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New Generation Light Ammunition 6.8mm Caliber For NGSW (Next Generation Squad Weapon)

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Abstract– To be able to increase the fighting power of the United States Infantry troops, the US Army developed lightweight ammunition, namely 6.8 mm caliber. The development of 6.8 mm ammunition is due to the development of body armor (individual troop personal protective equipment) which increasingly uses materials that are difficult to penetrate by old ammunition such as 5.56 mm caliber and 7.62mm caliber at relevant distances. With this 6.8 mm caliber, it is expected that even body armor with strong materials can be penetrated even with a long shooting distance of about 600 m, with such a distance it is penetrated, especially with a close distance it will certainly facilitate the penetrating power of the 6.8 mm caliber against body armor with strong materials. In this paper, a literature study was conducted on the latest 6.8 mm ammunition for NGSW (Next Generation Squad Weapon) which began to be developed in the United States. There are three Defense Industries in the United States that are trusted by the US Army to be able to conduct research and development related to 6.8 mm ammunition as NGSW (Next Generation Squad Weapon), namely Sig Sauer, General Dynamics, and Textron Systems. Each industry produces 6.8 mm lightweight ammunition with different ammunition materials and also makes prototypes of weapons with different types. Textron System produces 6.8 mm ammunition with CT (cased telescoped) ammunition models, General Dynamics produces 6.8 mm TVCM (True Velocity Cartridge) ammunition with SAAMI standards, and for Sig Sauer produces 6.8 mm Hybrid Cartridge ammunition made from steel. As for the prototype weapons, namely the Textron NGSW-R 6.8 mm made by Textron Systems, the RM 277 Assault Rifle with the "BullPup" system made by General Dynamics, and for Sig Sauer's 6.8 mm MCX Spear. Of the three American Defense Industries, Sig Sauer is considered to have the best design and development, both for ammunition design and the design of the Assault Rifle prototype that will use the 6.8 mm NGSW ammunition.

Keywords: Cartridge, Ballistic, Ammunition, Ammo, Projectile, Caliber, Small Arms, Weapon.

I. INTRODUCTION

The development of weapons technology continues to be carried out by Weapons Industries around the world, especially in light ammunition. Light ammunition continues to be developed because after all, in warfare and combat no matter how sophisticated the technology of civilization will still be needed squad troops or Infantry troops to infiltrate and invade enemy areas such as headquarters and installations of combat opponents. Therefore, the US Army is currently looking for an alternative in the form of the Next Generation Squad Weapon (NGSW), which focuses on a new 6.8mm round that has much greater capabilities than the 5.56mm. With better stopping power, this weapon will increase the effective range of US soldiers and address the issue of better body armor penetration capability. Three prototypes made by Sig Sauer, General Dynamics and Textron Systems were tested by the US Army. These prototypes represent standard and submachine gun variants. The innovative polymer Cased Telescoped (CT) bullets used in the latter rifle provide significantly higher velocity and 35% weight reduction compared to conventional brass bullets (Jenzen-Jones & Fitch, 2019). On the other hand, India decided to purchase the Sig Sauer 716 Second Generation rifle that uses a 7.62 mm caliber. This rifle will give the Indian Army a huge range advantage. An added benefit is that 7.62 mm is still produced

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globally, which means access to ammunition is not an issue. The imbalance in defensive and offensive modern technologies equipping soldiers in 2021 suggests that imbalances in the reinforcement of certain defenses against attack are likely to characterize future battlefields between competing nations. To create overmatch conditions, armies must reconsider their troop equipping schemes that rely on technology and tradition. With sleeve telescopic ammunition technology and 6.8mm caliber next-generation troop guns, armies can equip their soldiers with more powerful and flexible firepower. This provides a significant tactical advantage and can change the game in the short to medium term. If soldiers use next-generation weapons and calibers equipped with older 5.56 mm and 5.45 mm (Russian) technology, they will have a significant tactical advantage in terms of range and firepower. The reconstruction of conventional platoons will be most beneficial if combined with creative thinking that capitalizes on upcoming weapon technology opportunities.

