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O. Bilenko, D. Pavlov

National Academy of the National Guard of Ukraine, Kharkiv

FEATURES OF SECURITY FORCES WEAPONS' SPECIFICATION DESIGNING

Security forces weapons' specification designing is an actual problem since antiterrorist and law enforcement activities appear more important issues in modern conflicts. Meanwhile, police and other security forces over the globe still apply combat weapons while providing law enforcement, antiterrorist, and other force domestic actions. As proper analysis demonstrate, the field of security forces' weapons engineering, as opposed to combat weapons, is still not sufficiently explored. Appropriate rational specifications for such weapons must be designed aimed future collateral loses mitigating. The aim of the article is to ground the general principles of security forces weapons' specifications designing by means of summarizing separate researches' results concerning weapon technical characteristics influence on fire missions' effectiveness. Common dependencies and methods of external ballistics are applied. Outcomes are represented as three guidelines groups such as kinetic non lethal weapon, limited range weapon, and security forces sniper rifles.

Keywords: *kinetic non-lethal weapon, limited range weapon, sniper rifle, security forces, weapon specification.*

Introduction

Army and security forces' mission effectiveness depends also on their weapons correspondence to missions practice demands. Weapon specification designing is still an actual problem [1] since modern warfare strategies and domestic law enforcement principles tend to permanent changing. Obtaining economical and political control over certain regions is reached today sooner by means of destabilization establishing rather than terrain occupying. Supporting internal criminals, terrorists and illegal armed formations is becoming nowadays the way to wage a war. The antiterrorist and law enforcement activities provided by security forces, and by armed forces too, appear more important issues in modern conflicts, as opposed to classic wars [2]. In such conditions wide range of missions are usually carried out by the national security forces. There are various missions from civil order supporting to terrorists and illegal armed formations combating that can require special weapons to be used [3]. In such missions the security forces' weapon usage patterns can essentially differ from armed forces ones.

In general the main security forces' weapon usage patterns are

– firing in condition of irrelative persons presence (settlements, installations, crowded places, transport facilities, etc.) when their injuring is probable;

– targeting terrorist or law breaker who shields himself with hostage body (to avoid hostage injuring it requires fire to be extremely precise and rapid);

– targeting law breakers who must be suppressed only (it is required non lethal target hitting effect).

These specific weapon usage patterns require weapon performance to be special as following

– if weapon is used for target suppressing, following weapon characteristics such as projectile casualty-producing, stopping, and penetrating effects, projectile kinetic and specific energies, projectile ballistic coefficient (C) and shape, weapon environmental factors (especially air temperature) response must be regulated (in this case it must be regulated as well as minimal as maximal of these characteristics' values);

– providing irrelative persons safety it must be regulated maximum projectile flight range, projectile casualty-producing range, projectile ricochet parameters;

– small target hitting (for example, target sector not shielded with hostage body) requires regulation of grouping pattern, optical sight zoom, mechanic sighting devices parameters;

– to avoid injuring of those irrelative persons who are behind target at fire direction it is required projectile target perforating power, projectile behind target power, projectile casualty-producing power, and projectile kinetic energy to be limited (in this case it must be regulated as well as minimal as maximal of these characteristics' values);

– to meet projectile kinetic and specific energies requirements and weapon environmental conditions response demands it is necessary to regulate muzzle velocity V_{muz}, ballistic coefficient and their values dispersion.

A whole number of articles concerning weapon specifications have appeared last time [4–8]. But in these articles mainly influence of separate weapon technical characteristics on fire mission effectiveness are described. Thus, all of these issues can be summarized in order to design appropriate weapon specification guidelines.

The aim of the article is to ground the general principles of security forces weapons' specifications designing by means of summarizing separate researches' results concerning weapon technical characteristics influence on fire missions' effectiveness.

