Small arms bullets in body armour testing

Strēlnieku ieroču lodes bruņu vestu testēšanā

I. Šitvjenkins, A. Viļumsone, H. Torbicka

Keywords: armour, bullets, penetration, ballistics testing, threats, weapons, ammunition, protection level, blunt trauma.

Abstract

Each time choosing material for the needs of Armed forces the choice of concrete technical parameters has to be made. Undoubtedly, with reference to Armed forces definition of technical parameters is connected with the analysis of operatively tactical requirements, for what operative purposes material is used for. Creating or choosing system of protection the analysis of operative tactical requirements is reduced to definition the level of threats against which protection system will protect a life and health of the soldier. It is vital important to identify possible real levels of threats, against which system has to protect life and health of the soldier. Otherwise there will be uncovered threats levels and system will not work efficiently. According to International Action Network on Small Arms (IANSA) there are 640 million small arms in the world or one for every ten people on earth. Small arms are responsible for 60–90% of the direct conflict deaths that occur each year. Ten to fourteen billions of ammunition is manufactured every year, which is enough to kill every person in the world. For military personnel small arms made threat are the bullets of the hostile fire or friendly force. Widely applied individual system protecting from bullets is the bullet-proof vest. Many countries has developed standards defining level of the protection for the bullet-proof vest, but only for level definition are sewn up by means of shooting of a ballistic material by certain kinds of bullets from cartridges of small arms or certain kinds of objects simulating bullets. There are also limitations on blunt trauma, defined by the depth or by actual damage of the body. Bullet-proof vests depending on the level of protection against the threats in accordance with applied bullet or imitator of the bullet. Some standards define level of penetrating velocity of the certain type of bullet or fragments under defined probability of penetration. The authors of this publication have conducted theoretical research and have compared classes on protection level in widely applied standards with wide applied small arms ammunition in the countries of the North Atlantic Treaty Organization and also outside. Theoretical research has specified discrepancy between used bullets in standards on defining highest classes of protection and bullets with high relative energy applied in small arms ammunition in the countries of the North Atlantic Treaty Organization and outside. The specified discrepancy is as a matter of fact discrepancy between the highest threats modulated in standards and highest probable threats in a real situation that in turn influences requirements on the level of protection and the subsequent changes in the design of a system of protection. The generalized information and references allow officials to use it with a view of set up requirements and testing methodologies in technical specifications in accordance with official's country operational tactical requirements for the Armed Forces.

From the beginning of mankind people were forced to protect themselves from the cruel

Table 1. **Ballistics standards analysis, protection levels and ammunition testing**
1. tabula. **Ballistisko standartu analīze, aizsardzības līmeni un testa munīcija**

USA NIJ 0101.04 max. trauma 44 mm		Germany Technical Guidelines trauma 18-22 mm trauma in CS 36-44mm		UK HOSDB 2007 max. trauma 25 mm 44 mm in HG1/A		Russia GOST R 50744-95 actual damage level		Poland PN-V-87000:1999 max. trauma 40 mm		CEN prEN ISO 14876 Body Armour Standards max. trauma 44 mm	
I	.22 LR LRN 2.6 g min. 320 m/s .380 ACP FMJ RN 6.2 g min. 312 m/s	Special	9 mm Makarov PM VMR/Fe-core 350 ±10 m/s	HG1/A	9 mm FMJ, 8.0 g 360±10 m/s .357" Remington, 10.2 g 365±10 m/s	1	9 mm Makarov PM 5,9 g 57-H-181C Пст 305-325 m/s 7.62 mm Nagan revolver 6,8 g 57-H-122 P 275-295 m/s	1	9 mm Makarov 6,0 g min. 300 m/s		
IIA	9mm FMJ RN 8.0 g min. 332m/s .40 S&W FMJ 11.7 g min. 312m/s	SKL	9 mm LUGER 8,0 g 360 – 370 m/s	HG1	9mm FMJ, 8.0 g 360±10 m/s .357" Remington, 10.2 g 365±10 m/s						
II	9mm FMJ RN 8.0 g min. 358 m/s .357 MAGNUM, JSP 10.2 g min. 427m/s							2	9mm Parabellum FMJ 8,0g min. 358 m/s	1	9×19 mm FMSJ 8.0 g 360 ± 10 m/s
IIIA	9mm FMJ RN 8.0 g min. 427 m/s	SK1	9 mm LUGER VMR/WK 8,0g 400 – 420 m/s	HG2	9mm Carbine FMJ, 8,0g 425±10 m/s	2	5.45 PSM 2,5 g 7H7 Пст 310 – 335 m/s			2	9×19 mm FMSJ 8.0 g 415±10 m/s
	44 MAGNUM SJHP 15.6 g min. 427m/s	Special	7.62 Tokarev TT 5,5 g VMR/VK with steel jacket 500±10 m/s		.357" Remington, 10.2 g 450±10 m/s		7.62 Tokarev TT 5,5 g 57-H-134C Пст 415 – 445 m/s	3	7.62 Tokarev TT 5,5 g min. 420 m/s		
		Special	7.62 Tokarev TT 5,5 g VMR/Fe-core 530±10 m/s	SG1	12 Gauge True Cylinder, 28,4 g 435±25 m/s	2a	18.5 mm (12 gauge) Hunting 35,0 g 390 – 410 m/s			3	9×19 mm FMSJ 8.0 g 425±10 m/s
		SK2	.357 MAGNUM MsF/HK 7,1 g 570 – 590 m/s			3	5.45 mm AK 74 3,4g 7H6 ПС 870 – 890 m/s				.357 Mag FMJ 10.2 g 430±10 m/s
		Special	7.62 mm AKM 8,0g FMS/Fe-core 730±10 m/s				7.62 AKM type 1943 710 – 740 m/s				
III	7,62 mm NATO M80 FMJ 9.6 g min. 838m/s	SK3	5,56×45 VMS/WK 4,0g 910 – 930 m/s 7,62×51 VMS/Wk 9,75g 820 – 840 m/s	RF1	7.62 mm NATO Ball, 9.3 g 830±15 m/s	4	5.45 AK 74 3,4g 7H10 ПП 890 – 910 m/s			4	5.56×45 mm M193 3.6 g 970±15 m/s
						5	7.62 SVD 9,6 g 57-H-323C ЛПС 820 – 840 m/s	4	7.62 PS AKM 7.9 g min. 710 m/s		7.62×51 mm NATO Ball 9.4 g 830±15 m/s
		Special	7,62×51 VMS/HK 8,0g tungsten carbide 860±10 m/s				7.62 AKM 7,9 g 57-H-231 ПС 710 – 740 m/s				
IV	.30-06 caliber AP M2 10.8 g min. 869m/s	SK4	7,62×51 VMS/HK 9,75 g 810 – 830 m/s			5a	7.62 mm BZ AKM 7,4 g 57- БЗ-231 БЗ 720 – 750 m/s	5	7.62 BZ AKM 7.7 g min. 725 m/s	5	7.62×51 mm AP 9.7 g Hardened Steel Core 820±15 m/s
Special	According to customer requirements	Special	7.62 mm SVD 10,4 g 7-БЗ-3 Б-32 890±10 m/s			6	7.62 mm SVD 9,6 g CT-M2 820 – 840 m/s				
						6a	7.62 mm SVD 10,4 g 7-БЗ-3 Б-32 800 – 835 m/s				