Like Sweden for example, they have several options to either invest in older weapons such as traditional infantry weapons like the AK 5 with 5.56mm caliber (modified FN FNC) and Kulspruta 90 (FN Minimi 5.56mm), or they can switch to 7.62mm weapons equipping the Home Guard with updated AK 4C rifles (G3 rifles). Rethinking the balance of weapons and upgrading to more powerful rounds at the platoon level could be a creative way to compensate for the lack of mass in the short term, given Sweden's vast landscape and the relatively small size of the Swedish Army today. One of the important lessons from the fighting in Ukraine is that the Ukrainian armed forces are very weak in defending its territory due to its relatively short age (term of combat capability). This is where technology and more flexible thinking can greatly increase the strength of battalion units in Infantry forces when facing an enemy that may have greater mass but less capable weaponry (Finlan, 2021).

The purpose of developing 6.8 mm ammunition is to replace assault rifles used by United States Army Infantry troops that still use 5.56 mm ammunition such as M4A1 and M16 with assault rifles that use 6.8 mm caliber ammunition (Lopez, 2022). This replacement was carried out on the basis of increasing the ability of assault rifles to penetrate body armor that was increasingly developed as well, especially body armor made in Russia and China. If previously 5.56 mm ammunition had poor penetration power against body armor, it is hoped that the development of 6.8 mm ammunition can be a solution to these problems. In addition, this 6.8 mm ammunition also has a high level of accuracy with good penetration power, it is expected to be able to shoot targets with a distance of 610 m with accuracy and be able to penetrate body armor with a distance of 500 m (Lane, 2022) which previously on this 5.56 mm ammunition was only about 250-300 m so that 5.56 mm could penetrate body armor, and even then sometimes it still did not penetrate.

II. RESEARCH METHODOLOGY

This research methodology uses a literature review system by searching journals and collecting data with keywords: Cartridge, ballistic, ammunition, ammo, projectile, caliber, small arms, bullet, and weapon. These sources are articles that have been published to Google Scholar. The bibliography of the article is obtained from several articles and books that are related to each other. The literature study method is an analysis of books, literature, notes and reports that are relevant to the problem to be solved (Nazir, 2009). According to (Hasibuan & Zainal, 2007) literature review is a summary containing theories, findings, and other research sources obtained from references to be used as a basis for conducting research.

This literature review utilizes a systematic literature review (SLR) approach that involves identifying, assessing and interpreting all findings related to the topic of discussion from various sources. A systematic review is a term used to refer to a particular research methodology, the development of which is to locate, collect and then evaluate research relating to a particular topic focus.

The stages of the SLR method are elaborated into 3 stages, namely: Planning, in writing refers to the problem formulation described in the introduction, the data used in this research is secondary data, secondary data can be obtained through literature studies, related scientific articles, implementation, the application of the SLR method can help find sources. At the stage of searching for reference sources or relevant literature using keywords, searching for journals that use English for international journals, while using Indonesian for national journals, reporting, the final stage in the SLR method where writing or analyzing the results that have been sought will be made in the form of writing which is then continued in the discussion of this literature review.

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This literature review analyzes and identifies articles related to the latest generation of ammunition with 6.8 mm caliber as NGSW (Next Generation Squad Weapon) filtered and summarized to introduce what is 6.8 mm caliber which will be used as the latest bullet or ammunition that will be used by squad or infantry troops in the future, especially will be used by the US Army. Articles used in this review include theoretical studies and reviews that are considered relevant.