Basic section

Following methods and procedures are considered

– the projectile muzzle velocity dispersion determination method for non-lethal weapons (NLW), also often referred as less-lethal weapons [3] and limited range weapon (LRW) [4];

– the projectile ballistic coefficient values dispersion determination method for kinetic weapons [5];

– the procedure to define reasonable technical characteristic values for kinetic NLW [6];

– the procedure to define reasonable technical characteristic values for security forces kinetic LRW [7];

– the procedure to define reasonable technical characteristic values for security forces sniper rifle [8].

Outcomes are represented as three guidelines groups such as kinetic non lethal weapon, limited range weapon, and security forces sniper rifles.

Large size and mass projectiles are more suitable for kinetic NLW. It is explained by necessity of low ballistic coefficient values that correspondingly allows NLW valid range [9] to be wider. Such weapons can be indirectly indicated by low muzzle velocity values.

For example, within weapon complexes FORT 500 rifle with TEREN 12P cartridge and FORT 500 rifle with TEREN 12K cartridge the most suitable in this case is first one because its projectile 30 times more massive than second weapon complex's one (correspondingly first weapon complex projectile has muzzle velocity 2.5 times lower than second complex). These parameters' values affect NLW valid range (first complex has 5 meters valid range, second complex has no valid range at all).

Narrow NLW valid range band [9] essentially limits of such weapon's operational properties. Practically the only way for existing kinetic NLW to extend valid range is adopting of several cartridges that provide differ valid range on trajectory location with mutual overlapping. Such difference can be achieved with different propellant loading mass for the same cartridge. This approach also could allow air temperature affected projectile muzzle velocity declining to be compensated [10].

Modern NLW projectiles are usually stabilized by means of about a longitudinal axis rotation (gyroscopic stabilization) or by using of such projectile profiles that provide its drag force center to be positioned behind the mass center (so called drag stabilization) [11]. Some NLW have non stabilized spherical projectiles.

Among all types of NLW projectile those stabilizing by means of about a longitudinal axis rotation (that is weapon with rifled barrel) should be considered as more rational variant for high performance NLW. In addition to rotation affected higher fire accuracy such projectiles usually have bigger transverse loading (mass to cross section ratio); correspondingly they have the less ballistic coefficient value, and, thus, provide prolonged valid range of NLW.

Drag stabilized projectiles' ballistic coefficient usually less than spherical projectile one. But such shape projectiles can have essential disadvantage due to uncertain time of stabilization frequently founded within them. This stabilization time uncertainty leads to enlargement of such projectiles' ballistic coefficient values dispersion. For example, as it is reported in [12], Teren-12P cartridge's projectile has not been stabilized until 10 m range in 4 cases from 23 shots (17%). In such case ballistic coefficient value has grown at 40...85 %. It refers valid range to be reduced at 27…45 % and value of fire mission execution probability to be fall down at 29…56 % (providing 95% probability projectile to rich its target). This problem can not be solved by enhancing accuracy of projectiles production.

Thus, non spherical projectiles combined with smooth-bore weapons shouldn't be considered as suitable NLW system for security forces to carry out their high accuracy fire missions.

Spherical projectiles usually have relatively large ballistic coefficient values. It essentially reduces valid range of NLW combined with such projectiles.

It can be concluded that the projectiles stabilizing by means of about a longitudinal axis rotation is the most rational issue for security forces NLW. Such projectiles provide the most advanced, among other NLW projectiles, characteristics such as extended valid range, on trajectory projectile parameters stability, advanced accuracy.

Limited range weapons are not still adopted by security forces. But fire missions with necessity of limited projectile casualty-producing range can be performed with adopted weapons having large projectile BC and muzzle velocity values. Such parameters combination provides lower values of indeterminacy range [9] and projectile casualty-producing range.

Let's examine three 9 mm gun projectiles (used with standard loading and standard gun) PST (ПСТ in original), THV, FMJ, PSO 9×19.000 (ПСО 9×19.000 in original), metal powder shell-free (tabl. 1) on its suitability to limited casualty-producing range firing. Dependencies of projectiles' kinetic energy on distance from muzzle for 9 mm gun projectiles are depicted at the fig. 1. Obviously, metal powder shell-free projectile and THV in this case have advantage since their C and V_{muz} values are relatively large.

