

International hard ballistic standards

Vehicle armor

NIJ Standard 0108.01

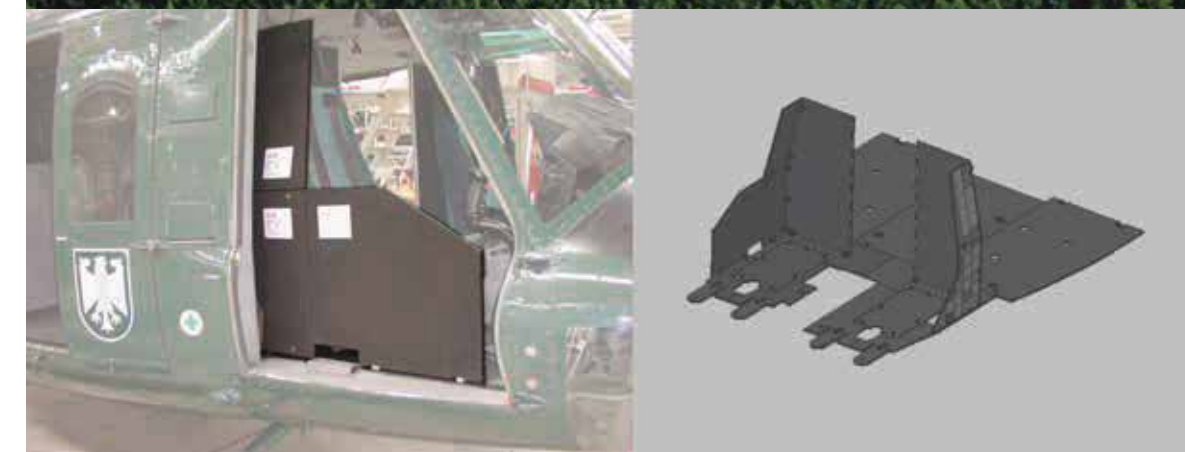
Armor Type	Test Ammunition	Nominal Bullet Mass	Suggested Barrel Length	Shot Distance	Required Bullet Velocity	Number of Test Specimen	Test Specimen Size	Required Hits per Armor Specimen	Permitted Penetrations
I	.22 LHV Lead	2.6 g 40 gr	15 to 16.5 cm 6 to 6.5 in	5 m	320 ± 12 m/s 1050 ± 40 ft/s	1	min. 30.5x30.5 cm ² min. 12x12 sq in	5	0
	.38 Special RN Lead	10.2 g 158 gr	15 to 16.5 cm 6 to 6.5 in	5 m	259 ± 15 m/s 850 ± 50 ft/s	1	min. 30.5x30.5 cm ² min. 12x12 sq in	5	0
II-A	.357 Magnum JSP	10.2 g 158 gr	10 to 12 cm 4 to 4.75 in	5 m	381 ± 15 m/s 1250 ± 50 ft/s	1	min. 30.5x30.5 cm ² min. 12x12 sq in	5	0
	9mm FMJ	8.0 g 124 gr	10 to 12 cm 4 to 4.75 in	5 m	332 ± 12 m/s 1090 ± 40 ft/s	1	min. 30.5x30.5 cm ² min. 12x12 sq in	5	0
II	.357 Magnum JSP	10.2 g 158 gr	15 to 16.5 cm 6 to 6.5 in	5 m	425 ± 15 m/s 1390 ± 50 ft/s	1	min. 30.5x30.5 cm ² min. 12x12 sq in	5	0
	9mm FMJ	8.0 g 124 gr	10 to 12 cm 4 to 4.75 in	5 m	358 ± 12 m/s 1175 ± 40 ft/s	1	min. 30.5x30.5 cm ² min. 12x12 sq in	5	0
II-A	.44 Magnum Lead SWC Gas Checked	15.55 g 240 gr	24 to 26 cm 9.5 to 10.25 inch	5 m	426 ± 15 m/s 1400 ± 50 ft/s	1	min. 30.5x30.5 cm ² min. 12x12 sq in	5	0
	9mm FMJ	8.0 g 124 gr	10 to 12 cm 4 to 4.75 in	5 m	332 ± 12 m/s 1090 ± 40 ft/s	1	min. 30.5x30.5 cm ² min. 12x12 sq in	5	0
III	7.62mm 308 Winchester FMJ	9.7 g 150 gr	56 cm 22 in	15 m	838 ± 15 m/s 2750 ± 50 ft/s	1	min. 30.5x30.5 cm ² min. 12x12 sq in	5	0
	.30-06 AP	10.8 g 166 gr	56 cm 22 in	15 m	868 ± 15 m/s 2850 ± 50 ft/s	1	min. 30.5x30.5 cm ² min. 12x12 sq in	5	0