influence of the environment on their lives and health to provide more or less better living conditions by adding to their own skin additional protection layers such as skin and fur of hunted animals. Unfortunately mankind has never been able to live according to the laws of the nature and in peace with other people and social groups. That is why in addition to natural threats of the environment the man made (artificial) threats were created to solve own social group interests in the way to discriminate or total destroy other social groups in the fighting for the better live conditions, better land, goods, gold, food, slaves, energy sources and other interests. According to International Action Network on Small Arms (IANSA) data [1] there are 640 million small arms in the world or one for every ten people on earth. Small arms are responsible for 60–90% of the direct conflict deaths that occur each year. Ten to fourteen billion of ammunition is manufactured every year. For military personnel small arms made threat are the bullets of the hostile fire or friendly force. Bullets damage the intended target by tissue or mechanical disruption through impact or penetration. There are several standards modulating real weapon shooting against armour material for body armour manufacturing reviewed by authors (Table 1). Almost all of them defining levels of protection depending on the bullet type and velocity it hits armor panel or plate without penetration:

- USA NIJ 0101.04 "Ballistic Resistance of Personal Body Armor" [2]
- Germany Technical Guidelines (TG) "Ballistic testing of protective vests" [3]
- UK HOSDB "Body Armour Standards for UK Police (2007) Part 2: Ballistics Resistance" [4]
- Russia GOST R 50744-95 "Armour clothing" [5]
- Poland PN-V-87000:1999 "Ballistic body armour" [6]
- CEN EN ISO 14876 "Protective clothing – body armour" [7]

Standards shown in Table 1 defining the level of protection for the bullet-proof vest by shooting certain type and amount of the bullet imitating small arms shooting into ballistics material with no penetration required and limited blunt trauma or actual damage of the internal organs from the hit. Authors didn't analyze standards defining the level of protection by the level of the velocity for certain types of bullets penetrating armour material under defined level of probability. Two standards: US DOD MIL-STD-662F "V50 Ballistics test for armour" [8] and NATO STANAG 2920 "Ballistic test method for personal armour materials and combat clothing" [9] are built on this principle. Both of them are intended mostly to be used for fragmentation testing, however MIL-STD-662F as projectiles use also the same rifle bullets with identical level of the velocities [10] as mentioned in the reviewed standards Table 1. According to Table 1 standards can be divided into two main groups: levels imitating hand guns, like pistols, revolvers and sub-machine guns shooting (NIJ I-IIIA; SKL-SK2; HG1/A-HG2; GOST 1-2; PN 1-3; ISO 1-3) and levels imitating high powered rifles, assault rifles, machine guns and sniper rifles shooting (NIJ III-IV; SK 3-4; RF1; GOST 3-6a; PN 4-5; ISO 4-5). It will not be easy to compare standards, because of the different ammunition type being used, different velocity levels, and different blunt trauma measurement. Attempt to transfer one standard to another could be problematic due the reasons mentioned above. In order to find appropriate standard with possible highest level of penetration it is necessary to make analysis on the ammunition most commonly used worldwide against human. There are a lot of criteria of the bullet penetration capability [11]. The authors chose the penetration relative energy of the bullet as the criteria in order to compare different or certain types of bullets. Relative energy is calculated as bullet energy at the velocity V_0 divided on area of the bullet projection on penetration plane at hit angle 0. Due to different deformation mechanism non armor piercing type bullets and armour piercing bullets will be analyzed separately. Table 2 shows non armour piercing types bullet used for the first group of the protection levels against hand guns like pistols, revolvers and sub-machine guns as well as other types of non armour piercing bullets used in the military and law enforcement application worldwide. Table 3 shows non armour piercing types of bullets used for the second group of the protection levels against high powered rifle, assault rifles, machine guns and sniper rifles shooting as well as other types of the non armour piercing bullets used in the military and law enforcement application worldwide. Table 4 shows armour piercing types of bullets manufactured for the military and law enforcement application worldwide not divided into groups like in non armour piercing bullets.

