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The 84 mm recoilless support weapon system in the armament arsenal of the Hungarian Defence Forces

Tisztelt Olvasóink!

Az idei évtől kezdve, folyóiratszámainkban egy-egy angol nyelvű tanulmányt, szacikket is közlünk. A Magyar Honvédség tudományos-ismeretterjesztő kiadványaként ily módon is csatlakozni kívánunk a NATO-országok szakajtójához. Az angol nyelvű írások között hazai szerzők nemzetközi figyelemre számot tartó írásait, illetve külföldi szerzők Magyarország haderőfejlesztési programjához kapcsolódó elemző cikkeit közöljük. Elsőként a Magyar Honvédségben a közelmúltban rendszeresített Carl-Gustaf M4 típusú, vállról indítható, többcélú hátrasiklás nélküli (HSN) fegyvert mutatjuk be. Szerkesztőségünk erről a harceszközzel az év második felében magyar nyelvű tanulmányt is közöl. (A szerk.)

INTRODUCTION

Today's modern infantry forces are often deployed in urban or complex combat environments as part of anti-insurgency or peacekeeping operations as well as traditional force-on-force conflict scenarios. In these situations tactical flexibility is a key element for success.

As part of the Zrínyi 2026 National Defence and Armed Forces Development Programme, the Carl-Gustaf M4 shoulder-launched, recoilless multi-role anti-tank weapon system is introduced into the army in support of the anti-tank capabilities of the Hungarian Defence Forces. The Carl-Gustaf M4 recoilless weapon works on the principle of counteraction. Most of the countermeasure is provided by the gas pulse of the throwing charge, and to a lesser extent



Figure 1. The Carl-Gustaf M4 in firing position

by the force exerted by the gas pressure acting on the outlet cross-section of the nozzle. It is also interesting to note that for some ammunition it works as a DAVIS cannon, where the counter-ballast mass (metal powder) fires backwards, allowing the weapon to operate from a confined space, similar to the German Panzerfaust 3 system. For shoulder-launched guns using the gas impulse of the propellant charge, the open barrel ends at a gas-dynamically aligned venturi end, so that when firing, the amount of gas exiting backward is maximized by its pulse force and the volume of the system is moved. In other words, the impulse force of the projectile gases flowing in the opposite direction to the movement of the projectile balances

ÖSSZEFOGLALÁS: A Zrínyi 2026 honvédelmi és haderőfejlesztési program részeként a Magyar Honvédség páncéltörő képességének fejlesztése érdekében kerül rendszeresítésre a Carl-Gustaf M4 típusú, vállról indítható, többcélú hátrasiklás nélküli (HSN) fegyver. A Carl-Gustaf M4 rendszeresítése jelentős képességnövekedést jelent a Magyar Honvédség számára. Az M4-esek a jelenleg rendszerben álló RPG 7-es kézi páncéltörő gránátvetőket váltják le. A minőségi átvétel első három szakaszának feladatait 2019 májusában, augusztusában, illetve novemberében a Magyar Honvédség Logisztikai Központ Átvételi Osztály munkatársai hajtották végre.

KULCSSZAVAK: Zrínyi 2026 program, Carl-Gustaf M4 fegyverrendszer, páncéltörő képesség, hátrasiklás nélküli fegyverrendszer

ABSTRACT: As part of the Zrínyi 2026 National Defence and Armed Forces Development Programme, the Carl-Gustaf M4 shoulder-launched, recoilless multi-role anti-tank weapon system is introduced into the army in support of the anti-tank capabilities of the Hungarian Defence Forces, resulting in a significant capability growth for the HDF. The M4 weapons are planned to replace the current RPG 7 weapons. The first three phases of quality acceptance were completed in May, August and November 2019 by the HDF Logistics Centre Department of Technical Acceptance.

