

SELF-PROPELLED ARTILLERY

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TAMSE VCA-155

Notes: Also known simply as the VCA, this self-propelled artillery vehicle is used only by Argentina. It marries the TAP chassis (an abandoned heavy tank version of the TAM light tank) with the turret from the Italian Palmaria self-propelled artillery vehicle. The VCA-155 was designed to replace the elderly AMX Mk F3 that the Argentines were using (and still use, until all of them have been replaced). The VCA-155 first entered service in 1997, but production rates have been slow and only 19 were in service by 1999. Since Palmaria turret is no longer being produced, it is unlikely that there will be any more procurement of these turrets; however, Argentina purchased a total of 20 of these turrets, so it is possible that there may be one more VCA-155 in the Argentine Army's future.

The TAP chassis is basically a lengthened version of the TAM with seven roadwheels on each side. The VCA-155 is surprisingly modern, with equipment normally found in many 1st World SP howitzers. This is not only due to forward-thinking engineers and designers, but also due to the Palmaria turret and its equipment. This combat equipment includes fire control and mission plotting computers, inertial navigation, two long-range secure radios (one of which is slaved to the fire control equipment) as well as secure short and medium-range radios for general communications, and a digital link to the VCCDT FDC vehicle. A system called TRUENO also allows the VCA-155 to operate in automatic mode, taking directions from the FDC, inputting them directly to the fire control computer, and requiring only that the howitzer charges be loaded manually. Without the FDC, the gun has a basic, if uncomplicated, fire control system, capable of direct fire and requiring normal fire solution calculations for proper targeting (though this process is speeded up by the VCA-155's computer). Like most modern vehicles, turret rotation is hydraulic with manual backup. The gun has a semiautomatic loader; it loads the rounds into the gun from a magazine consisting of half its onboard ammunition, and requiring that the charges for the projectile be loaded manually. This greatly reduces crew fatigue.

Though the turret is the Palmaria's turret, it uses an L/41 gun, rather than the Palmaria's L/39 gun. This gives it a slight edge in range while keeping costs down somewhat. (Italy developed the L/41 version of its L/39 gun specifically for the export market.) The gun is capable of firing all but the most modern of 155mm rounds. The turret also has a coaxial machinegun. The turret is slightly to the rear of center of the vehicle. The driver is on the front left, with the powerpack on his right; the front vision block can be switched between day and night channels. The commander is in the turret on the right, with vision blocks surrounding his hatch and a pintle-mounted weapon; to his right in the turret is a loader's hatch which is a simple hatch with no vision blocks and no weapon mount. The gunner has night vision gear for the gun and general use, as well as a fire control equipment for direct fire if necessary. Two loaders complete the crew. On each side of the turret is a bank of four smoke grenade launchers. Vehicular ammunition supply is on the short side; the VCA-155 normally travels with several ammunition supply vehicles (normally high-capacity trucks). The VCA-155 has a rear door for the loading of projectiles and charges from an exterior ammunition source.

Power is provided by an MTU MB-833 Ka500 diesel engine, developing 720 horsepower, with an automatic transmission and torsion bar suspension. In addition, the VCA-155 has a 5kW APU that allows the VCA-155 to operate longer without the engine on. Armor is welded aluminum, and is pretty decent compared to other SP howitzer vehicles. The VCA-155 normally carries two drum-type long-range fuel tanks at the rear; unlike comparable Russian designs, these drums have fuel pumps which allow them to sit level with the rear of the vehicle, stopping fuel from pouring into the vehicle if they are hit. Armor is of aluminum alloy; since it has a light tank chassis, hull armor, especially the glacis, is substantial, and the turret was armored to match the hull. There are large turret bustle racks for crew equipment on the rear of the turret. There are "windows" on the rear sides of the turret; these can be opened for observation, ventilation, or to supervise external ammunition source loading. They have armored covers, and the covers swing down for opening. There are also large doors on the sides of the turret; these do not have vision blocks in them and are merely doors.

Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
\$884,890	D, A	500 kg	40 tons	5	21	Passive IR (D, G), Image Intensification (G)	Shielded

Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
143/100	40/28	873+400	266	Trtd	T4	TF21 TS8 TR8 HF32 HS6 HR6

Fire Control	Stabilization	Armament	Ammunition
+2	Basic	155mm L/41 Howitzer, MAG, MAG or M-2HB (C)	47x155mm, 1700x7.62mm or 1000x .50

Montreal Locomotive Works Sexton

Notes: Though the Canadians and British liked the US M-7 Priest self-propelled howitzer, the 105mm howitzer was not a standard issue gun for the Canadians or British during World War 2, which led to supply problems. The Canadian MoD therefore decided to build a self-propelled howitzer based on the Priest, but using the 25-pounder field gun that was standard with Canadian and British forces. This vehicle became the Sexton; in addition to the Canadian Army, the Sexton was used by the British (in the later years of the war) and several other Commonwealth nations used the Sexton. The last known user was India, who used the Sexton II and the Sexton GPO until the mid-1980s, and still keeps most of their Sexton force in functional storage.

The Sexton was actually three vehicles, all based around the 25-pounder gun. The Australians also built an SPH based around the 25-pounder gun (the Yeremba), but based on yet a different chassis. The Sexton I was based on the Ram tank; the Sexton II was based on the M-3A1 Lee hull, and the Sexton GPO was a mobile FDC used with Sexton-equipped units (and will be found in Canadian Artillery Support Vehicles). At any rate, the Sexton ended up looking basically the same (since all three had a Sherman chassis), and differed only in small details.

The Sexton I is based on a Ram tank chassis, which was in turn based on stock M-4 Sherman hulls. Only 175 were built (with the remaining being Sexton IIs or GPOs). The vehicle had a crew of six: driver, commander, gunner, gun-layer, loader, and radio operator. As with most such vehicles, the interior is cramped, most internal space taken up with firing equipment, fuzes, charge bags, and the shells themselves. The Sexton I used a British (later Canadian)-built engine, a Continental RG-75-C1 gasoline engine developing 400 horsepower, and with a manual transmission and with tillers for steering. The Sexton II upped the ante to a Continental RG75 developing 475 horsepower, again with the manual transmission and tiller transmission. The engine is at the rear on an extended chassis deck. The Sexton used the VVSS suspension pioneered on the M-3 Grant and Lee and made famous by the M-4 Sherman. There are no shock absorbers, as shock absorption is included in the VVSS suspension. For use with the Sexton GPO, the Sextons had three hookups for field telephones, and also carried three field telephones on the vehicle in addition to their radios.

The main armament consisted of a self-powered 25-pounder gun. The gun has a depression of -9 degrees and an elevation of +40 degrees; it could also traverse 15 degrees right and 25 degrees left. This gun movement, however, was manual, done by hand wheels. Depression was more than sufficient for direct fire, and the Sexton sometimes carried anti-armor shells and was used as a tank destroyer. Sextons were also sometimes used as anti-aircraft artillery. The howitzer had to be extensively modified to take the 25-pounder gun, particularly in the recoil dampening department and to compensate for a lack of gun trails. Two Bren guns were provided to the crew, though they did not have actual mounts. No pulpit-type mount, like on the US M-7 Priest, was present on the Sexton. The Sexton did, however, carry 50 magazines for its Bren guns. Rudimentary (even for the time) aiming tools were provided; however, most firing calculations were carried out in the GPO. There was no overhead protection, other than tarps which could be mounted on small bows. Most of the crew was in the open area around the gun; however, the driver was in the front of the superstructure on the right side, and had an open window in front of him, with an armored shutter which had a vision slit in it.

The Australian Yeremba took the same idea, using the same 25-pounder gun/howitzer. The Yeremba was based on a modification of the M-3 Grant tank, however, with its standard guns and turret removed. The Australians took the best parts of the Sherman suspension and melded them with the Grant chassis; the Americans referred to the actual Yeremba tank as the M-3A5 Grant. The modifications included the HVSS suspension of later Sherman versions. The Yeremba is a post-war design, not produced until 1950-52, and in service only until 1957; it was, however, the cheapest solution the Australians had to the lack of mobile artillery for a few years. The driver is in front under the main gun and the commander and loader have positions to occupy when they are traveling. A pair of GM-6-71 diesels totaling 375 horsepower were installed in place of the gasoline engine. A Sherman-type suspension replaced the Grant's suspension, and a more substantial muzzle brake was added to the gun muzzle. The Yerembas were declared obsolete in 1957, and never saw any combat service, with only 14 such conversions taking place. An advantage had by the Yeremba is somewhat heavier armor; this includes a more sharply-raked glacis.