Table 2 **Non armour piercing bullets analysis (1st group)**
2. tabula. **Ne bruņusitēju ložu analīze (1. grupa)**

Ammunition type	**Bullet diameter mm**	**Bullet weight g**	**Vo m/s**	**Square mm²**	**Energy J**	**Energy J/ mm²**	**Source**
9×18 mm Makarov	9,23	6,00	300,00	66,88	270,00	4,04	[6], [12]
9×18 mm Makarov 57-H-181C Пст	9,23	5,90	305,00	66,88	274,42	4,10	[5], [12]
.45 ACP	11,43	14,90	245,00	102,56	447,19	4,36	[12]
.380 ACP	9,04	6,20	312,00	64,15	301,77	4,70	[12]
5.45×18 mm PSM 7H7 Пст	5,64	2,50	310,00	24,97	120,13	4,81	[5], [12]
9×18 mm VMR/fe-core	9,23	6,00	340,00	66,88	346,80	5,19	[3], [12]
.22 LR	5,66	2,60	320,00	25,15	133,12	5,29	[12], [2]
7.62×38R mm Nagant	7,49	7,00	285,00	44,04	284,29	6,46	[12], [5]
Revolver							
.40 S&W	10,11	11,70	312,00	80,24	569,46	7,10	[12], [2]
.45 ACP +P	11,43	10,70	381,00	102,56	776,61	7,57	[12]
9×19 mm VMR/WK DM 41SR	9,03	8,00	355,00	64,01	504,10	7,88	[3]
9×19 mm 7H21	9,03	5,30	460,00	64,01	560,74	8,76	[13]
12 gauge (18.5 mm) True Cylinder	18,50	28,40	410,00	268,67	2387,02	8,88	[4]
7.62×42 mm СП-4	7,82	9,97	300,00	48,00	448,65	9,35	[12]
9×19 mm QD-PEP II/s	9,03	6,00	450,00	64,01	607,50	9,49	[3]
9×19 mm Action 4	9,03	6,10	450,00	64,01	617,63	9,65	[3]
7.62×25 mm Tokarev 57-H-134C Пст	7,82	5,50	415,00	48,00	473,62	9,87	[5], [12]
7.62×25 mm Tokarev lead core	7,82	5,50	420,00	48,00	485,10	10,11	[12]
9×19 mm VMR/WK DM 41SR	9,03	8,00	410,00	64,01	672,40	10,50	[3]
12 gauge (18.5 mm) Hunting	18,50	35,00	410,00	268,67	2941,75	10,95	[5]
9×19 mm FMJ DM11 A1B2	9,03	8,00	420,00	64,01	705,60	11,02	[4]
9×19 mm FMJ RN	9,03	8,00	427,00	64,01	729,32	11,39	[2]
9×19 mm 7H31	9,03	4,20	600,00	64,01	756,00	11,81	[13]
7.92×24 mm (under development)	7,92	4,60	503,00	49,24	581,92	11,82	[14]
7.62×25 mm VMR/WK steel jacket	7,82	5,50	490,00	48,00	660,28	13,75	[3], [12]
.357 Magnum JSP	9,07	10,20	427,00	64,58	929,88	14,40	[2], [12]
.44 Magnum SJHP	10,92	15,60	427,00	93,61	1422,17	15,19	[2], [12]
7.62×25 mm Tokarev fe-core	7,82	5,50	520,00	48,00	743,60	15,49	[3], [12]
.357 Magnum R357M3	9,07	10,20	445,00	64,58	1009,93	15,64	[4], [12]
.357 Magnum MSF	9,07	7,10	570,00	64,58	1153,40	17,86	[3], [12]
5.7×28 mm Ball SS190	5,71	2,02	715,00	25,59	516,34	20,17	[12]
4.6×30 mm 2.6 g	4,65	2,60	600,00	16,97	468,00	27,57	[15], [16]

Table 3 **Non armour piercing bullets analysis (2nd group)**
3. tabula. **Ne bruņusitēju ložu analīze (2. grupa)**

Ammunition type	Bullet diameter mm	Bullet weight g	Vo m/s	Square mm^2	Energy J	Energy J/ mm^2	Source
9×39 mm СП-5	9,20	16,20	290,00	66,44	681,21	10,25	[12]
5.56×45 mm LE223T3	5,70	4,01	735,00	25,50	1083,15	42,47	[12], [4]
7.62×39 VMS/fe-core M43	7,90	8,00	720,00	48,99	2073,60	42,33	[3], [12]
7.62×39 mm 57-H-231	7,90	7,90	740,00	48,99	2163,02	44,15	[5], [12]
5.45×39 mm 7H6 ПС	5,60	3,40	870,00	24,62	1286,73	52,27	[5], [12]
.30-30 Win	7,82	9,72	725,00	48,00	2554,54	53,21	[12]
5.45×39 mm 7H10 ПП	5,60	3,40	890,00	24,62	1346,57	54,70	[5], [12]
6.8×43 mm (under approval)	7,00	7,45	800,00	38,47	2384,00	61,98	[18]
7.62×51 mm NATO Ball L2A2	7,82	9,30	815,00	48,00	3088,65	64,34	[12], [4]
5.56×45 mm M193	5,70	3,60	955,00	25,50	1641,65	64,37	[12], [7]
.303 British Ball Mk7	7,90	11,27	749,00	48,99	3161,24	64,53	[12]
5.56×45 mm NATO DM11	5,70	4,00	910,00	25,50	1656,20	64,94	[3], [12]
7.62×54R mm 57-H-323C	7,92	9,60	820,00	49,24	3227,52	65,55	[5], [12]
7.62×54R mm CT-M2	7,92	9,60	820,00	49,24	3227,52	65,55	[5], [12]
7.5×54 mm Ball ordinaire	7,82	9,25	825,00	48,00	3147,89	65,57	[12]
7.62×51 mm NATO Ball M80	7,82	9,65	838,00	48,00	3388,33	70,58	[2]
5.8×42 mm DBP87	5,95	4,26	960,00	27,79	1963,01	70,63	[12], [21]
7.62×51 mm NATO Ball DM111	7,82	9,45	850,00	48,00	3413,81	71,11	[3], [12]
.308 Win Lapua FMJBT D46	7,85	12,00	760,00	48,37	3465,60	71,64	[22]
7.5×55 mm Ball GP11	7,81	11,34	780,00	47,88	3449,63	72,04	[12]
7.62×51 mm NATO Ball L40A1	7,82	9,70	850,00	48,00	3504,13	73,00	[4], [12]
.308 Win Swiss P Ball	7,85	11,40	790,00	48,37	3557,37	73,54	[23]
.243 Win Ball	6,17	6,48	836,00	29,88	2264,42	75,77	[12]
.30-06 M2	7,85	9,72	887,00	48,37	3823,70	79,05	[12]
.308 Win Lapua Lock Base B476	7,85	11,00	860,00	48,37	4067,80	84,09	[19]
7×57 mm	7,25	9,00	900,00	41,26	3645,00	88,34	[12]
.300 Win Mag Swiss P Ball	7,82	11,40	865,00	48,00	4264,88	88,84	[24]
.300 Win Mag Match	7,82	12,30	880,00	48,00	4762,56	99,21	[22]
6.5×55 mm M41 Ball	6,70	9,30	870,00	35,24	3519,59	99,88	[12]
.300 Win Mag DM121	7,82	13,00	885,00	48,00	5090,96	106,05	[21]
7 mm Remington Magnum	7,21	9,72	948,00	40,81	4367,70	107,03	[12]
.338 Lapua Magnum	8,61	16,20	900,00	58,19	6561,00	112,74	[20]