Table 1

9 mm cartridges projectile characteristics

Projectile identity	Projectile mass, g	Ballistic coefficient, m^2/kg	Muzzle velocity, m/s	Casualty-producing range, m
THV	4.30	24.41	345	165
Metal powder shell-free	2.55	18.25	485	210
PST	6.10	12.48	315	330
FMJ	6.75	10.45	300	400
PSO	7.80	7.69	360	640

If projectile casualty-producing energy is supposed as 20 J, casualty-producing range for THV projectile is 165 m, for metal powder shall-free it is 210 m; it is 2 and 1.6 times correspondingly less than more widely-spread PST projectile having 330 m casualty-producing range.

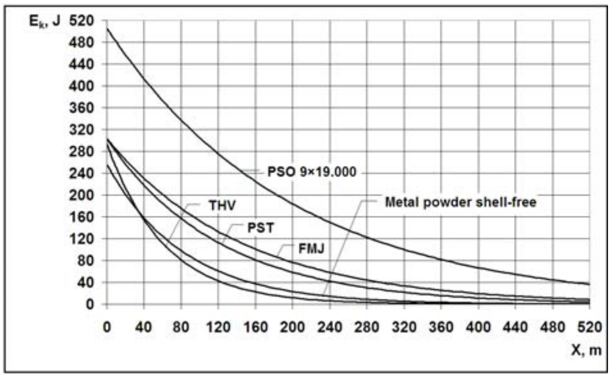


Fig. 1. Dependencies of projectiles kinetic energy on distance from muzzle for 9 mm gun projectiles (used with standard loading and standard gun)

For the purpose of LRW indeterminacy range reducing it is possible usage of technologies allowing projectile ballistic coefficient to be changed upward abruptly after its valid range distance is overcome.

As another promising issue it can also be considered jet projectile [13] with large C and small mass values. Such projectile could maintain certain velocity until jet propulsion would be terminated due to projectile propellant exhaustion. After projectile jet propulsion is stopped, projectile's velocity will degrade abruptly due to large C and small mass values. Undoubtedly, such projectile's valid range, velocity, and energy parameters can be predetermined.

Security forces sniper weapons projectile's time to rich target must be as small as possible since it is necessary to hit moving target. Such characteristics can be achieved with higher velocity projectile having small ballistic coefficient value. It also provides minimal trajectory altitude, and, by this way, it allows fire to be more accurate when target distance is defined incorrectly.

At the fig. 2 it is depicted dependences of projectiles' flight time on target distances for several cartridges that can be used as sniper munitions such as 7.62×54R SN (СН in original), 7.62×54R US (УС in original), 5.45×39 US, 6.5×54R MBO (МБО in original), and 5.6×39 MBO.

Values of moving target frontal shift within projectile's flight time are represented at the tabl. 2.