- Particularities:**
- * These items must be specified by the user. All of the items must be specified.
- Test relevant parameters:**
- Angle of incidence no greater than 5°.
 - Impact at least 5 cm (2 in) from a previous hit or the edge of the test specimen.
 - Condition the test specimen at a temperature of 20 ± 28°C (68 to 82°F) for at least 24 h prior to test.

RUSSIA - GOST R 50744-95

Class	Type of Weapon	Calibre (mm)	Ammunition		Test Conditions			
			Type	Mass [g]	Shot Distance [m]	Bullet Velocity [1] [m/s]	Max. BFD [mm]	
Special class								
S	Knife	-	-	-	-	-	49 ± 1 Joule	-
S1	Hunting Rifle	18.5	Lead-core	34.0 ± 1.0	5 ± 0.5	400 ± 10	-	17
S2	FSP	-	Steel Sphere Ø6.35 mm	1.05	-	V 50(%)	-	-
Main class								
BR1	9mm APS	9x19	Fe Core, S7N1815	5.9	5 ± 0.1	335 ± 10	-	17
BR2	SR-1 Vector	9x21	Lead Core, 7N28	7.93	5 ± 0.1	390 ± 10	-	17
BR3	Jarygin Pla	9x19	Hardened Fe Core, 7N21	5.2	5 ± 0.1	455 ± 10	-	17
BR4	AKM	7.62x39	Hardened Fe Core, 7N10	3.5	10 ± 0.1	895 ± 15	-	-
		Mild Steel Core, S7N231	7.9	10 ± 0.1	720 ± 15	-	-	
BR5	Dragunov SVD	7.62x54	Hardened Fe Core (PP), 7N13	9.4	10 ± 0.1	830 ± 15	-	-
		Armor Piercing (AP), 7B23	7.9	10 ± 0.1	810 ± 15	-	-	
BR6	OSW-96	12.7x108	Armor Piercing (AP), 57B2542	48.2	50 ± 0.5	830 ± 20	-	-



- Particularities:**
- (1) Bullet velocities measured 3 ± 0.1 m behind the muzzle. Fragment velocities measured 0.75 m in front of the target.
 - (2) Exact procedure and Steelball described in GOST 3722.