In all cases, the armor was greatly reduced to accommodate the heavy weight of the main gun and still keep a decent speed, and because the vehicles were not expected to have toe-to-toe slugfests with enemy armor. One Bren was placed in a small swiveling sponson up front; the other had no actual mount.

During and after World War 2, some 72 Sextons were converted by the Canadians to Kangaroo APCs. A special variant of the Sexton was developed as one of Hobart's Funnies; this had a screen which was erected for swimming as well as bilge pumps, and used on Gold and Sword beaches and most of the European Invasion campaign. Most of them did make it ashore, either by swimming or by landing ships. (These may be simulated by adding \$400 to the cost of the Sexton Mk II and using a swimming speed of 4.)

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
Sexton I	\$246,878	G, A	500 kg	25.86 tons	6	23	Headlights	Open
Sexton II	\$247,867	G, A	500 kg	26.4 tons	6	23	Headlights	Open
Yeremba	\$247,238	D, A	500 kg	29 tons	6	25	Headlights	Open

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
Sexton I	129/90	36/25	682	222	Std	T5	HF8 HS3 HR3
Sexton II	143/100	40/28	682	264	Std	T5	HF8 HS3 HR3
Yeremba	115/80	32/22	682	139	Std	T5	HF10 HS5 HR4

Vehicle	Fire Control	Stabilization	Armament	Ammunition
Sexton I/II	None	None	25-Pounder (87.6mm) QF Ordnance Howitzer Mk II, 2xBren	105x87.6mm, 1500x.303 (in 50-round Magazines)
Yeramba	None	Basic	25-Pounder (87.6mm) QF Ordnance Howitzer Mk II, Bren (C), Bren	105x87.6mm, 1500x.303 (in 50-round Magazines)

VSEL AS-90 (L-131)

Notes: The AS-90 evolved from the former international European program called GBT-155 which should have produced the SP-70 self-propelled artillery vehicle. The AS-90 entered service in 1995, with 179 built for the British Army by the early 2000s; however, LRIP started as early as 1985. Being a sort of "hurry up" program (the FV-433 Abbot and the M-109 were getting a bit too long in the tooth, and no suitable replacement was available), many components from other vehicles were used on the AS-90, including the L/39 155mm howitzer used on the FH-70, armor partially made from SP-70 armor panels, and a number of automotive components from the Challenger 1 main battle tank. The "hurry up" nature did not, however, prevent the British from coming up with first-class SP artillery vehicle. The test program that produced the AS-90 was named "GBT-155." A further upgrade of the AS-90, the AS-90 Braveheart was cancelled and not reinstated into the budget until after the British intervention in the 2003 Iraq invasion. The AS-90 currently equips three field regiments of the Royal Horse Artillery and the Royal Artillery, with Bravehearts equipping some of the batteries of the Royal Artillery.

The AS-90 is capable of firing any sort of munitions which are compatible with NATO 155mm howitzers in general, including those made by Singapore, China, the Middle East, and about a dozen other examples. Though the L/39 gun is standard on British AS-90s, Kuwaiti AS-90s use an L/52 barrel as standard. An L/45 barrel and an L/41 barrel have also been tested and are available, but have not yet had any customers. (These alternate barrels came out of the British Army tests of larger guns for the Braveheart, until they decided to go for the 52-caliber gun.)

The British AS-90 and the Braveheart

As stated above, the British AS-90 uses a 155mm L/39 howitzer, and has a coaxial L-8A2 machinegun. The turret is capable of fire from any facing direction. The driver is on the front left behind the glacis plate and the commander is in the turret on the left; he is not normally furnished a weapon and does not have a mount, but some have been retrofitted. The commander has 360-degree vision blocks, but no cupola. The loader has a hatch on the right turret roof, but it is a simple hatch and has no vision blocks. On either side of the turret are large armored boxes for storage (two on the right and three on the left); these are rather large boxes, almost 2x1 meters. The position where the third box would be on the right side is blocked by a hatch on the side of the turret. On either side of the main gun, facing outwards, are cluster of five smoke grenade launchers. Behind the commander and loader's hatches is a large flat area of deck space, which gets pressed into equipment storage in short order. The rear of the turret has a pair of large gears; a conveyor (normally carried by the PLS DROPS-type vehicle that are used for such, but sometimes carried by the AS-90 externally) leads directly from the resupply truck to the AS-90. The AS-90 has a 7-compartment automatic fire detection and suppression system. The AS-90 fitted with an advanced navigation and gunlaying system (AGLS); as the navigation system lies on inertial navigation, it has a somewhat limited capacity for self-laying and conducting fire missions on its own, and usually depends upon an FDC for fire coordinates, which the AS-90's fire control computer crunches and automatically feeds to the gun. Computerized fire control helps this, as does a mapping module. Gun loading is semiautomatic, with an arm taking the round from the magazine to the gun breech, and the loader puts in the bagged charge. The magazine holds 31 rounds; 17 more are carried in a bin on the floor of the vehicle and must be loaded into the magazine or breech manually. The loader may also have to shift around the rounds in the magazine to present the autoloader with the proper rounds to be fired; the 17 rounds in the bin are usually special rounds such SFMs and suchlike, and are normally loaded manually by the loader. The loader and the crew of the ammunition truck also load the rounds from the truck; often, the loader himself must load these fresh rounds into the magazine and bin, as well as charge bags. Needless to say, the loader is a busy fellow during a fire mission.

