation through which light is visible through the witness plate.

Component: A discrete part of a vehicle protection system that requires ballistic protection assessment. For the purpose of this assessment, two kinds of components are used, those representing main area and those representing Structural Weak Areas (Excluded Zone). The definition of component as used in this document is not that commonly used in Vulnerability Analysis, which includes non-protective parts of the vehicle to evaluate the full vulnerability of a vehicle (e.g. mobility kill).

LAUNCHER

PROJECTILE TRAJECTORY
VELOCITY VECTOR

OBLIQUITY

NORMAL

TANGENT PLANE

SEE DETAIL VEW

PROJECTILE TRAJECTORY

YAW VERT.

YAW HOR.

COMPOUND YAW

Figure C.15 - Angle of impact and yaw

Composite armour: An armour system consisting of two or more different armour materials assembled together to form a protective unit. Not to be confused with composite materials such as GFRP that may form one armour element.

Delamination: The separation of a panel into layers in the thickness direction.

Excluded zone (EZ): The zone allocated around the perimeter of an armour component that is deemed to encompass any Structural Weak Areas present by virtue of the materials, manufacture or joining process employed when fabricated into or attached to the vehicle structure. The area that is not classified as Excluded Zone is the main area.

FAIR impact: An impact that meets the specified conditions of velocity, angle of impact, yaw and impact position, within the tolerances defined for each condition (see Section 5.6).

Fragment simulating projectile (FSP): A specific fragment simulator type based on a standardized cylindrical projectile with a chisel nose (see Figures C.6 and C.13). Available in a homologous size series. Designed to be capable of gun firing to simplify armour testing.

Fully engineered target: An armour configuration fully representative of final vehicle production configuration, i.e., having the same geometrical construction, materials and total areal density. These targets could be panels or mock-ups of vehicle components containing welds or overlaps, etc.

Impact location: The impact location is defined to be at the centre point of the impact.

Main area armour: A component of representative relatively uniform area of an armour that may include Localized Weak Area.

Opaque armour: Any protection system through which vision is not possible – see transparent armour.

Partial penetration (PP): A projectile impact that does not result in light being visible through the WP.

Protection capability or Expected protection capability (EPC): The potential of a protection system to resist an attack. The protection capability may be expressed as the probability that the occupants survive without injuries during a particular attack scenario. The protection capability is related to the ballistic resistance of the protection components and the impact probability of those components.

Protection Level: The degree of protection defined in the STANAG 4569. The Protection Levels are defined as threats with conditions specified in Appendix 1 of the present Annex to STANAG 4569. To be declared compliant to a certain STANAG 4569 Protection Level, the protection system of a logistic or light armoured vehicle shall demonstrate adequate protection capability when evaluated with the threats under the conditions specified.

Relative vulnerable area (RVA): The ratio of unprotected (vulnerable) area (A_U) over the total threatened area (A_O) of a protection system.

Shall: A statement that makes the associated requirement in this document fully mandatory.

Shatter gap: The reduction in velocity range over which a projectile may exhibit a distinct change in its characteristics of interaction with a target, from projectile shatter to projectile remaining intact. This may cause the armour to exhibit multiple V_{50} values. The significance for armour testing is to ensure that penetration at lower velocities in the projectile intact form is not greater than when fractured at high velocity impact with the target.

Shot location witness: A suitable measurement technique to provide evidence of the exact impact point in relation to the intended shot location (see Figure C.5) of the projectile. It is used to assess impact fairness for multiple hit testing (see Yaw card).

Should: A statement that makes the associated requirement in this document not fully mandatory, but highly recommended.

Spall: The material detached and ejected of a layer of armour material from the rear surface of the armour. Spall can be produced by both perforating and non-perforating impact of a projectile on an armour panel.

Strike face: The surface of a test target designed to face the attack of a ballistic threat.

Striking or impact velocity (V_s): The velocity of the projectile upon impact with the target face.

System acceptance testing: The process, including ballistic testing of components (Phases 2 and 3) and vulnerable area assessment (Phase 4) performed on a vehicle armour system to assess its capability to achieve a given Protection Level.

Target distance: The distance between the muzzle of the test launcher barrel and the strike face of the target (see Figure C.5).

Test series: All the impacts required to assess the ballistic performance of one component / threat combination.

Transparent armour: Any protection system through which vision is possible – see opaque armour.

UNFAIR impact: A shot not conforming to one or more of the specified conditions (velocity, angle of impact, yaw and impact position) (see Section 5.6).

V_{50} ballistic limit: The striking velocity at which 50% of the impacts of a projectile will result in complete penetration of a given armour on specified attack conditions.

Vehicle target: An armour system that may be a fully functional vehicle, or a ballistic structure (vehicle without non-armour related components such as power packs, fire control, etc.).

Vision Block: A narrow aperture made of a transparent material in an armoured vehicle to allow the crew to see outside the vehicle. The small width of the aperture requires the crew to position their eyes very near the block to effectively see outside. Vision blocks need to be tested with thinner witness plates in closer proximity to the test target to reproduce typical ocular conditions.

V_{proof}: The minimum nominal velocity specified for a particular projectile for a pass/fail or acceptance test where a given number of rounds are fired at a test specimen and where no complete penetration is allowed in the initial qualification test series. An increase in the number of V_{proof} rounds fired will improve the statistical confidence in the result.

Vulnerable Area (VA): The surface area of a component found not protective according to the STANAG 4569 criteria. The Vulnerable Area is accounted in the calculation of the Relative Vulnerable Area.

Weak Areas: The zones of an armour system that potentially reduce the expected ballistic resistance of a protection system. Two types of weak areas, structural and localized, are defined below:

- Structural weak areas (SWA) are armour zones inherent in the design that differ from the uniform main areas and are usually associated with discontinuities in the armour system. These include openings, holes, gaps, welds (including heat affected zones) and joints between major armour panels, bolts and edges, overlaps, etc. Structural weak areas are assumed for the purpose of the assessment to be located within the excluded Zone and are excluded from the armour main areas, and thus shall be tested separately (Phase 3).

- Localized weak areas (LWA) are smaller potential weak areas included in the armour main areas. They could be inherent in the design such as mosaic tile joint, small holes or other geometric features uniformly distributed on armour panel main surfaces. They could also be defects that are not visually detectable to eye examination such as flaws, cracks, inclusions, voids, porosity, and limited delamination.

Witness plate: A material sheet placed behind a target impact area to indicate the effects of debris caused by the projectile impact.

Yaw angle: The maximum resultant angle between the main axis of the projectile and its trajectory (velocity vector) irrespective of plane (see Figure C.15).

Yaw card: A material placed in the projectile's line of flight, whose perforation signature is used to determine the projectile yaw. The yaw card can also be used as impact location witness sheet (see Figure C.5).