Table 4 **Armour piercing bullets analysis**
4. tabula. **Bruņusitēja ložu analīze**

Ammunition type	Bullet diameter mm	Bullet weight g	Vo m/s	Square mm^2	Energy J	Energy J/ mm^2	Source
9×21 mm Gurza RG-052	9,00	6,70	415,00	63,59	576,95	9,07	[12]
9×39 mm СП-6	9,20	16,20	290,00	66,44	681,21	10,25	[12]
9×19 mm AP DM91	9,03	5,70	480,00	64,01	656,64	10,26	[25]
7.92×24 mm BAP (under development)	7,92	4,30	516,00	49,24	572,45	11,63	[14]
4.6×30 mm 2 g DM11	4,65	2,00	685,00	16,97	469,23	27,64	[15], [17]
7.62×39 mm API 57-БЗ-231	7,90	7,40	720,00	48,99	1918,08	39,15	[5], [12]
5.45×39 mm AP 7H22	5,60	3,68	890,00	24,62	1457,46	59,20	[12]
5.56×45 mm AP DM31	5,70	4,00	925,00	25,50	1711,25	67,10	[26]
7.62×54R mm API 7-БЗ-3 Б-32	7,92	10,40	800,00	49,24	3328,00	67,59	[5], [12]
7.62×51 mm NATO AP DM151	7,82	9,50	830,00	48,00	3272,28	68,17	[27]
7.62×51 mm NATO AP P80	7,82	9,75	823,00	48,00	3301,98	68,78	[12], [3]
5.56×45 mm AP M995	5,70	4,00	1000,00	25,50	2000,00	78,42	[12]
7.62×51 mm VMS/HK Bofors	7,82	8,40	960,00	48,00	3870,72	80,63	[3]
7.62×54R mm API 7-БЗ-3 Б-32	7,92	10,40	880,00	49,24	4026,88	81,78	[2], [12]
.308 Win Lapua AP	7,85	10,70	870,00	48,37	4049,42	83,71	[19]
.30-06 M2 AP	7,85	10,80	869,00	48,37	4077,87	84,30	[2], [12], [34]
.308 Win Swiss P AP	7,85	12,70	810,00	48,37	4166,24	86,13	[28]
.300 Win Mag Swiss P AP	7,82	12,70	855,00	48,00	4642,01	96,70	[29]
.338 Lapua Magnum Swiss P AP	8,61	16,80	830,00	58,19	5786,76	99,44	[31]
.300 Win Mag AP DM131	7,82	12,80	885,00	48,00	5012,64	104,42	[30]
.300 Win Mag AP	7,82	12,30	920,00	48,00	5205,36	108,43	[12]
.338 Lapua Magnum API	8,61	16,40	895,00	58,19	6568,41	112,87	[20]
.338 Lapua Magnum AP	8,61	16,10	905,00	58,19	6593,15	113,30	[20]

Figure 1 visually shows non armour piercing types of bullet used for the first group of the protection levels against hand guns like pistols, revolvers and sub-machine guns (marked in blue) as well as other types of the non armour piercing bullets used in the military and law enforcement application worldwide (marked in pink). Fig 2 shows non armour piercing types bullet used for the second group of the protection levels against high powered rifle, assault rifles, machine guns and sniper rifles shooting (marked in blue) as well as other types of the non armour piercing bullets used in the military and law enforcement application worldwide (marked in pink). Fig 3 shows armour piercing type's bullet manufactured for the military and law enforcement application worldwide not divided into groups like in non armour piercing bullets, however bullets applied in standards are marked in blue and other bullets available on the market in black. The above mentioned analysis will not show completely real situation, due to different mechanism of bullet penetration depending on bullet's shape and design. However this analysis provides understanding how dramatically can relative penetration energy change depending on the caliber and type of ammunition. Moreover it shows the discrepancy between bullets applied in ballistics material testing and other types of bullets widely applied in military and law enforcement application. At the same time this is the difference between real possible threat and threat modulated in laboratories.

Based on this analysis there are two bullets with high relative energy from cartridges 5.7×28 mm and 4.6×30 mm types uncovered by standards for the 1st group (non armour piercing) of hand guns like pistols, revolvers and submachine guns. Cartridges 5.7×28 mm used for the

Figure 1. **Bullets relative energy – 1st group**
1. att. **Ložu īpatnējā enerģija – 1. grupa**