Power for the AS-90 is the same as that of the Braveheart, being a Cummins VTA-903 turbocharged diesel with an automatic transmission. Some automotive components are also taken from the Challenger 1 tank. The engine and transmission form a unitary powerpack, and are removed and installed together. Layout for the AS-90 and the Braveheart version is essentially identical; what's different is the gun and the electronics. As with many British-made vehicles, the interior includes a ration cooker/water heater that is large enough for the entire crew's rations at once. Another difference is the secondary armament; the loader's hatch normally has an L-7 machinegun on a pintle mount (though his seat rotates); on the Braveheart, an additional heavy weapon is mounted by the commander's hatch. In other crew protection, the AS-90 has an overpressure NBC system with a vehicular system backup, and a 5kW APU for powering systems with the engine off. There a door in the rear, primarily for reloading the AS-90 from an external source, but also used for entrance and exit. This door is small, to give the AS-90 as small an open area as possible, to enter and exit, the crew much crouch almost double.

The gun of the AS-90 can be quickly and fairly easily upgraded; 75 minutes in 2nd Echelon maintenance is all it takes to put a new, longer barrel on an AS-90 and calibrate the fire control equipment to the new barrel. The gun, regardless of length, has an elevation of +70 degrees and a depression of -5 degrees.

The AS-90 Braveheart entered service with British Forces in 1992, though production and adoption has been slow. The AS-90 Braveheart is a development of the Kuwaiti AS-90D, and therefore the Braveheart has superior performance in desert conditions. The original termination occurred due to things like non-standard charges and other minor things which, altogether, made the Braveheart difficult is not impossible to integrate into existing artillery units. These problems were later solved. The Braveheart has an additional loader, as it was discovered that on the AS-90, one loader could all too often not keep up. (Unfortunately, the capacity of the ration heater remained unchanged, so one crewmember has to wait a bit for his dinner.) The Braveheart may be equipped with an L/39 or an L/52 cannon barrel, though none have used the L/39 barrel since testing phase. The Braveheart has a Dynamic Reference Unit (DRU) allowing the Braveheart to fire accurately with up to a 20 degree cant. Both charges and projectiles are handled automatically, leaving only fuze attachment to the crew's devices. Unlike the AS-90, the Braveheart does not require stabilizing spades at the rear.

This is due to a hydrogas suspension system for the rear 4 shock absorbers. Included in the fire control system is the automatic loading system and the vehicle's fire control system. The fire control system can fire, position, and produce a fire solution using on-board mapping systems and computers. These computers (and radios) are helped by the installation of GPS with an inertial guidance backup. In essence, the Braveheart does not need an FDC, though one is often used to provide faster solutions and intelligence; indeed, the Braveheart crew doesn't need to even open their hatches or stick their heads outside of the vehicle to produce accurate fire (until it needs reloading, of course). This is enhanced by a telephone to talk to the crew. At the rear of the turret is an air conditioner. The Braveheart has the British equivalent of a BMS with vehicle and ammunition state monitors, and navigation screens for the driver and commander, and firing information for the gunner and loaders. There is a mapping module and computer, able to plot courses and waypoints.