III. RESULT & DISCUSSION

1. Bullet Projectile Perspective Design

The diameter on the new projectile is an important component in its design. Based on the findings of the previous analysis and initial estimates, the designed perspective projectile has a diameter of 6.8 mm. The construction of the projectile is the next component after determining the diameter. To conclude the review of commonly used armor-piercing projectiles, four different approaches are offered to this problem, which are as follows:

a. 6.8 mm Steel Penetrator projectile (6.8 mm SP);
b. 6.8 mm Jacketed Tungsten Penetrator projectile (6.8 mm JTP);
c. 6.8 mm Tungsten Penetrator projectile (6.8 mm TP);
d. 6.8 mm Light Tungsten Penetrator projectile (6.8 mm LTP)

1.1. 6.8 mm Steel Penetrator projectile

The idea for this bullet was derived from the M855A1 round used in the first projectile, but the diameter was changed. The M855A1 Enhanced Performance Round (EPR) is a bullet projectile or ball ammunition in 5.56 x 45 mm caliber bullets (Woods, 2010). The 6.8 mm SP (steel penetrator) component consists of a hardened steel penetrator weighing 2.29 grams, a copper slug, and a reverse drawn copper jacket that encloses it. The steel penetrator does not affect the total weight of the projectile, so it should be possible to achieve higher muzzle velocities with reasonable peak chamber pressures. Figure 1 shows the construction scheme of the designed 6.8 mm SP.

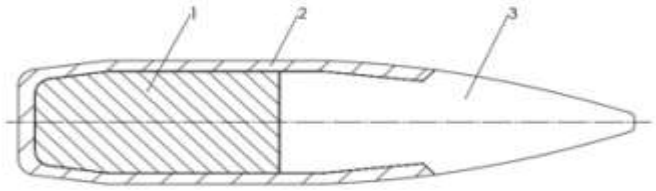

Figure. 1. Projectile 6.8 mm SP (Steel Penetrator)

1 – copper slug, 2 – copper jacket, 3 – steel penetrator

1.2. 6.8 mm Jacketed Tungsten Penetrator projectile (JTP)

The 28.22 mm long and 6.8 mm long JTP projectile or bullet consists of a 4.59 g tungsten penetrator housed in an aluminum sleeve fully lined with a copper jacket, as shown in Figure 2.

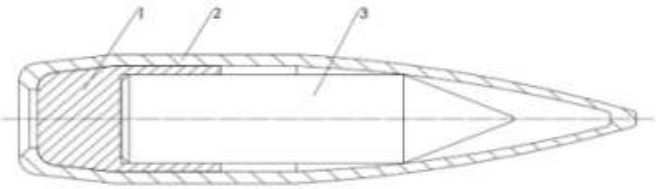

Figure. 2. Projectile 6.8 mm Jacketed Tungsten Penetrator (JTP)

1 – Alummunium sleeve, 2 – copper jacket, 3 – tungsten penetrator

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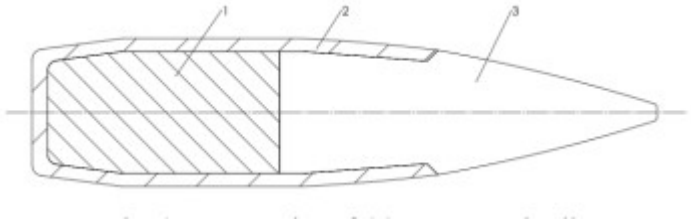
This design features a larger ogive radius, which aims to improve external ballistic performance at supersonic speeds. In addition, the overall length is shortened when compared to the 6.8 mm SP, which results in a reasonable weight of 7.29 g for a 6.8 mm projectile.

1.3. 6.8 mm Tungsten Penetrator projectile (TP)

Due to the use of tungsten-penetrating bullets, the 6.8 mm TP (Fig. 3) has a much larger total weight than other designs. It consists of a copper plug and core weighing 5.01 grams, and an inverted drawn copper (coated) jacket covering part of it. The arrow-shaped penetrator increases the armor-piercing capacity of the projectile. However, it has a major impact on the weight of the projectile, raising its total weight to 9.24g. This must be taken into account when conducting an evaluation of the peak chamber pressure required to achieve the expected muzzle velocity.