KEY WORDS: Zrínyi 2026 Programme, Carl-Gustaf M4 weapon system, anti-tank capability, shoulder-launched weapon system

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the residual force resulting from the movement of the projectile. Therefore, one advantage of these weapons is that the average reaction force acting on the weapon is approximately zero, meaning that the user is not subjected to any force resulting from the firing process. At the same time, the firing gas pressure in the barrel when firing is well approximated by one order of magnitude less than with conventional guns, and therefore the wall thickness of the barrel is also lower. On the other hand, they have the disadvantage that the charge energy used to create the equilibrium pulse is actually a waste job, so that the thermal efficiency of the shot is significantly worse than conventional shotguns. The M4 is loaded from behind. When filling, the venturi tube can be swivel-mounted around a tap, which allows the filling space to be exposed. [11]

In order to give adequate responses to the changing security environment from the perspective of anti-tank and support capabilities, the Swedish defence and security company Saab AB has developed and introduced a new version of its highly successful multi-role weapon system: the Carl-Gustaf M4 (CGM4). Since the introduction of the M1 models in 1948, the Carl-Gustaf has become one of the most reliable and battle-proven weapon systems in modern military history. The Carl-Gustaf is a lightweight, low cost weapon that uses a wide range of ammunitions, which makes it extremely flexible and suitable in a wide variety of missions.

The Carl-Gustaf is an 84 mm recoilless anti-tank weapon made with rifled barrel. There are four types available from M1 to M4. The Carl-Gustaf anti-tank armour has a range of 700 to 1000 meters, and it can effectively destroy armoured targets from 400 to 700 meters with an armour penetration of 400 to 500 mm. Depending on the type of ammunition used by the operator, the weapon system can perform additional combat support tasks. There are two handles on the lower front of the tube and one shoulder support on the rear of the tube. The weapon has a 3x magnification monocular optical sight with a viewing angle of 17°.

The latest M4 penetration capability- its effective range, armour penetration, and fire control accuracy- is about the double that of the current RPG system. Its biggest advantage is that it can be used for various types of grenades (tanks, ranges, or anti-life variants), and if special ammunition is used, it can be fired from inside a building. Using the Aimpoint fire control computer (FCS), the weapon lead is automatically calculated for moving targets, significantly increasing the chance of hit. The HEAT 751 grenade with double-cumulative heads also allows armour-type combat tank types to be penetrated, which the RPG family currently operating in the Hungarian Defence Forces has not been able to achieve with our regular ammunition.

THE CGM4 RECOILLESS WEAPON

The weapon is manufactured in Sweden by the Saab's business area Dynamics. Established in 1946, the M1 version has been modernized several times over the past decades and remains in production today. An improved version was introduced in 1964 under the name Carl-Gustaf M2.

The Carl-Gustaf M3 version was introduced in 1985. In 2010 Saab AB announced that a new version of the M3 was under design and development, and in 2013 the company received a request from the US Army and Special Operations Command (USSOCOM) to develop a lighter



Figure 2. CAD model of the Carl-Gustaf M4

and shorter version without affecting handling or ruggedness. The final result of that project was a weight-reduced weapon now known as the Multi-Role Anti-armour Anti-personnel Weapons System (MAAWS) in the United States. The latest version of the Swedish recoilless weapon is the Carl-Gustaf M4, which can also be equipped with an intelligent targeting system. The M4 weighs less than 7 kg and has an even shorter tube length than its predecessors (below 1 metre). In case of the M4, the weight was reduced by replacing the forged steel tube with a thin stranded steel

Figure 3. Different kinds of ammunitions of the Carl-Gustaf M4 recoilless weapon depending on tasks



tube reinforced with a carbon fiber outer sleeve. The external steel parts were replaced with plastics and aluminum.

The Carl-Gustaf M4 is a man-portable multi-role weapon system that provides high tactical flexibility through its wide range of ammunition types. Since 1948, Carl-Gustaf has been able to cope with a full range of battlefield challenges. The evolution of the M4 series shows that the weapon has adapted to modern conflict environments while offering compatibility with future innovations.

Switching the steel components to titanium and improving the carbon fibre wrapping was one of the ways that this reduction in weight was achieved. The new design is also shorter in length, meaning it is easy to carry and handle in different tactical situations. The M4 is therefore fully optimised for dismounted soldiers who need a lightweight, high-impact weapon.

The most important changes are the following:

- Shorter length compared to its predecessors and a weight of less than 7 kg.
- Compatibility with intelligent sight systems (FCU-Firing Control Unit).
- Improved ergonomics enabling soldiers to adjust the weapon to suit them, including an adjustable shoulder rest and front grip.
- It can be loaded faster than its predecessors, allowing shooting rates of up to 6 shots per minute.
- Round counter: integrated shot counter for improved logistics and maintenance.
- 3 kg lighter than its predecessor and has a total weapon length of less than 1 m.