VPAM - APR 2006

Test Level	For comparison DIN EN 1663 (BR) DIN EN 1522/23 (FB) VPAM BRV 1999 (VR) STANAG 4569 AEP55 (Level)	Weapon (example)	Cartridge	Calibre	Ammunition and Projectile			Test Conditions		Minimum number of shots				
					Type	Mass [g]	Manufacturer Type	Shot Distance [m]	Bullet Velocity [m/s]	Number of Test Specimen	Test Specimen Size	Triangle Shooting (1)	Multihit Test (2) (optional) (4)	V50 Ballistic Limit (3) (optional) (5)
PM 1	BR 1 FB 1 VR 1			.22 Long Rifle	L / RN	2.6 ± 0.1	Winchester	10 ± 0.5	360 ± 10	3	500 x 500 mm ²	3 (7) (per test specimen)	3 (7) (per test specimen)	16 (better 20 to 30)
PM 2				9mm Luger (7)	FMJ / RN / SC tinned	8.0 ± 0.1	DAG, DM41	5 ± 0.5	360 ± 10	3	500 x 500 mm ²	3 (7) (per test specimen)	3 (7) (per test specimen)	16 (better 20 to 30)
PM 3	BR 2 FB 2 VR 2			9mm Luger (7)	FMJ / RN / SC tinned	8.0 ± 0.1	DAG, DM41	5 ± 0.5	415 ± 10	3	500 x 500 mm ²	3 (7) (per test specimen)	3 (7) (per test specimen)	16 (better 20 to 30)
PM 4 (7)	BR 3 FB 3 VR 3			.357 Magnum	FMJ / CB / SC	10.2 ± 0.1	Geo	5 ± 0.5	430 ± 10	3	500 x 500 mm ²	3 (7) (per test specimen)	3 (7) (per test specimen)	16 (better 20 to 30)
					44 Rem. Mag.	FMJ (copper) / FN / SC	15.6 ± 0.1	Speer	5 ± 0.5	440 ± 10	3	500 x 500 mm ²	3 (7) (per test specimen)	3 (7) (per test specimen)
PM 5				.357 Magnum	FMJ / CB	7.1 ± 0.1	DAG special	5 ± 0.5	580 ± 10	3	500 x 500 mm ²	3 (7) (per test specimen)	3 (7) (per test specimen)	16 (better 20 to 30)
PM 6				7.62 x 39	FMJ / PB / FeC	8.0 ± 0.1 core 3.6	PS cold hardened	10 ± 0.5	720 ± 10	3	500 x 500 mm ²	3 (7) (per test specimen)	3 (7) (per test specimen)	16 (better 20 to 30)
PM 7 (7)	BR 5 FB 5 VR 5			.223 Rem. (7)	FMJ / PB / SCP	4.0 ± 0.1	MEN, S5109	10 ± 0.5	950 ± 10	3	500 x 500 mm ²	3 (7) (per test specimen)	3 (7) (per test specimen)	16 (better 20 to 30)
PM 8	BR 6 FB 6 VR 6			.308 Win.	FMJ / PB / SC	9.55 ± 0.1	MEN, DM111	10 ± 0.5	830 ± 10	3	500 x 500 mm ²	3 (7) (per test specimen)	3 (7) (per test specimen)	16 (better 20 to 30)
					7.62 x 39	FMJ / PB / HC	7.7 ± 0.1 core 4.1 hardness 65 HRC	BZ	10 ± 0.5	740 ± 10	3	500 x 500 mm ²	3 (7) (per test specimen)	3 (7) (per test specimen)
PM 9				308 Win. (7)	FMJ / PB / HC	9.7 ± 0.2 core 4.0 ± 0.2 hardness 62 ± 2 HRC	MEN / CBC, FNB, P 80	10 ± 0.5	820 ± 10	3	500 x 500 mm ²	3 (7) (per test specimen)	3 (7) (per test specimen)	16 (better 20 to 30)
PM 10				7.62 x 54 R	FMJ / PB / HC	10.4 ± 0.1 core 5.3 hardness 63 HRC	B 32	10 ± 0.5	860 ± 10	3	500 x 500 mm ²	3 (7) (per test specimen)	3 (7) (per test specimen)	16 (better 20 to 30)
PM 11				308 Win. (7)	FMJ / PB / WC	8.4 ± 0.1 core 5.9	Nammo, AP 8	10 ± 0.5	930 ± 10	3	500 x 500 mm ²	3 (7) (per test specimen)	3 (7) (per test specimen)	16 (better 20 to 30)
PM 12				308 Win. (7)	FMJ / PB / WC	12.7 ± 0.1 core 5.58 hardness 1330 HW 10	SWISS P AP	10 ± 0.5	810 ± 10	3	500 x 500 mm ²	3 (7) (per test specimen)	3 (7) (per test specimen)	16 (better 20 to 30)
PM 13				.50 Browning	FMJ / PB / HC	43.5 ± 0.5 core 35.0 hardness 55 ± 2 HRC	SWISS P penetrator	10 ± 0.5	930 ± 10	3	500 x 500 mm ²	3 (7) (per test specimen)	3 (7) (per test specimen)	16 (better 20 to 30)
PM 14				14.5 x 114 (7)	FMJ / PB / HC	63.4 ± 0.5	B 32	10 ± 0.5	911 ± 10	3	500 x 500 mm ²	3 (7) (per test specimen)	3 (7) (per test specimen)	16 (better 20 to 30)

- Particularities:**
- On a test specimen 3 shots have to be fired with a hit distance of 120 mm to each other. Any single impact must not be closer to the inside of the clamping frame than 75 mm. At the test of inhomogeneous specimen as ceramic panels the hit triangle may be enlarged to hit three single plates in their centres.
 - On the test specimen 3 impacts are defined which have a distance to each other of 3 times the diameter of the calibre (tolerance + 5 mm). The border of the multihit impact group must have a minimum distance of 120 mm to any other impact of the triangle shooting. Any single impact must not be closer to the inside of the clamping frame than 75 mm.
 - The calculation of the ballistic limit value V50 has to be carried out according to the method VPAM KNB paragraph 6.4.3 of the VPAM - APR 2006.
 - For inhomogeneous test specimen (e.g. ceramic panels) the multihit test is only carried out for information purposes.
 - For inhomogeneous test specimen (e.g. ceramic panels) the V50 ballistic limit test is only carried out for information purposes.
 - For inhomogeneous test specimen furthermore 3 gaps as shown in attachment 2, fig. 4.1 and 4.2 of VPAM - PM 2007, are tested. The test centre defines the high risk areas of other inhomogeneous test specimen.
 - Test barrel with a transition of 7.5 mm.
 - In these steps both calibres are to use.
 - Twist rates 178 mm ± 5%.
 - Twist rates 254 mm ± 5%.
 - Arbitrary shot distance. Appropriate hits have to be ensured in terms of velocity, oscillation and impact point.
 - Twist rates arbitrary.