1.4. 6.8 mm Light Tungsten Penetrator (LTP) projectile

The final proposed design is a midpoint between all previous designs to maintain the overall weight of the projectile at an acceptable level.

The 6.8mm caliber Light Tungsten Penetrator (LTP) projectile consists of a 2.24-gram tungsten penetrator with an open front of a retractable copper jacket, an interior filled with copper slugs, and an aluminum cartridge. Despite its relatively light weight of 6.86 grams, this design still uses a high-density tungsten core at the front of the projectile. To achieve a much higher muzzle velocity while maintaining a reasonable chamber pressure, such a feature is essential. This can improve external ballistic performance and the projectile's ability to penetrate armor. Fig. 4 shows the projectile design.

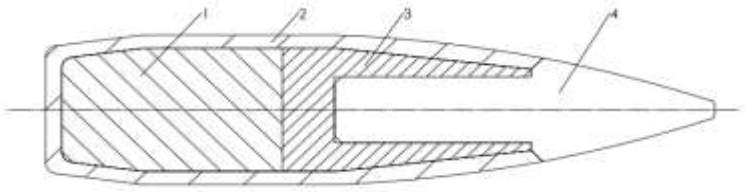


Figure 4. Projectile 6.8 mm Light Tungsten Penetration (LTP)

1 – copper slug, 2 – copper jacket, 3 – alumunium sleeve, 4 – tungsten penetrator

1.5. The following table displays the technical data of the designed projectile:

Parameter	6.8 mm SP	6.8 mm JTP	6.8 mm TP	6.8 mm LTP
Panjang Proyektil (mm)	31.37	28.22	28.98	29.20
Berat Proyektil (g)	7.09	7.29	9.24	6.86
Berat Penetrator (g)	2.29	4.59	5.01	2.24
Ogive Radius (mm)	60.0	62.2	83.6	60.0

Table 1. Technical data of the projectile design

(Piasta & Kupidura, 2023)

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2. Overview of the Cartridge Program for Next Generation Squad Weapon (NGSW)

An analysis of ammunition designs participating in the Next Generation Squad Weapon (NGSW) program was conducted to meet the requirements for a new cartridge. The NGSW was established and began development in the United States in 2017 with the aim of replacing assault rifles and light machine guns such as the M4, M249 LMG, and M240 MG with the latest assault rifles, ammunition, and fire control systems (Mizokami, 2018). Initially, the United States Army awarded this development to three military industries located in the United States, they competed for further development contracts on this NGSW where the 6.8 caliber was claimed by them to be able to provide the balance of lethality needed in long-range combat and close quarter battle (CQB). In addition, according to them, the 6.8 mm caliber bullet will replace the NATO standard 5.56 mm caliber bullet because 6.8 mm is lighter and more lethal (Adde, 2019). The three main competing industries for the program with their respective 6.8 mm caliber production are:

a. SIG Sauer Inc: SIG MCX SPEAR rifle, SIG MG 6.8 mm machine gun using 6.8 x 51 mm hybrid cartridges;
b. LoneStar Future Weapons dan Berreta USA: Genesis RM-277R bullup rifle dan Genesis RM-277 AR machine gun dengan menggunakan peluru 6,8 x 51 mm True Velocity Composite-Cased Munition (TVCM) polymer cased ammunition yang didesain oleh True Velocity;
c. Textron Systems: Senapan CT Textron 6,8 mm, LSAT LMG (Lightweight Small Arms Technology - Light Machine Gun) dengan menggunakan peluru 6,8 mm Cased-Telescoped cartridge.

Textron Defense Systems' design was withdrawn during the program, but the first two contenders remained in competition. In January 2022, the NGSW fire control system was selected over the Vortex Optics XM157 NGSW-FC (Next Generation Squad Weapon - Fire Control) system won by L3Harris Technologies.

The US Army announced Sig Sauer as the winner of the competition for the XM5 rifle, XM250 automatic rifle and 6.8mm ammunition in April 2022.