The new Carl-Gustaf M4 multi-role system enables soldiers to deal with any tactical situation from neutralising armoured vehicles or enemy troops in defilade to clearing obstacles and engaging enemies in buildings.

The Carl-Gustaf M4 system's combat flexibility comes from its unique range of ammunition including anti-armour, anti-structure, multi-role, anti-personnel and support rounds. With a multitude of tactical options from destroying armour to creating smoke screens, and all from a single weapon, troops can become a much more effective fighting force.

The system has two basic sights:

- Open sight: Different range scales on the rear open sight optimised for night operations through the use of illuminated dots
- Red dot sight: gives the user improved accuracy, reduced reaction time and, with night vision goggles, night fighting capability

The previously mentioned 3x magnifying optical sight or the Aimpoint FCS13-RE fire control system can also be mounted on the sighting bracket.

The Carl-Gustaf M4 enables users to react faster to threats and tactically relocate when required. An interface informs users on the firing rounds, so the lifecycle of an individual weapon can be accurately assessed. Warranty is valid for 1000 full-size shots per tube.

84 MM HE 441D AMMUNITION AGAINST SOFT TARGETS

The HE 441D equipped with mechanical time and striking igniters. In case of the HE 441D, the shell body is made of steel with inserts of rubber, containing approximately 800 steel ball bearings enclosing the HE explosives and can be set to impact detonation or air burst. At the time of detonation the steel pellets are ejected to form an evenly distributed, highly lethal cloud.



Figure 4. Shoulder launched recoilless weapon



Figure 5. 84 mm HE 441D ammunition against soft targets

The HE 441D Shell is spin-stabilized and fitted with a combined mechanical time and impact fuse. The timer mode allows an explosion to occur within the desired time period.

The operator selects air burst or impact mode prior to loading. It can also be fired through windows or from inside of a building to engage the occupants of a structure.

Figure 6. The 84 mm HE 441D is a dual purpose ammunition. The operation of the ammunition depends on the method of loading it



84 MM HEAT 551 AMMUNITION DEVELOPED FOR THE DESTRUCTION OF ARMoured VEHICLES

The HEAT 551 is a reliable and efficient ammunition that defeats approximately 90% of all armoured vehicles at ranges out to 700 meters. It is also effective against concrete bunkers, and - at low altitude and low speed - against aircrafts.



Figure 7. 84 mm HEAT 551 ammunition developed for the destruction of armoured vehicles

In addition to its great penetrating power, the fragments of the shell body have a highly lethal effect on personnel in close proximity to the target. The HEAT 551 is rocket assisted which provides high speed, flat trajectory and short flight time to the target.

84 MM HEAT 655 CS FOR ARMoured DESTRUCTION FROM CONFINED SPACE

The 84 mm HEAT 655 CS Round (High-Explosive Anti-Tank Confined Space) is intended for use against all types of Armoured Fighting Vehicles from confined space during urban warfare firing from inside a building (through the window). It has a shaped charge warhead (Bimetallic) with high effect behind armour.

With a highly destructive guided explosive device it can be used to destroy secondary targets such as bunkers and unarmed vehicles.

CUMULATIVE WEAPONS, REACTIVE ARMOUR AND THE TANDEM WARHEAD 84 MM HEAT 751 ANTI-TANK MISSILE GRENADE

In the head of cumulative ammunitions and anti-tank missiles there are explosives with tapered cavity, usually lined with metal. In case that such a cavity is formed in the explosive that faces the target, the force released in the explosion is amplified in that direction - a cumulative effect, also known as the Munroe effect (Munroe 1888). When the cumulative projectile is activated on the target surface, the metal will flow and form a beam as a result of the cumulative effect. As a result of the high compression speed, the molten metal jet moving towards the armour impinges on



Figure 8. The Carl-Gustaf recoilless weapon and the 84 mm HEAT 655 CS ammunition



Figure 9. 84 mm HEAT 655 CS developed for armoured destruction from confined space

the surface of the armour at a speed of approximately 15,000 m/s and produces a surface pressure of approximately 2,000,000 bar (2×10^5 MPa) and then penetrates it. Armour penetration is provided by the combined effect of



the cumulative radius of the metal, the molten metal particles of the armour, and the explosive charge. Cumulative rays passing through the armour may detonate the ammunition in the tank, but its effect alone is sufficient to destroy the operating personnel. The cumulative warheads of around 100 mm diameter used today are capable of penetrating hundreds of mm of homogeneous steel armour.