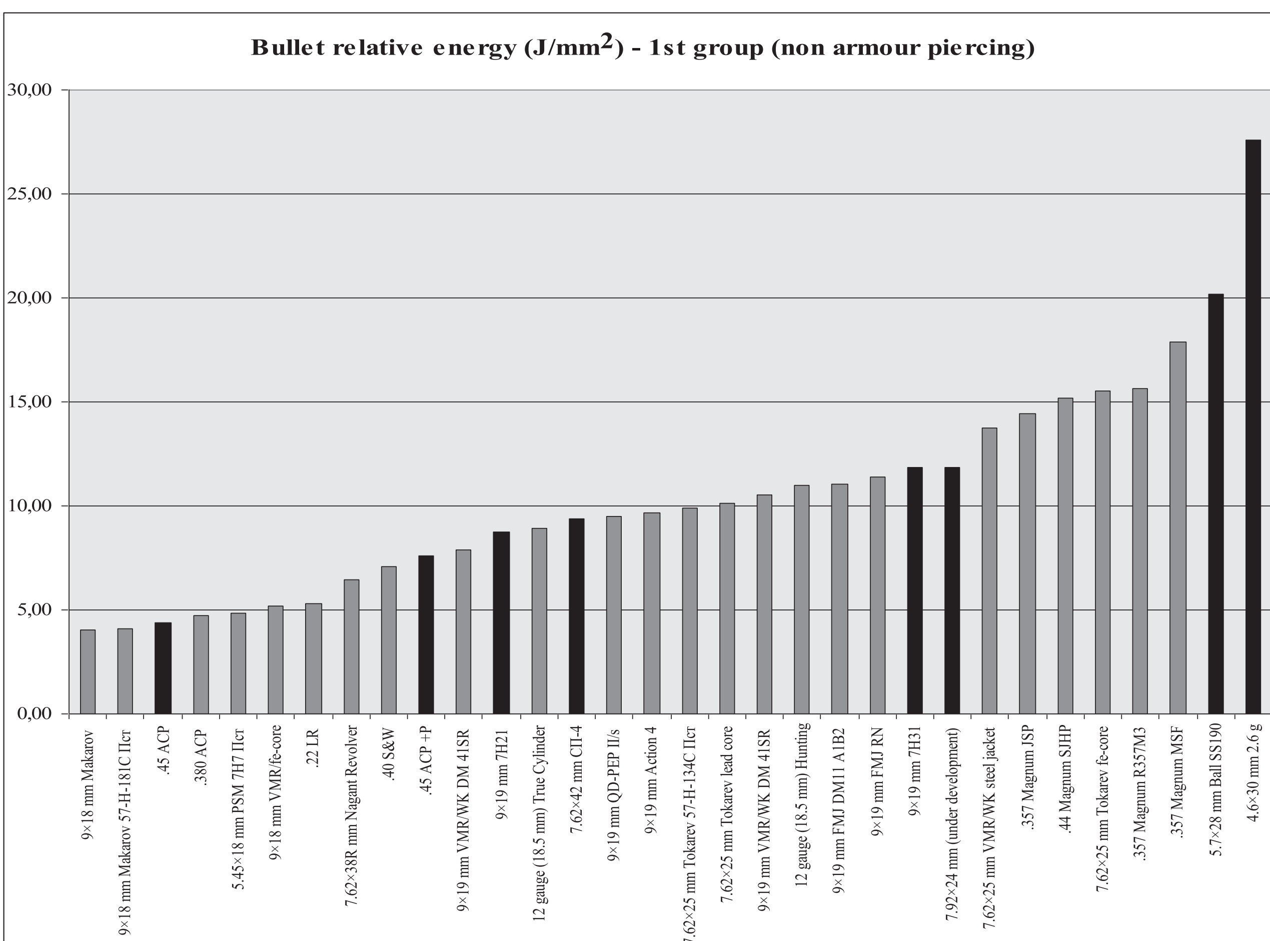
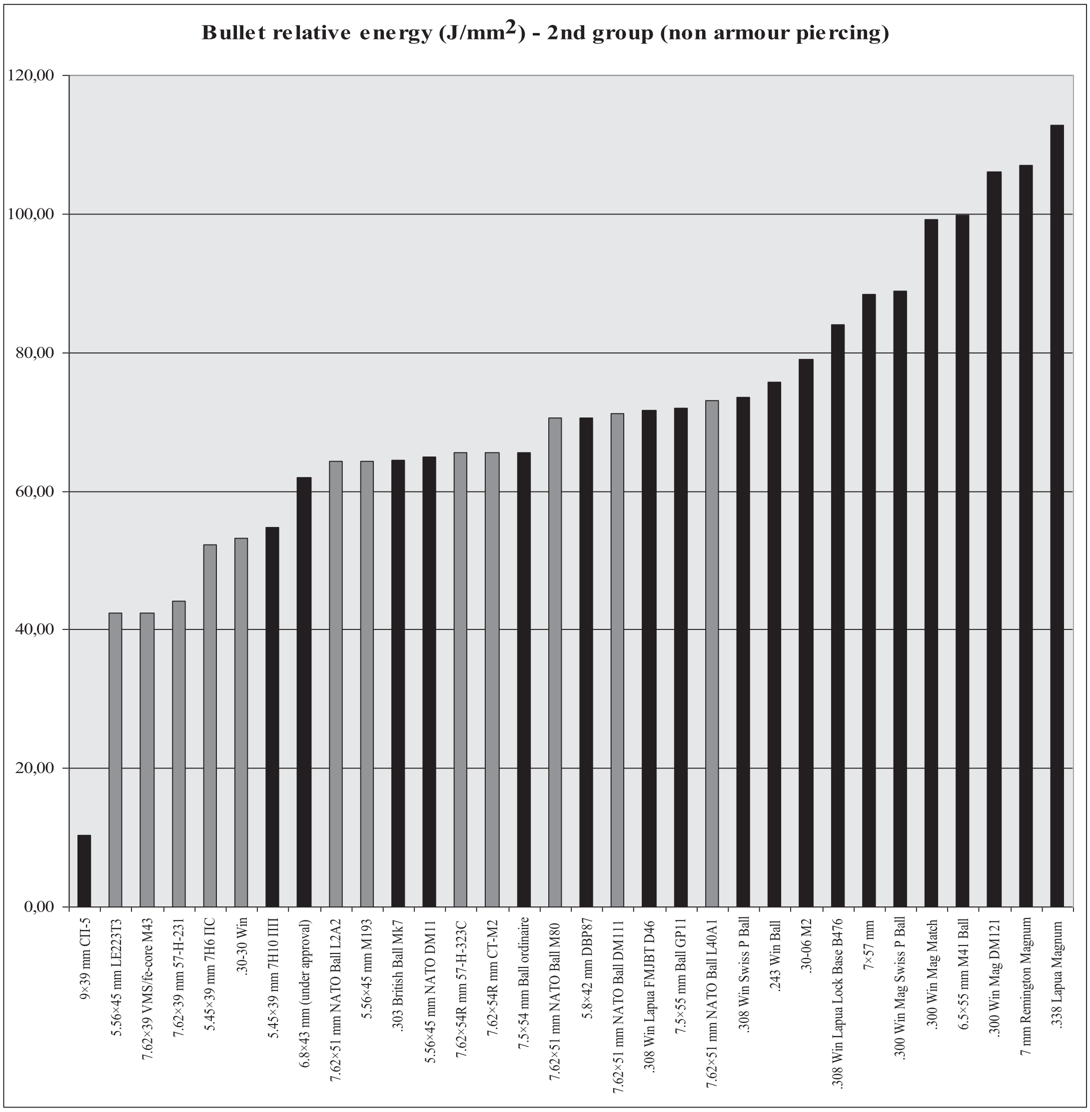
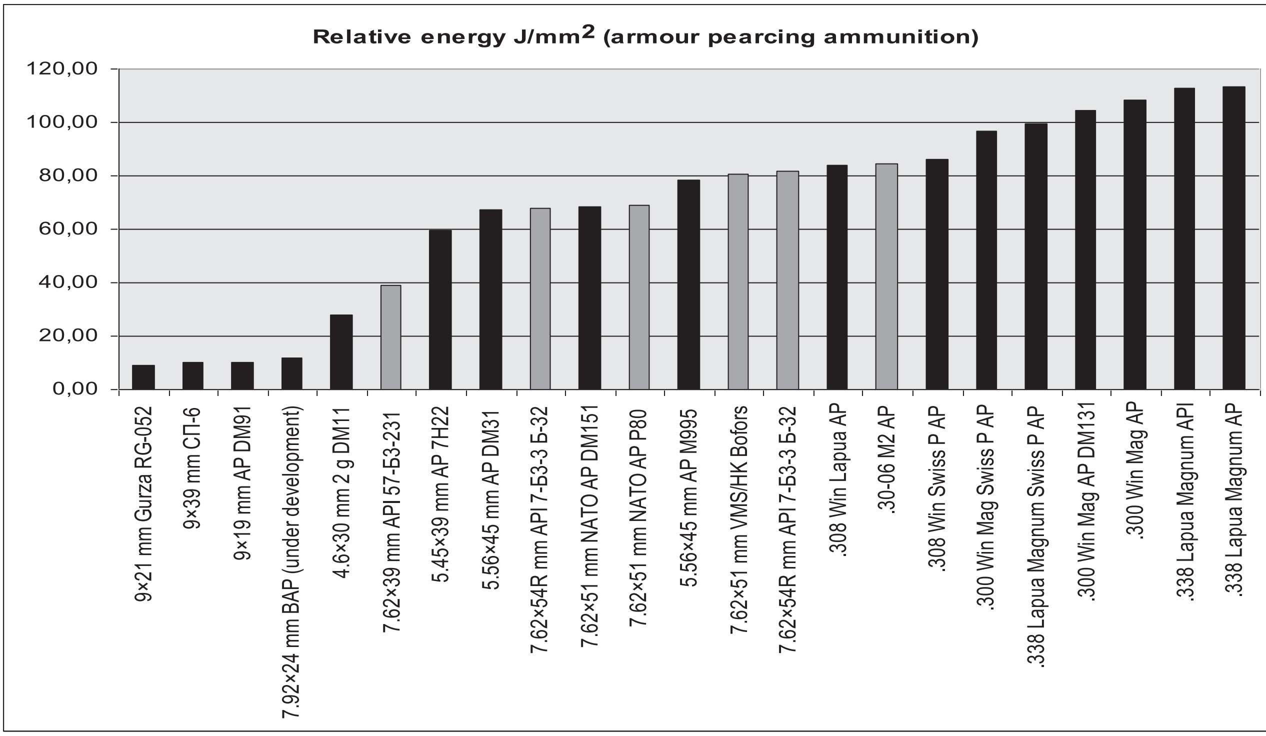