2.1. 6.8 x 51 mm Sig Sauer Hybrid Cartridge

SIG Sauer designed the 6.8×51 mm Hybrid cartridge for its bulletless and rimless rifles in 2019. This bullet originally had a case consisting of a stainless steel base, brass body, and locking washer. However, over time, the design has changed, and the steel base and brass case body now lack a locking washer.

Steel-base cartridges can withstand chamber pressures of more than 550 MPa, enabling higher muzzle speeds than ordinary brass cartridges. As a result, the steel base improves external ballistic performance and bullet energy on target. Table 1 collects data on the 6.8 mm Hybrid bullet as a whole. Although the specific construction of the projectile is not yet known as the design is set by the US Armed Forces, the available information shows that this bullet has characteristics similar to a boat tail and is rather long like a hybrid ogive. The following Figure 5. shows the hybrida bullet.

Figure 5. 6.8 x 51 mm Sig Sauer Hybrid Cartidge

2.2. 6.8 x 51 mm TVCM True Velocity Cartridge

As part of the Next Generation Squad Weapon (NGSW) program, True Velocity is making TVCM 6.8×51 mm cartridges with composite casings. These cartridges are designed for the new 6.8×51 mm Amicus rifle which has a patented automatic system with gas and short recoil. The new cartridge case consists of two parts: a body made of composite and a base made of steel. A boat-tail hybrid projectile with a relatively small diameter meplat is used as the bullet. The cartridge has a large standard rifle primer in it.

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The maximum peak pressure with a muzzle velocity of 920 m/s is unknown as the program is ongoing and ballistic data and specifications are currently stored. The technical data of the 6.8 mm TVCM cartridge is shown in Table 1.

According to available information, polymer casings are made without the typical neck. This simplifies the structure, increases the shear strength, durability of the ammunition and provides a larger volume for the propellant. In contrast, to safely extract spent cartridges, a steel base must be used.

Polymer cartridges have a very important feature, which is that although their external profile is defined by space, their internal shape can be freely designed. This allows the constructor to achieve the ideal cartridge volume and shape for propellants with the required ballistic parameters. The use of plastic casings increases weapon efficiency due to the reduced weight of the casings and lower heat transfer due to the insulating properties of the polymer.

This 6.8 mm True Velocity Cartridge or TVCM bullet is a bullet used for civilian or competition that has been certified by SAAMI (Sporting Arms and Ammunition Manufacturers' Institute). The 6.8 mm True Velocity Cartridge bullets certified by SAAMI by True Velocity have a maximum average pressure of 65,000 psi and 135 bullets at 3,000 fps (Sagi, 2022).

Figure 6. 6.8 x 51 mm TVCM True Velocity Cartridge

2.3. 6.8 mm CT Textron Cartridge

Textron Systems and Winchester make NGSW Cased-Telescoped ammunition. The bullet consists of a primer, which is a projectile completely inside a cylindrical polymer sleeve with propellant surrounding it. Compared to a comparable brass cartridge, this solution reduces the weight of the cartridge by 37%. Due to the shorter overall length of the bullet, this particular design allows the use of longer projectiles, which results in an improved ballistic coefficient. Table 1 shows the current technical data available for the 6.8 mm Hybrid cartridge bullet. Long boattail projectiles are used in the 6.8 mm CT cartridge. The front of the bullet is made of different materials for target penetration, possibly hardened steel to improve terminal ballistic performance. In Fig. 7 below a cross-section of a 6.8 mm CT cartridge is shown.