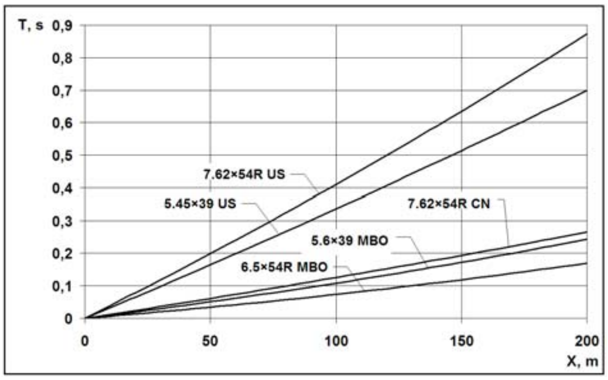


Fig. 2. Projectile flight time versus target distances

Table 2

Target frontal shift within projectile's flight time

Target move type and velocity, m/s	Target shift within projectile's flight for 70 m/200 m firing distance, m				
	7.62×54R SN	7.62×54R US	5.45×39 US	6.5×54R MBO	5.6×39 MBO
Slow step, 1	0.09/ 0.27	0.28/ 0.87	0.23/ 0.70	0.07/ 0.24	0.05/ 0.17
Quick step, 1,5	0.13/ 0.40	0.42/ 1.31	0.35/ 1.05	0.11/ 0.37	0.07/ 0.25
Slow running, 3	0.26/ 0.80	0.85/ 2.62	0.70/ 2.10	0.22/ 0.73	0.15/ 0.51
Moderate speed running, 5	0.43/ 1.33	1.41/ 4.37	1.16/ 3.49	0.37/ 1.22	0.25/ 0.85
Scamper, 7	0.60/ 1.86	1.97/ 6.11	1.63/ 4.89	0.51/ 1.70	0.35/ 1.19

As it can be seen at the tabl. 2, moving target hitting is impossible due to it's more than half size frontal shift unless appropriate aiming point shift or lateral sight's data adjustment is made.

In such case special sport rifles intended for moving targets competitive firing could be suitable since they have as usually high velocity projectiles. For example projectile of 5.6 mm rifle MC-80-1 (in original МЦ-80-1) with 5.6×54R MBO cartridge complex has muzzle velocity 1570 m/s. This projectile provides suitable target shifting parameters for full-length (chest) silhouette target (70 m for slow running, 200 m for slow step) and head silhouette (70 m for quick step). Internal ballistic limitations require small projectile mass in order high projectile velocity to be reached. But small mass provoke high projectile deceleration and lead to substantial effective range shortening. It is unacceptable for army sniper weapons, but it would be suitable for security forces sniper missions since their usual firing range is not big [14].

For security forces sniper missions it can also be used rifles with rimfire .22 Long Rifle cartridges [15]. Such weapon's projectiles have kinetic energy approximately 50–70 J at 100 m distance that 40–50 times less than Dragoonov's sniper rifle projectile at the same distance. Thus .22 Long Rifle projectiles would be safer for irrelative persons and hostages. Meanwhile, these rifles can be suggested for only motionless target hitting due to their relatively small projectile velocity.

Loading parameters' set-on accuracy can essentially affect precision of fire. Therefore, keeping precision of loading parameters, especially those within them as propellant mass, projectile's mass and diameter, is important for security forces sniper missions' performance. Due to technology limitations munitions manufacturers are not always able to provide necessary cartridges' parameters accuracy and uniformity.

In order to provide stability of muzzle velocity values it is reasonable to use less strength propellant while correspondingly enlarging its quantity for the same cartridge. It allows while remaining technologically affected additive error of propellant portion value its relative error to be reduced.

The selective method is suggested to reduce projectiles' mass and diameter values dispersion. It means manufactured projectiles amount to be assorted by groups with regard to its mass and diameter values. Each cartridge consignment must consist of projectiles of the same group. Projectiles' mass and diameter nominal values and dispersion data must be denoted at the cartridge packing. It would allow professional sniper to take into account these data while zeroing his weapon or caring out sniper fire missions. Projectiles may be assorted also within available cartridge by calibration with special calibers.

Thus, considering selective method there is a possibility to advance projectile muzzle velocity stability without needs of any cartridge manufacturing technology advancing.

Sniper shot as usually entails target escape from sniper's visual field due to rifle recoil. It not allows series of shots to be made within short time interval that sometimes can be needed to hit important target surely. Barrel lifting angle (recoil affected barrel upward shifting) decreasing and optical sight visual field increasing can help to meet this problem.