Figure 2. **Bullets relative energy – 2nd group**
2. att. **Ložu īpatnējā enerģija – 2. grupa**



pistols FN Five-Seven USG and sub-machine guns FN P90, both manufactured by Belgium company Fabrique Nationale de Herstal (FN Herstal SA) [32]. Pistols FN Five-Seven USG are in armament in 42 countries (information provided by FN Herstal SA) within NATO and non-NATO countries. Sub-machine guns FN P90 are in armament in 40 countries (information provided by FN Herstal SA) among them NATO and non-NATO countries. Hand guns chambered for 5.7×28 mm are in use worldwide, that means bullet from cartridges 5.7×28 mm are possible threat, yet it is not covered by standard ballistics testing. Cartridges 4.6×30 mm used for the pistols UCP and sub-machine guns MP7, both manufactured by German company Heckler&Koch GmbH [33]. Pistol UCP is currently under development (information provided by Heckler&Koch GmbH), but sub-machine guns MP7 are in armament in 33 countries within NATO and non-NATO countries. Hand guns chambered for 4.6×30 mm are in use worldwide, which means bullets from cartridges are possible threat; unfortunately it is not covered by standard ballistics testing. Also multi hit from both 5.7×28 mm and 4.6×30 mm submachine guns is very probable. For the 2nd group rifles chambered for cartridges 6.5×55 mm, 7×57 mm, 7.5×55 mm, 7.5×54 mm and .303 British [12] not so widely distributed in the world in military and law enforcement application, however manufacturing of the cartridges still