- Test relevant parameters:**
- Ambient temperature: 20 ± 3 °C.
 - Relative humidity: 65 ± 10 %.
 - Test specimen temperature: +20 ± 3 °C.
 - Angle of impact: 90° (0° NATO) and, if indicated, other angles defined in the product specific guidelines.

Military armor

NATO STANAG 4569 and AEP-55 Vol. 1 (Ed. 1)

Level	Ammunitions	KE Threat					Artillery Threat (FSP 20mm)						
		Accepted Test Projectiles		vproof [m/s]	Attack Angle 1)		Minimum number of shots 2)		Attack Angle 1)		Minimum number of shots 2)		
		Name	Weight [g]		Azimuth	Elevation	Phase 2: Main Area Ballistic Evaluation3)	Phase 3: Structural Weak Area Evaluation4)	vproof [m/s]	Azimuth	Elevation	Phase 2: Main Area Ballistic Evaluation3)	Phase 3: Structural Weak Area Evaluation4)
5	25mm x 137 APDS-T	PMB 073 Overkill Contraves	121.5 (150 with sabot)	1258 ± 20	± 30°	0°	12 (6) 5) (multi-hit tests) (6)	3 (single hit tests)	960 ± 20	0° - 360°	0° - 90° (8)	5 (single hit tests)	3 (single hit tests)
4	14.5mm x 114 API / B32	Russian 14 mm API / B32 Barnaul AP1 57-BZ-5615 Chinese 14.5mm Type 56 US Army Research Lab. surrogate	64 64 64 63.4	911 ± 20	0° - 360°	0°	12 (6) 5) (multi-hit tests) (6)	5 (single hit tests)	960 ± 20	0° - 360°	0° - 90° (8)	5 (single hit tests)	3 (single hit tests)
3	7.62mm x 51 AP (WC core)	Nammo AP8 Bofors Carl Gustav FPV AP	8.4 8.4	930 ± 20	0° - 360°	0° - 30°	22 (10) 5) (multi-hit tests) (6)	10 (single hit tests)	(770 ± 20) 7)	0° - 360°	0° - 30°	5 (single hit tests)	3 (single hit tests)
		Russian 7.62 x 54R B32 API Chinese 7.62 x 54R B32 API	10.04 10.04	854 ± 20									
2	7.62mm x 39 API BZ	Russian 7.62mm x 39 API BZ Chinese 7.62mm x 39 Type 56	7.77 7.67	695 ± 20	0° - 360°	0° - 30°	22 (10) 5) (multi-hit tests) (6)	10 (single hit tests)	(830 ± 20) 7)	0° - 360°	0° - 22°	5 (single hit tests)	3 (single hit tests)
		MB0 (US designation) C21 (Canadian designation) DM41 (German designation)	9.65 9.5 9.45	833 ± 20									
1	7.62mm x 51 NATO Ball	SS 109 (Original design) M855 (US designation) DM11 (German designation)	4 4 4	900 ± 20	0° - 360°	0° - 30°	22 (10) 5) (multi-hit tests) (6)	10 (single hit tests)	(520 ± 20) 7)	0° - 360°	0° - 18°	5 (single hit tests)	3 (single hit tests)
		M193 (Original design)	3.56	937 ± 20									