In response to the use of ammunition with cumulative effects, after World War II, the development of tank armour turned to layered armour to prevent cumulative beam penetration. In addition, reactive armour (ERA – Explosive Reactive Armour) has been introduced. It consists of a plurality of blocks of explosives, which – similar to the spacers of ballast armour used in World War II –, were placed on a spacer plate (tray). The explosive body (brick) of reactive armour is activated if it comes into contact with ammunition during combat. Reactive armour can be used with good effectiveness against weapons with a cumulative mechanism of action (artillery ammunition, infantry or air-to-ground anti-tank missiles). Due to its geometric design, the metal sheathing of the ERA explosive bricks directs the energy of the ERA explosion in the opposite direction of the projectile's impact. The ERA explosive bricks detonated by attacking ammunition operate the combat part of the cumulative head away from the surface of the tank's armour. The explosion of reactive armour explosive body (ERA) bricks disrupts the formation of cumulative radiation, thereby reducing the cumulative beam armour transmission as it destabilizes or splits the beam. The cumulative ray is scattered by the detonation waves of the ERA, and the explosion of the brick "blows" the cumulative ray so that it can no longer penetrate the main armour.

In order to deactivate the ERA armour, a tandem-warhead anti-tank missile has been developed, which first smaller head overcomes the ERA explosive brick and the second cause penetration. This tandem-warhead anti-tank missile type plays a significant role in penetrating armoured vehicles with reactive armour (applicable typically on Russian types). This is the construction of Carl-Gustaf's 84 mm HEAT 751 ammunition's tandem-warhead. This capability – the tandem-warhead missile and the operational capability against Russian reactive armoured vehicles – is superior

Figure 10. HEAT 751 tandem-warhead ammunition of the 84 mm Carl-Gustaf weapon

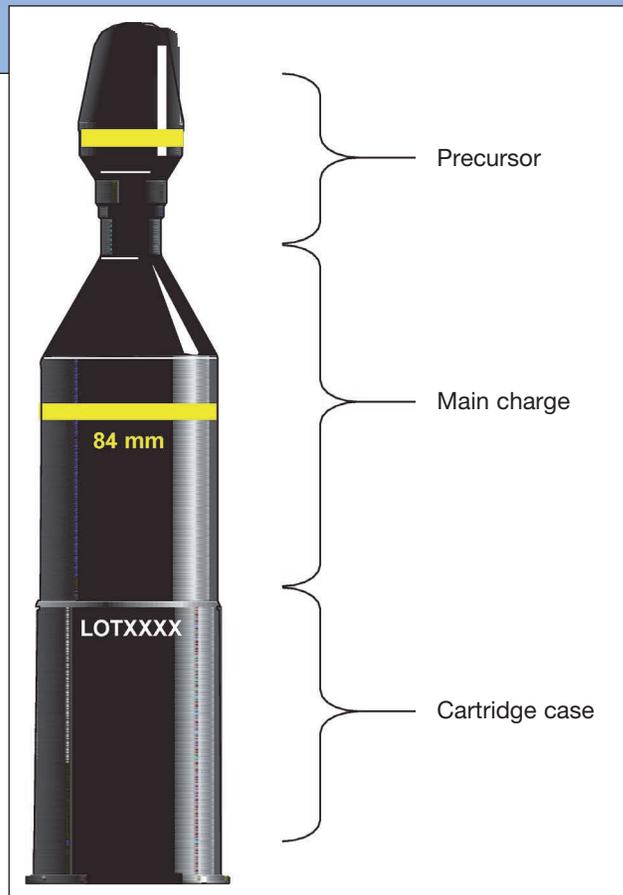


Figure 11. Structure of the HEAT 751 tandem-warhead ammunition

to RPG 7 and brings new capabilities to the Hungarian Defence Forces' armament arsenal.

The 84 mm HEAT 751 is equipped with a tandem warhead that produces an armour penetrating force exceeding 500 mm after first penetrating the ERA (Explosive Reactive Armour) protection of the target. This is more than enough to defeat the side armour of any currently operating tank, even when equipped with add-on ERA. The HEAT 751 is fin-stabilised and rocket motor assisted giving a flat trajectory and short time of flight to the target. HEAT 751 will with the first charge penetrate the ERA-tile and with its main charge strike through the main armour.