Figure 7. Cross-section of a 6.8 mm CT bullet cartridge

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Table 2. Technical data of 6.8 mm caliber NGSW (Next Generation Squad Weapon) rounds

No.	Parameter	Value		
		6.8 x 51 mm Sig Sauer	6.8 x 51 mm TVCM	6.8 mm CT Textron
1.	Diameter Proyektil (pelor) [mm]	7.06	7.06	~7.0
2.	Panjang Selongsong (cartridge) [mm]	71.8	71.0	51.0
3.	Panjang Proyektil [mm]	51.2	49.48	~36.0
4.	Berat Proyektil [g]	8.75	8.75	8.8
5.	Keceptan Muzzle [m/s]	915.0	920.0	915.0
6.	Muzzle Energy [J]	3662.8	3703.0	3683.9
7.	Tekanan Maks. Ruang [MPa]	550	448.16*	-

*Maximum Average Pressure value for SAAMI method

(Piasta et al., 2022)

3. Prototype Assault Rifle NGSW 6.8 mm Calibre

3.1. Weapon Prototype developed by Textron

In September 2019, Textron presented its prototype at a conference at Fort Maneuver Center. Assault rifles and multipurpose machine guns are the two types of weapons developed by this company. The new generation assault rifle developed by the company "Textron" is named Textron NGSW-R 6.8 mm. The prototype of this new generation assault rifle is shown in Figure 8.

Figure 8. 6.8 mm NGSW Assault Rifle Prototype developed by Textron

It can fire a 6.8 mm caliber round weighing 8.8 grams/135 grains with a muzzle velocity of about 3000 fps/915 m/sec or even more (Popenker, 2018). In addition, the company provides different types of weapons: they have sealed bolt, forward feed, gas piston, and can be reconfigured between 6.5 mm and 7.62 mm. Textron is still in competition with General Dynamics and Sig Sauer for the contract to manufacture Next Generation Scout Guns (NSGW). All three companies won awards to build prototypes that will be tested by teams from spring 2010 to the end of 2021. No production contract is guaranteed.

3.2. General Dynamics' RM277 Assault Rifle Prototype

For the NGSW-R (Next Generation Squad Weapon-Rifle) program, funded by the United States Army, a consortium of companies, led by General Dynamics, is developing the General Dynamics RM277 6.8 mm assault rifle. In addition to General Dynamics, which serves as the project leader and system integrator, the consortium also consists of Beretta USA, which handles the weapon itself, and True Velocity, which handles the new ammunition. The companies have provided little information on current developments. RM277 - 6.8 mm is the general name of the dynamic assault rifle (Figure 9). The General Dynamics prototype differs from the Textron and Sig Sauer prototypes in that it is built with a magazine behind the trigger mechanism called "Bullpup".

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Figure 9. 6.8 mm NGSW Assault Rifle Prototype developed by General Dynamics

General Dynamics describes an assault rifle with performance gas operation and recoil operation, average impulse, with an air-cooled system. These assault rifles incorporate gas piston, gas port, and recoil operation as they use both operating mechanics, i.e. gas operation and recoil operation that can be operated at the same time. Ammunition is delivered from magazines with a capacity of between 20 to 30 rounds, which are cooled by air inside the barrel. In addition, this weapon has a silencer (suppressed) at the front end of the barrel. When a shot is fired, the introduction of the silencer system reduces the acoustic level at the muzzle. Also, the additional weight at the front of the barrel helps with grouping and aiming accuracy by compensating for oscillations when firing. The company states that the silencer and barrel will have the same service life, which means they can be used together with the barrel for the same number of shots. This raises questions about the quality of the silencer and the need to use high-quality materials, which could lead to an increase in the cost of the system.

Analysis showed that the weapon's lower receiver was made of a metal alloy. This assault rifle has dual capabilities, making it suitable for both right- and left-handed shooters. Shooters can also use the reloading handle from both the left and right sides of the weapon. The cartridge ejection port is located on the right, but the ejection mechanism could possibly have a changed function depending on the operator's needs, such as whether they need to shoot left- or right-handed. The weapon is equipped with a STANAG 4694 “NATO Accessory Rail” on the top of the weapon, which allows for the attachment of additional accessories and modularity. Charging: The top front of the weapon has a handle for charging. The company states that the weapon is designed to have light weight and high accuracy while reducing recoil during firing.