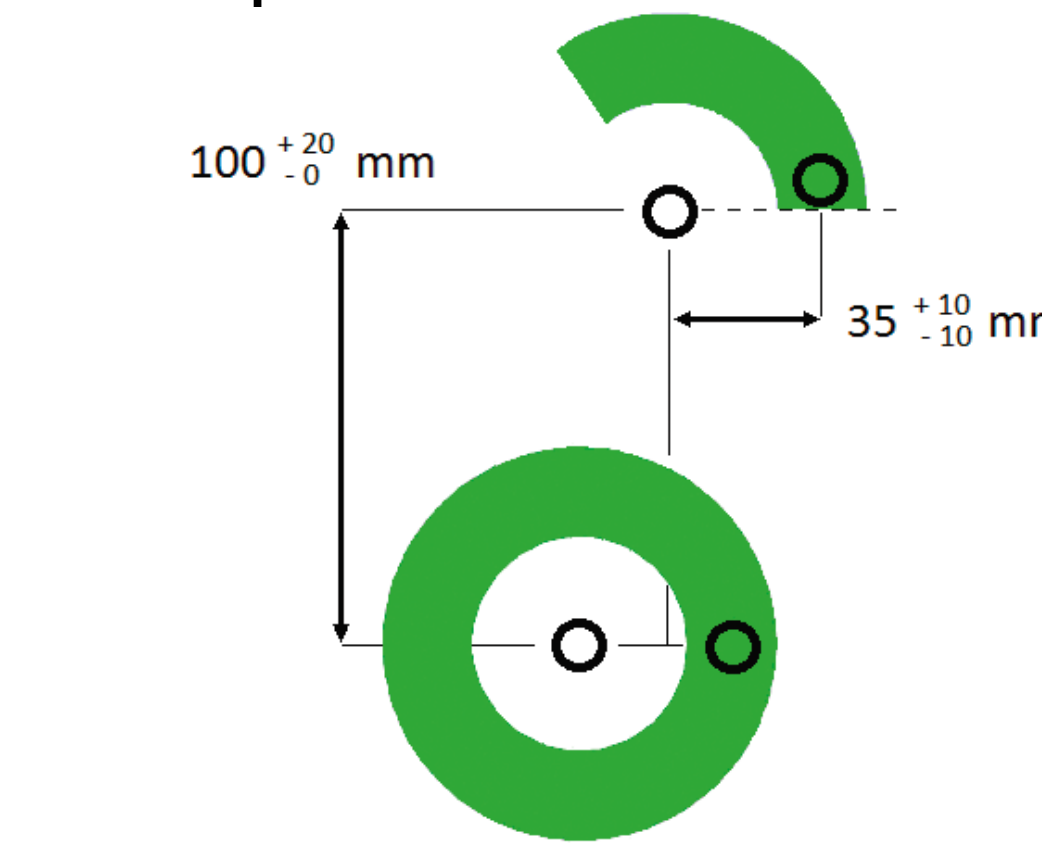
- Particularities:**
- Ballistic testing shall be conducted at the most severe impact condition allowable. Computation of this angle shall take into account the projectile attack angle in azimuth and elevation as well as the inclination of the armor panel on the vehicle.
 - Minimum number of rounds for each projectile type and armor configuration that shall be used to assess the KE and FSP ballistic protection levels 1-5.
 - All assessments shall be made using either fully engineered targets or vehicle targets to determine the ballistic resistance of the main surfaces of the armor panels.
 - Vehicle targets are the best target samples for SWA evaluation. Fully engineered targets may be used as long as the SWA are constructed in the exact same manner as for the actual vehicle.
 - Could be reduced to 10 shots for levels 1 to 3, 6 shots for level 4 and 4 shots for level 5, if the back surface damage is judged by National Authority to give full confidence that further rounds will produce no CE.
 - The multi-hit parameters for levels 1, 2 and 3 are defined in table B1, and illustrated in figure B1, for level 4 in table B3 and figure B1 and for level 5 in table B4 and figure B4 of AEP-55, Annex B. The alternative multi-hit test protocol requires three impacts in an equilateral triangle with a separation of 120 mm between impacts. The pattern is illustrated in table B2 and figure B3 of AEP-55, Annex B.
 - Any vehicle successfully assessed using the alternative requirements specified shall be classified as compliant with STANAG 4569 KE Level X (PARTIAL).
 - No testing against Level 1 - 3 fragment threats is required by STANAG 4569, but is optional to the National Authority.
 - It is mandatory to test at a 300 attack angle. Testing between attack angles of 300 and 900 is optional to the National Authority.