Figure 12. The 84 mm HEDP 502 ammunition for urban environment



Table 1. Technical data

	Weight-complete round (kg)	Weight-projectile (kg)	Muzzle velocity (m/s)	Max velocity (m/s)	Armour Penetration (mm)	Arming range (m)	Effective range (m)
84 MM HE 441D	3,2	2,3	240	-	-	40-70	1250 (air burst) 1300 (impact)
84 MM HEAT 551	3,2	2,4	254	339	350	5-15	700
84 MM HEAT 655 CS	4,8		205	-	> 500	9-20	300
84 MM HEAT 751	3,8	2,9	210	336	+> 500	24-40	> 600
84 MM HEDP 502	3,3	2,5	225	-	150	15-40	300-500
84 MM SMOKE 469C	3,1	2,2	240	-	-	-	1300

84 MM HEDP 502 AMMUNITION DEVELOPED FOR FIGHTING IN BUILT-UP AREAS

For rapid response forces coping with various types of threat, the 84 mm HEDP 502 is an optimal solution against light-armoured vehicles, concrete and brick walls, field fortifications and bunkers. This fin-stabilised, high explosive dual purpose HEDP round is optimised for fighting in built up areas. In the HEAT role the warhead gives a devastating behind armour effect. The round has both an impact and a delay function. Impact mode is used mainly against armoured targets with a high behind armour effect, a capability that is created by a special warhead design. Delay mode is used against field fortifications, bunker and enemies under cover in built up areas.

84 MM SMOKE 469C GRENADE FOR CREATING EFFECTIVE SMOKE

The 84 mm SMOKE 469C instantly generates an effective smoke screen on impact that can be used in many combat situations. Among the different missions we can mention screening, blinding and spotting. Screening is realized by creating a smoke screen between the enemy and own position. For the spotting mission, the team can support other units by pointing out the targets. Finally, launching the round direct on the target, the enemy are blinded. On impact a smoke screen with a width of 10 to 15 m and with good screening effect is instantly obtained.

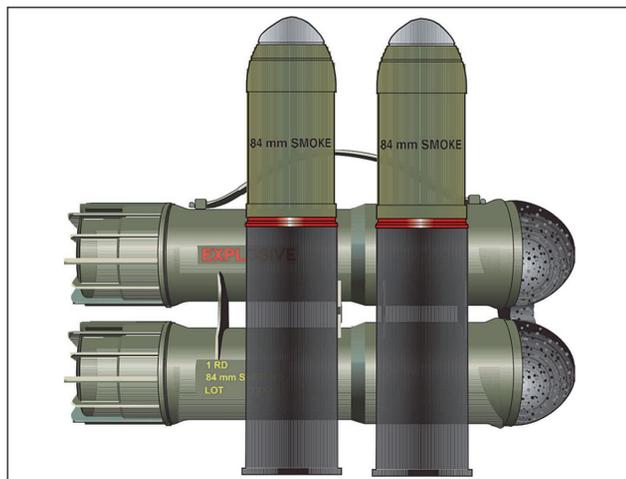


Figure 13. 84 mm SMOKE 469C grenade

CONCLUSIONS

The Carl-Gustaf M4 model, which is an upgraded version of Saab AB's combat-proven Carl-Gustaf M3, has been designed to provide users with flexible capability and agility in

any scenario. It is lighter and has a shorter design than its predecessor. The shorter length was developed in response to the need to wield the weapon in urban terrain, while weight savings were achieved through using lighter components whenever possible by switching the steel components to titanium and improving the carbon fiber wrapping. The result is a new, bold design. Its operational flexibility and high accuracy offer a truly powerful combination, and the recoil force is as close to recoilless as one can get a weapon.

The procurement of the equipment takes place within the framework of the comprehensive Zrínyi 2026 National Defence and Armed Forces Development Programme. Through the Zrínyi 2026 scheme, the Hungarian Defence Forces will acquire capabilities which contribute to the overall effectiveness of the army. As a result, our defence forces will become more prominent in Central Europe, thereby further strengthening the country's ties with its NATO allies. In addition, the developments will enable Hungary to play a more active role in Central European Defence Cooperation and in the Visegrad Group (V4) as well.

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