The fire control suite includes automatic lay of the gun from computer coordinates. Semi-accurate fire is available with the gun moving at a slow speed, but a full stop is recommended. Advanced fire control is available for direct fire or direct lay situations, or the coaxial machinegun. In addition, the Braveheart uses LINAPS, the Laser Inertial Digital Gun Sight, which provides exact bearing and elevation of the barrel and the FIN3110 ring laser-gyro, which is embedded to the GPS, as well as incidental benefit to direct fire for the main gun and coax. The Braveheart is powered by a 660-horsepower turbocharged diesel engine, coupled to an automatic transmission, and an 8kW APU is provided to power systems while the engine is off. The Braveheart is capable of firing virtually any 155mm howitzer round, including the newest US M-982 Excalibur GPS-guided rounds. It is also capable of firing the new Denel Assegai family of 155mm rounds, which include VLAPs (Velocity-enhanced Long-range Artillery Projectile). Other special rounds useable include US and German Sensor-Fused Munition (SFM) rounds.

Action in Iraq led to the development of the Braveheart Desert AS-90. This blends features from the Braveheart with the AS-90D, and the improvements of the AS-90D are present on the Desert Braveheart. The Desert AS-90 has a thermal cover and thermal paint, which provides protection to the crew from the hot metal of the vehicle. This has incidental benefit in evading thermal imaging and passive IR sensors, giving the observing vehicle -2 to detect the Desert Braveheart using IR, Thermal, or FLIR sensors. The Desert Braveheart also carries a radio and radar jammer, making radar detection one level harder, attempts at MIJI done at -4, and radio-guided missiles are at -3 to hit. The Desert AS-90 is otherwise different in its filters, engine appointments, and power cooling systems, as well as wider tracks for negotiating sandy terrain.

A modification of the AS-90 Braveheart's turret was mounted on a PT-91 Twardy tank chassis, creating the Polish Krab self-propelled artillery system. The Braveheart underwent trials in Sweden, but ultimately not chosen due to cost; trials are currently being done in India with a Braveheart turret mounted on the chassis of a T-72.

The Kuwaiti Version: AS-90D

The AS-90D is essentially an evolved version of the AS-90, optimized for the desert fighting environment. This includes a high-efficiency air filtration system and better air filters (under the glacis, they take up most of the front end). A 5kW APU has been added, along with a powerful air conditioning system which can cool the interior of the vehicle even with the back loading doors open. The oil, fuel, and transmission fluid lines are specially sealed against the elements (especially dust and sand), as are the engine, transmission, and drive train themselves. The Kuwaitis chose to keep the ration heater, as well as install a small refrigerator (about the size of a medium cooler). The tracks are about 0.3 meters wider each to provide better traction in deep sand. Rubber and metal shields are installed on the lower hull to keep down the sand that the AS-90D generates itself when moving, and the driver can erect a small windscreen for when he drives with his head outside of the hatch. The Kuwaitis wanted better direct-fire capability for its AS-90Ds, so a ballistic computer has been installed for use by the main and coaxial machinegun in direct fire. The Kuwaitis also chose to give their AS-90Ds a commander's machinegun. (As with a standard AS-90, the commander's seat rotates and the machinegun is on a track.) Some of the Braveheart's howitzer fire control was available for the AS-90D, with the GPS, mapping computer, and fire solution computer being installed. These computers aren't as powerful as later iterations, and fire solutions useful for accurate fire are best done by an FDC. (Without an FDC, increase scatter by 5 meters.) The gun is an L/52 gun.

Twilight 2000 Notes: Few Bravehearts made it into active service in the Twilight 2000 timeline; perhaps 15% of Britain's AS-90 force were Bravehearts. The rest of the AS-90s were "stock" AS-90s, with 60% of them having L/39 barrels, 25% with L/52 barrels, 12% with L/45 barrels, and 3% with L/41 barrels. The Desert Braveheart never made it to the party, but some (about 10) AS-90Ds made it into Kuwaiti service.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
AS-90 L/39	\$797,499	D, A	875 kg	45 tons	4	35	Passive IR (D, G), Image Intensification (G)	Shielded
AS-90 L/41	\$802,661	D, A	819 kg	45.13 tons	4	35	Passive IR (D, G), Image Intensification (G)	Shielded
AS-90 L/45	\$814,985	D, A	705 kg	45.39 tons	4	35	Passive IR (D, G), Image Intensification (G)	Shielded
AS-90 L/52	\$835,552	D, A	504 kg	45.85 tons	4	35	Passive IR (D, G), Image Intensification (G)	Shielded
AS-90D	\$925,852	D, A	504 kg	46.13 tons	4	37	Passive IR (D, G), Image Intensification (G), Thermal	Shielded