Target Conditioning:

- Prior to ballistic testing, each target should be pre-conditioned to a temperature of 20° ± 5°C and a relative humidity specified by the National Authority for at least 12 hours.
- The targets should be conditioned once their temperature is no longer within the tolerance band of a 5°C.
- The National Authority may require testing under extreme environmental conditions. In this case, the requirement should take into account the climatic zones defined in STANAG 2895.
- The precise requirements shall be defined in a specification or technical description.



STANAG 4569 L1 - L3 Multi-hit pattern



Personal armor

NIJ 0101.04 Level III in conjunction with III-A softpanel

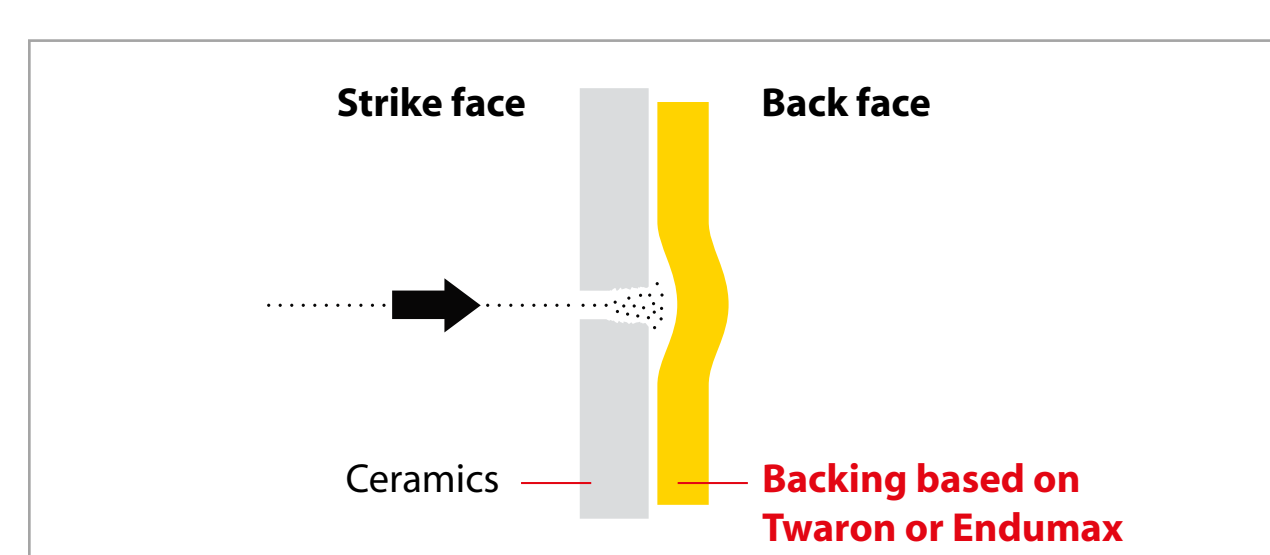
Material	Endumax XF23
Weight app.	15.5 kg/sqm
Shots per insert	6x 7.62x51 Nato Ball

NIJ 0101.04 Level III + in conjunction with III-A softpanel

Material	Endumax XF23 with AL203 ceramic strikeface
Weight app.	25 kg/sqm
Shots per insert	6x 7.62x51 Nato Ball or 6x 7.62x39 Mild Steel Core or 6x 5.56x45 M193 or 6x 5.66x45 M855

NIJ 0101.04 Level IV in conjunction with III-A softpanel

Material	Endumax XF23 with AL203 ceramic strikeface
Weight app.	35 kg/sqm
Shots per insert	1 x 7.62x63 APM2



Our solutions meeting the standards

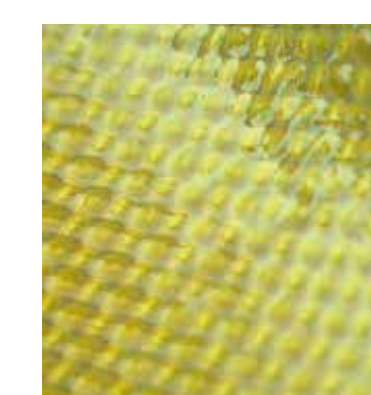
Endumax UD

Style	Weight [g/m ²]
Endumax XF23	198



Twaron Prepregs

System	Type
PVB Phenol	Duroplastic
Neopren based rubber	Duroplastic
PVB/PU/PE films	Thermoplastic



Twaron UD's

Style	Weight [g/m ²]
UD21	271



Twaron Fabrics

Style	Weight [g/m ²]
CT 736	410
T 750	460
T 760	635
R1	715