Followed weapon design issues can be recommended to decrease barrel lifting angle of sniper rifles

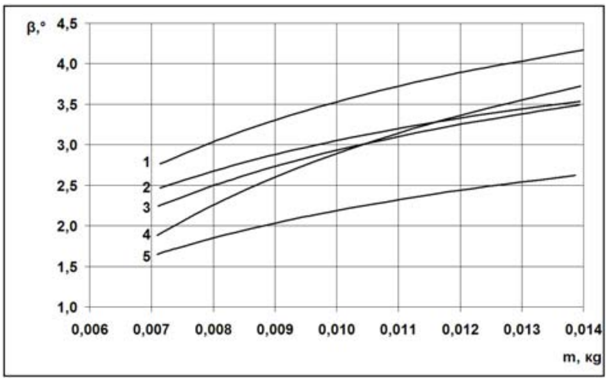
– barrel must be mounted as low as possible (relative to weapon's mass center); it allows to minify arm between recoil vector and weapon rest point; adjustable butt back plate also would provide means of that arm minifying;

– in order to enlarge weapon inertia moment relative to rest point it is reasonable to apply as possible long at length adjustable buttstock [16];

– to provide weapon inertia moment enlargement usage of special weights (if it possible) would be approved; for this purpose special holders must be mounted.

As it comes from above, the more big and heavy sniper rifle is, the more rapidly sniper fire mission can be done. At first sight such concept contradicts weapon designing traditions. But taking into account specificity of common security forces sniper fire missions (stationary position, no mobility needs) this idea could be worth to accept.

Also to decrease barrel lifting angle it would be suggested usage sniper munitions having highest projectile muzzle velocity while providing the same determined projectile muzzle energy (it is mentioned more light projectiles). Dependences of barrel lifting angle values on projectile mass at determined projectile muzzle energy E_m for Dragoonov's sniper rifle (SVD) and series of Fort-301 sniper rifle cartridges are depicted at the fig. 3.



1 – SVD (E_m=3427 J); 2 – Fort-301 (E_m=3715 J); 3 – Fort-301 (E_m=3414 J); 4 – Fort-301 (E_m =4137 J); 5 – Fort-301 (E_m=3112 J).

Fig. 3. Barrel lifting angle values versus projectile mass (providing E_m= const)

For the purpose of barrel lifting angle decreasing it would be reasonable accepting blowback bolt design for security forces sniper rifles. This design allows recoil to be balanced by massive bolt whose mass center is moved along barrel axis. Meanwhile the main disadvantages of blowback bolt design (overall rifle mass enlargement due to massive bolt and powerful munitions inapplicability) limit its usage in modern sniper rifles usually oriented on powerful cartridges for long range firing. But regarding security forces sniper mission specificities (mentioned above weapon mass and size tolerance, low energy projectiles preference) the blowback bolt design could be accepted.

Optical sight having wide viewing angle would be recommended for security forces sniper rifles to provide target remaining in visual field while firing. It is quite suitable for security forces because their common fire missions not need high zoom optics due to usually short range firing.

Conclusions

In view of security forces fire missions' specificities following guidance for weapons specifications designing are suggested.

Rifled barrel with non spherical projectiles are considered to be more effective for the non lethal kinetic weapons. Complete set of cartridges with overlapping performance characteristics is the better issue for kinetic non lethal weapon as opposed to universal munitions.

The fire missions with necessity of limited projectile casualty-producing range can be performed with weapons having large projectile ballistic coefficient and muzzle velocity values. The technologies providing abrupt projectile velocity degradation and jet projectile technologies are the promising issues for the limited range weapons designing.

High velocity light projectiles are more suitable for security forces sniper munitions. Also it is suggested usage of the assorted cartridges with large mass propellant loading. The .22 Long Rifle cartridges could be considered as promising munitions for security forces weapons. Mass and size tolerance is acceptable for the purpose of necessary qualities to be obtained. The rifles with adjustable buttstock and wide-angle optics are preferable. The blowback bolt design could advance sniper rifle accuracy.