Figure 3. **Bullets relative energy – armour piercing ammunition**
3. att. **Ložu īpatnējā enerģija – bruņusitēja munīcija**



remain. Research shows that there are cartridges existing for caliber .243 Win, .308 Win, .300 Win Mag and .338 Lapua Magnum and chambered rifles with higher relative energy of the bullets than bullets covered in the ballistics testing standards. Very famous sniper rifle chambered for all these caliber cartridges is AW (Arctic Warfare) manufactured by Accuracy International Ltd. According to the Accuracy International Ltd. information [44] AW sniper rifles are in use in over sixty countries worldwide, that mean that bullets from .243 Win, .308 Win, .300 Win Mag and .338 Lapua Magnum are possible threat. According to the research also armour piercing and armour piercing bullets available in market for .308 Win, .300 Win Mag and .338 Lapua Magnum as shown in Table 4, with relative higher energy than .30-06 M2 AP used in standard testing on NIJ level IV protection. Ruag Ammotec made reference for own manufactured ammunition capable penetrate NIJ IV++ body armour [28] [29]. Formally there is no NIJ IV++ level existing [2] only NIJ IV, but manufacturers of body armour have to take this information into consideration. Governmental agencies officials and individual armour systems manufacturers have to evaluate further using of .30-06 M2 AP bullet in the ballistics testing of armour material. Another cartridge what officials and manufacturers have to put attention on developing individual protection is 5.8×42 mm DBP87 standard cartridge for assault rifle, light support weapon, sniper rifle of the Armed Forces of the People's Republic of China. This cartridge in use only by Armed Forces of the People's Republic of China and not distributed therefore worldwide and possible threat is very limited. However it could be used as test cartridge, because according to Table 3 from limited data available in sources also show higher relative energy of the bullet 5.8×42 mm DBP87 than 5.56×45 mm NATO and the 5.45×39 mm caliber bullets. There is no data available for the 5.8×42 mm DBP87 heavier load and longer streamlined bullet with a steel core for longer range and better penetration for light support weapon and sniper rifle. Estimated relative energy for heavier load and longer streamlined bullet will be higher than relative bullet energy for the basic 5.8×42 mm DBP87, which makes this cartridge more interesting in ballistics testing as single hit and multi hit due to cartridge applied for assault rifles and light support weapons.

LITERATURE

1. 2006: Bringing the global gun crisis under control: The International Action Network on Small Arms (IANSA) [electronic source] – *www.iansa.org/media/releases/IANSA-report-summary.pdf* – created 2006.
2. U.S. Department of Justice, Office of Justice, National Institute of Justice, NIJ Standard-0101.04 "Ballistics Resistance of personal body armor", Washington, 2001, page 2–3.
3. Germany Technical Guidelines (TG) "Ballistic testing of protective vests".
4. John Croft, Daniel Longhurst, Home Office Scientific Development Branch, Sandridge, St.Albans, Publication No.39/07/B "HOSDB "Body Armour Standards for UK Police", page 12–13.
5. State Standard of the Russian Federation GOST R 50744-95 "Armour clothing. Classification and general technical requirements", Moscow, 1995, page 69–70.
6. Polish Committee for Standardization (PKN) Light ballistic covers (protection) Bulletproof and fragment-resistant vests General requirements and testing ref. nr PN-V-87000:1999.
7. CEN EN ISO 14876 "Protective clothing – body armour". Ashok Bhatnagar. Lightweight ballistic composites, Military and Law Enforcement application. – Cambridge, Woodhead Publishing, 2006, page 144–148.
8. Department of Defence Test Method Standard US DOD MIL-STD-662F "V50 Ballistics test for armour", Washington, 1997, page 7.
9. North Atlantic Treaty Organization (NATO) NATO Standardization Agency Standardization agreement STANAG 2920 Edition 2 "Ballistic test method for personal armour materials and combat clothing", Brussels, 2003, page 7. 67 *Baltic Defence Research and Technology Conference 2009.*
10. Department of Defence Test Method Standard US DOD MIL-STD-662F "V50 Ballistics test for armour", Washington, 1997, page 14.
11. Ashok Bhatnagar. Lightweight ballistic composites, Military and Law Enforcement application. – Cambridge, Woodhead Publishing, 2006, page 51–71.
12. Charles Q Cutshaw, Leland Ness. Jane's Ammunition Handbook 11.edition 2002–2003. – Surrey: Jane's Information Group Ltd, 2002, page 6–57.
13. Maxim Popenker. Special purpose small arms ammunition of USSR and Russia. [electronic source] – *http://world.guns.ru/ammo/sp-e.htm* 2005-2008
14. 7.92×24 mm ammunition [electronic source] *http://www.fsdip.com/website/VBRBelgiumHome/English/VBRB46x30mmammo/VBRB792x24mmammo/Ammunition792x24BAP67/tabid/315/Default.aspx* – no publishing data.
15. 4.6×30 mm cartridge (Germany), small arms and cannon ammunition [electronic source] *http://www.janes.com/articles/Janes-Infantry-Weapons/4-6-x-30-mm-cartridge-Germany.html* – no publishing dates.
16. 4.6×30mm: Ruag Holding [electronic source] – *http://www.ruag.com/de/Defence_Security/Amunition/PDF_Munition/4.6mmx30_Sintox_Ball_2.6g_DM21.pdf* – no publishing date.
17. 4.6×30mm: Ruag Holding [electronic source] – *http://www.ruag.com/de/Defence_Security/Amunition/PDF_Munition/4.6mmx30_Sintox_Penetrator_DM11.pdf* – no publishing date.
18. Ballistics result: Remington Arms Company Inc. [electronic source] – *http://www.remington.com/products/ammunition/ballistics/comparative_ballistics_results.aspx?data=R68R1*R68R2*RM68R1*PRC68R4* – no publishing date.
19. .308 Win: NAMMO Lapua Oy [electronic source] – *http://www.lapua.com/index.php?id=887* – no publishing date.
20. .338 Lapua Magnum: NAMMO Lapua Oy [electronic source] *http://www.lapua.com/index.php?id=888* – no publishing date.
21. .300 WIN.MAG Vollmantel (DM121): Metallwerk Elisenhütte GmbH [electronic source] – *http://www.elisenhuette.de/cms/cms/front_ content.php?idart=51* – no publishing date.
22. .300 WIN.MAG Match: Metallwerk Elisenhütte GmbH [electronic source] – *http://www.elisenhuette.de/cms/cms/front_content.php?idart=49* – no publishing date.
23. .308 Win SWISS P Ball (308 Win SWISS P Ball.pdf): Ruag Holding [electronic source] –*http://www.ruag.com/Defence_Security/Ammunition/Defence_Forces_and_Government_Agencies/Download_Factsheets* – no publishing date.
24. .300 Win Mag SWISS P Ball (300 Win Mag SWISS P Ball.pdf): Ruag Holding [electronic source] – *http://www.ruag.com/Defence_Security/Ammunition/Defence_Forces_and_Government_Agencies/Download_Factsheets* – no publishing date.
25. 9×19 mm Hartkern (DM91): Metallwerk Elisenhütte GmbH [electronic source] – *http://www.elisenhuette.de/cms/cms/front_content.php?idart=14* – no publishing date.
26. 5.56×45 mm Hartkern (DM31): Metallwerk Elisenhütte GmbH [electronic source] – *http://www.elisenhuette.de/cms/cms/front_content.php?idart=33* – no publishing date *Baltic Defence Research and Technology Conference 2009* 68.
27. 7.62×51 Hartkern (DM151): Metallwerk Elisenhütte GmbH [electronic source] – *http://www.elisenhuette.de/cms/cms/front content.php?idart=40* – no publishing date.