The innovation of this system is the use of energy from the propellant, namely gas operation and recoil, to automate the operation of the weapon. The system with barrel stroke has a combination of late barrel opening, which allows for easy bullet extraction while maintaining a high rate of fire, which allows for a high weapon system. An additional advantage is the force transmitted from the rifle to the shooter's (operator's) arm when firing without a special shock absorber, which improves control of the weapon. A system that uses gas operation may be applied to the weapon to ensure that the barrel has sufficient force to move to the rear dead position and to depress the recoil spring, which serves as an acceleration mechanism. With these two systems, the barrel can be made lighter, so the weight of the assault rifle can be reduced significantly.

There are two potential drawbacks of this weapon system. The first is that the accelerator mechanism makes weapon operation more difficult. The second is that there are two principles that have an effect on an automated weapon. Large parts and mass are present and moving during firing, causing a shift in the center of gravity and stability of the weapon. High mass and velocity have a high load on the components. This shortens the service life of the components and requires the installation of buffer and shock springs. Since the mass of the barrel changes, a movable barrel limits the use of removable muzzle devices, such as compensators, silencers, flash hiders, etc.

Bullpup firearms usually have a bolt and bolt behind the trigger mechanism. This type has several advantages compared to conventional ones. Compared to a carbine rifle with an equally long barrel, a shorter weapon can be made due to this design, which significantly improves the maneuverability and controllability of the weapon during firing. The advantages of a longer barrel, such as higher accuracy and initial velocity of rotation, are retained while keeping the design of the weapon simple. The bullpup design, however, has some limitations. The loud sound and pressure affect the shooter's face close to the action during firing. This type of trigger mechanism features worse than a conventional trigger mechanism because the trigger is moved forward.

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3.3. Assault Rifle 6.8 mm MCX SPEAR made by Sig Sauer

The third company to develop a prototype for the Next Generation Squad Weapon program is “SIG Sauer”. The following Figure 10 shows the prototype of the “MCX Spear - 6.8 mm”.

Figure 10. 6.8 mm NGSW Assault Rifle Prototype “MCX Spear” developed by Sig Sauer

Of the three companies developing NGSW weapons, SIG Sauer is the one taking the most conservative approach. This is because their prototype assault rifle is based on a 5.56mm caliber assault rifle, the SIG MCX made by Sig Sauer. This assault rifle is comparable in operation to 5.56 mm caliber assault rifles such as the M16/M4 but has a significant performance boost. The MCX Spear is the weapon most likely to be modified to fire more powerful rounds while the principle of the main performance mechanism of a weapon like the M4 will remain the same.

The principle of the MCX Spear 6.8 mm assault rifle is the pressurized gas from the cartridge. The rifle is operated short of a piston. The system has a non-automatic gas regulator that can be set in two modes. Like other weapons from the M4 family, the barrel is locked with a rotating bolt. The main difference between this system and the 5.56mm M16 assault rifle is the position of the recoil mechanism. In the 5.56 mm caliber M16 assault rifle, the main part of the recoil mechanism is located in the short barrel, as seen in Figure 11 which shows the entire inside of the short barrel of the 5.56 mm M4 assault rifle in the 6.8 mm MCX lance design. This is a great advantage as the weapon can have a collapsible stock (buttstock). With systems such as the 5.56 mm caliber M16 which due to its recoil mechanism located in the buttstock, it cannot be folded unless adapted to the needs of the shooter.

Figure 11. 5.56 mm Caliber M16A1 Assault Rifle whose recoil mechanism is in the stock.

This makes it suitable for operators and Special Forces who require a simpler weapon that significantly improves the maneuverability of the system. Another important difference is the use of a short stroke piston system rather than a direct firing system, which increases the reliability of the weapon.

A special buffer device, shown with the letter “B” in Figure 12 is used to reduce the recoil force caused by using more powerful ammunition from stronger ammunition.