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Відомості про авторів:

Біленко Олександр Іванович
доктор технічних наук доцент
начальник докторантури та ад'юнктури
Національної академії Національної гвардії України,
Харків, Україна
https://orcid.org/0000-0001-6007-3330
e-mail: bai69@ukr.net

Павлов Дмитрій Вадимович
кандидат військових наук
докторант
Національної академії Національної гвардії України,
Харків, Україна
https://orcid.org/0000-0003-3015-0061
e-mail: pdv78@ukr.net

Information about the authors:

Oleksandr Bilenko
Doctor of Technical Sciences Associate Professor
Head of Postgraduate Department of
National Academy of the National Guard of Ukraine,
Kharkiv, Ukraine
https://orcid.org/0000-0001-6007-3330
e-mail: bai69@ukr.net

Dmytrii Pavlov
Candidate of Military Sciences
Doctoral candidate of
National Academy of the National Guard of Ukraine,
Kharkiv, Ukraine
https://orcid.org/0000-0003-3015-0061
e-mail: pdv78@ukr.net

ОСОБЛИВОСТІ ФОРМУВАННЯ ВИМОГ ДО ЗБРОЇ СИЛ БЕЗПЕКИ

О.І. Біленко, Д.В. Павлов

Формування вимог до зброї сил безпеки є актуальною проблемою на сьогодні, оскільки антитерористична та правоохоронна діяльність стають важливими складовими вирішення сучасних конфліктів. В той же час майже у всьому світі поліція та інші безпекові служби ще досі використовують звичайну бойову зброю у правоохоронній, антитерористичній діяльності та при виконанні інших силових завдань всередині держави. Як показує відповідний аналіз, питання розробки спеціальної зброї для сил безпеки, на відміну від бойової зброї, досі залишаються недостатньо вивченими. Тому необхідно розробляти раціональні вимоги до такої зброї, щоб у майбутньому зменшувати можливість випадкових втрат серед громадян. Метою статті є розроблення загальних вимог до зброї сил безпеки шляхом узагальнення результатів окремих досліджень щодо впливу технічних характеристик зброї на ефективність виконання вогневих завдань. Використано відомі залежності та методи зовнішньої балістики. Результати представлено у вигляді трьох груп рекомендацій щодо: кінетичної зброї несмертельної дії, зброї з обмеженою відстанню дії та снайперських гвинтівок для сил безпеки.

Ключові слова: *кінетична зброя несмертельної дії, зброя з обмеженою відстанню дії, снайперська гвинтівка, сили безпеки, вимоги до зброї.*

ОСОБЕННОСТИ ФОРМИРОВАНИЯ ТРЕБОВАНИЙ К ОРУЖИЮ СИЛ БЕЗОПАСНОСТИ

А.И. Биленко, Д.В. Павлов

Формирование требований к оружию сил безопасности является актуальной проблемой сегодня, поскольку антитеррористическая и правоохранительная деятельность становятся важными составляющими разрешения современных конфликтов. В то же время практически во всем мире полиция и другие службы безопасности еще до сих пор активно используют обычное боевое оружие в правоохранительной, антитеррористической деятельности и при решении других силовых задач внутри страны. Как показывают результаты соответствующего анализа, вопросы разработки специального вооружения для сил безопасности, в отличие от боевого оружия, до сих пор остаются недостаточно изученными. Поэтому необходимо разрабатывать рациональные требования к такому вооружению, чтобы в будущем уменьшать возможность случайных потерь среди граждан. Цель статьи – разработка ряда требований к отдельным видам вооружения сил безопасности путем обобщения результатов разных исследований относительно влияния технических характеристик оружия на эффективность выполнения огневых задач. Использованы известные зависимости и методы внешней баллистики. Результаты представлены в виде трех групп рекомендаций относительно: кинетического оружия несмертельного действия, оружия с ограниченной дальностью действия и снайперских винтовок для сил безопасности.

Ключевые слова: *кинетическое оружие несмертельного действия, оружие с ограниченной дальностью действия, снайперская винтовка, силы безопасности, требования к оружию.*