28. .308 Win SWISS P AP Ball (308 Win SWISS P Ball.pdf): Ruag Holding [electronic source] – *http://www.ruag.com/Defence_Security/Ammunition/Defence_Forces_and_Government_Agencies/Download_Factsheets* – no publishing date.
29. .300 Win Mag SWISS P AP (300 Win Mag SWISS P AP.pdf): Ruag Holding [electronic source] – *http://www.ruag.com/Defence_Security/ Ammunition/Defence_Forces_and_Government_Agencies/Download_Factsheets* – no publishing date.
30. .300 WIN.MAG Hartkern (DM131): Metallwerk Elisenhütte GmbH [electronic source] – *http://www.elisenhuette.de/cms/cms/front_content.php?idart=48* – no publishing date.
31. .338 Lapua Magnum SWISS P AP (338 Lapua Magnum SWISS P AP.pdf): Ruag Holding [electronic source] – *http://www.ruag.com/Defence_Security/Ammunition/Defence_Forces_and_Government_Agencies/Download_Factsheets* – no publishing date.
32. FN Herstal small arms: FN Herstal SA [electronic source] – *http://www.fnherstal.com/index.php?id=176* – no publishing date.
33. Heckler&Koch products: Heckler&Koch GmbH [electronic source] – *http://www.heckler-koch.com/Products* – no publishing date.

I. Šitvjenkins, A. Viļumsone, H. Torbicka

Strēlnieku ieroču lodes bruņu vestu testēšanā

Vienmēr, izvēloties jebkuru materiāltehnisko līdzekli Bruņoto spēku vajadzībām, atbildīgas amatpersonas nonāk izvēles priekšā par konkrētajiem tehniskajiem rādītājiem. Neapšaubāmi Bruņoto spēku gadījumā tehnisko rādītāju noteikšana vienmēr ir saistīta ar operacionāli taktisko prasību analīzi, kādiem operacionālajiem mērķiem šis materiāli tehniskais līdzeklis ir paredzēts. Izveidojot vai izvēloties individuālo aizsardzības sistēmu, operacionāli taktisko prasību analīze pārtop par analīzi apdraudējumam, pret ko sistēma aizsargās karavīra dzīvību un veselību. Vitāli svarīgi identificēt reāli iespējamā apdraudējuma līmeņus, lai pēc iespējas precīzāk noteiktu prasības aizsardzības sistēmai, kura tiks paredzēta aizsardzībai pret konkrēto apdraudējumu. Pretējā gadījumā pastāvēs varbūtība, ka pret noteikto iespējamo apdraudējumu sistēma nenodrošinās pietiekamo aizsardzību. Viens no šādiem apdraudējumiem ir iespējamā pretinieka vai, iespējams, arī sabiedroto strēlnieku ieroču lodes un pretinieka vai sabiedrota munīcijas sprādziena rezultātā radītās šķembas. Plaši izmantojama sistēma, kas aizsargā pret lodēm un šķembām, ir bruņu veste. Daudzās valstīs ir izstrādāti standarti ar prasībām bruņu vestu aizsardzības līmeņiem, ko nosaka, attiecīgi atšaujot ballistisko materiālu ar noteikta tipa lodēm no strēlnieku ieroču patronām vai noteikta parauga objektiem, kas imitē šķembas un lodes. Papildus tam tiek ierobežoti pēctraumas līmeņi pēc dziļuma vai pēc traumas smaguma. Atsevišķie standarti nosaka ātrumu, pie kura lodes un šķembas ar noteikto varbūtību caursit ballistisko materiālu. Atkarībā no lodes vai šķembu imitatora veida bruņu vestes klasificē pēc aizsardzības līmeņa no zemākā līdz augstākajam vai attiecīgi pēc ātruma līmeņa, kurā lodes vai šķembu imitatori ar noteikto varbūtību caursit ballistisko materiālu. Publikācijas autori ir veikuši teorētisko pētījumu un salīdzināja munīciju, ko pielieto, modulējot apdraudējumu plaši izmantojamos standartos, ar munīcijas veidiem strēlnieku ieročiem, kas tiek plaši izmantoti Ziemeļatlantijas līguma organizācijas valstīs, kā arī ārpus tām. Teorētiskais pētījums ir norādījis uz zināmu neatbilstību starp izmantojamiem munīcijas veidiem standartos, nosakot aizsardzības līmeņus visaugstākajām klasēm un munīcijas veidiem ar lielo īpatnējo enerģiju lodēm, ko izmanto Ziemeļatlantijas līguma organizācijas valstīs, kā arī ārpus tām. Minētā neatbilstība pēc savas būtības norāda uz atšķirību starp reālo apdraudējumu un testēšanas procedūras standartos pieņemto apdraudējumu, kas savukārt ietekmē prasības pret aizsardzības līmeni un izmaiņas prasībās aizsardzības sistēmas elementiem. Apkopotā informācija ļauj atbildīgajām amatpersonām izmantot rezultātus, izvirzot savas prasības bruņu vestu tehniskajiem radītājiem tehniskajās specifikācijās attiecībā pret aizsardzības līmeņiem un testēšanas metodoloģijām.