The barrel and bolt carrier group move to the rear end of the lower receiver during firing. There, the barrel provides inertia to the buffer device, which absorbs some of the recoil force. The weapon has a magazine with a capacity of between twenty and thirty rounds. In addition, the weapon also has a silencer developed by SIG Sauer.

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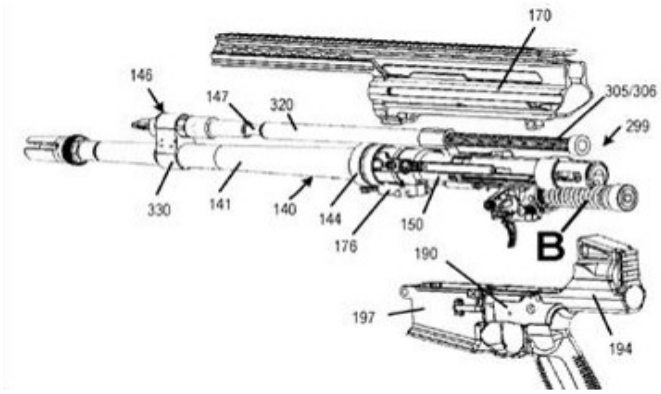

Figure 12. Diagram showing the location of components and mechanisms of the SIG MCX 5.56mm assault rifle, with the recoil mechanism located at positions 305/306.

For firing control it is similar to the M16 5.56 mm or M4A1 Karbin rifle, but the SIG Sauer NGSW-R 6.8 mm MCX Spear prototype has a non-return folding charging handle to the left of the receiver and a "standard M16 5.56 mm" T-shaped handle behind it. All sights are mounted using STANAG 4694 "NATO Accessory Rail" integrated rails located on the front and top of the receiver (DIMITROV, 2021).

IV. CONCLUSION

From the above, it can be concluded that improving the capabilities of intermediate bullets is necessary to meet the need to penetrate contemporary individual body armor used in infantry combat. For perspective rounds, 6.8 mm diameter projectiles should use armored projectiles made of elements with higher density than previous bullet projectiles, for example using tungsten. However, if a tungsten core is used in a 6.8mm-diameter projectile, the overall weight of the bullet increases rapidly, so the perspective design must compensate for maintaining the highest weight of the armor-piercing element while maintaining muzzle velocity for the ammunition's fast ballistic velocity, so that penetration power and accuracy are increased despite the heavy weight of the bullet material.

For the prototype assault rifle and ammunition developed by "Textron", the possible advantages of this system are the innovative design, ambidextrous weapon, and weight reduction with the use of cased telescoped ammunition with polymer casings. The introduction of untested ammunition designs may increase the possibility of system problems. In addition, the moving chamber may be a problem due to gas escaping from the gap between the chamber and barrel. Also, the movement of the chamber and the components that move it might affect the firing rate as a longer time is required to complete the entire firing cycle.

For the prototype assault rifle and ammunition developed by "General Dynamics" with a bullpup design (magazine is behind/below the buttstock) that incorporates a long barrel while maintaining a compact weapon. An ambidextrous weapon operated by operational gas and recoil mechanics. Possible problems can occur with two automation systems, one of which is the possibility of moving parts of the weapon rather than a non-bullup or conventional weapon system. The use of polymer ammunition can reduce the weight of ammunition as well as production costs. There are possible problems with ammunition durability and ammunition pressure rigidity. In addition, the polymer ammunition developed by General Dynamics is also still under further development and there is still little literacy about this 6.8 mm polymer ammunition. Then the standard used is the SAAMI (Sports Arms And Manufacturers Institute) standard where this bullet is only used for shooting and hunting competitions (used for civilians) so it is less suitable when used for the military.

For the prototype assault rifle and ammunition developed by Sig Sauer, this weapon design is the best design because it uses a conventional design. The weapon system is designed to promote faster rotation of the projectile in the barrel, resulting in increased accuracy and penetration power, especially if the ammunition used is a Brass-steel hybrid based on steel in the projectile and brass in the sleeve.

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