AS-90 Braveheart	\$1,117,062	D, A	373 kg	46.15 tons	5	39	Imaging (G) Passive IR (D, G), Image Intensification (G, C), Thermal Imaging (G)	Shielded
AS-90 Desert Braveheart	\$1,966,023	D, A	221 kg	46.4 tons	5	42	Imaging (G) Passive IR (D, G), Image Intensification (G, C), Thermal Imaging (G)	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
AS-90 L/39	112/79	31/22	750	244	Trtd	T4	TF10 HS6 TR4 HF12 HS5 HR3
AS-90 L/41	112/78	31/22	750	244	Trtd	T4	TF10 HS6 TR4 HF12 HS5 HR3
AS-90 L/45	112/78	31/22	750	246	Trtd	T4	TF10 HS6 TR4 HF12 HS5 HR3
AS-90 L/52	111/78	31/22	750	249	Trtd	T4	TF10 HS6 TR4 HF12 HS5 HR3
AS-90D	112/78	31/22	750	250	Trtd	T4	TF10 HS6 TR4 HF12 HS5 HR3
AS-90 Braveheart	111/78	31/22	750	247	Trtd	T4	TF12 TS7Sp TR4 HF14Sp HS6Sp HR3*
AS-90 Desert Braveheart	111/78	31/22	750	252	Trtd	T4	TF12 TS7Sp TR4 HF14Sp HS6Sp HR3*

Vehicle	Fire Control	Stabilization	Armament	Ammunition
AS-90 L/39	+1	Basic	155mm L/39 Howitzer, L-8A2, L-7 (L)	48x155mm, 3000x7.62mm
AS-90 L/41	+1	Basic	155mm L/41 Howitzer, L-8A2, L-7 (L)	48x155mm, 3000x7.62mm
AS-90 L/45	+1	Basic	155mm L/45 Howitzer, L-8A2, L-7 (L)	48x155mm, 3000x7.62mm
AS-90 L/52	+1	Basic	155mm L/52 Howitzer, L-8A2, L-7 (L)	48x155mm, 3000x7.62mm
AS-90D	+2	Fair	155mm L/52 Howitzer, MAG, MAG (L), MAG (C)	48x155mm, 4000x7.62mm
AS-90 Braveheart	+1	Fair	155mm L/52 Howitzer, MAG, MAG (L), M-2HB (C)	48x155mm, 3000x7.62mm, 1000x.50
AS-90 Desert Braveheart	+2	Fair	155mm L/52 Howitzer, MAG, MAG (L), M-2HB (C)	48x155mm, 3000x7.62mm, 1000x.50

*Roof AV for the turret and hull are 5. Floor AV is 6Sp.

Vickers FV-433 Abbot

Notes: This British SPH also served with India (who still operates some 80 "Value Engineered" Abbots). It was rapidly replaced by the AS-90 series in British service, fast enough to make them a hot item on the collector's market with many left over for museum pieces. In particular, they are common in European "tank-driving" adventures since they are lighter and easier to care for than a real tank. The comedian Ross Noble revealed on the 3 July 2011 *Top Gear* show that he owns and operates an Abbot, and he is far from alone. The Abbot is the SPH member of the FV-430 family of vehicles, though the chassis used is a stretched version of the FV-430 chassis with a different engine(s) and different configuration of its unitary powerpack. The Abbot entered British service in 1965, and left service in 1995. The designation of FV-433 Abbot continues the World War 2 convention of giving artillery vehicles ecclesiastic names, though it was the last artillery vehicle in the British Army to receive such a name.

The Standard Abbot

Unlike most of its contemporaries, the Abbot was equipped with the then-new L-13 105mm howitzer instead of a 155mm gun. This was done partially for reasons of economy and partially because of the limitations of the FV-430 chassis. In addition, the US-built M-109, which did have a 155mm gun, came into British service at about the same time, and it was felt that a relatively high-mobility howitzer in the Abbot might be desirable. A new family of ammunition was designed for the Abbot's gun. It was similar to US 105mm howitzer ammunition of the time, using mostly US-pattern primers for the shells and reduced-charge bag charges, ignited by electrical primers. In addition, the Mark 2 series included an improved-lethality HE round, improved smoke, colored marker (red and orange), Illumination, and HESH shells for direct-fire antivehicle combat. The L-13 on the Abbot has a maximum depression of -5 and elevation of +70, and HESH shells were designed for the L-13 because the gun was able to depress enough to engage vehicles. The shells also had new charge settings: Normal and Super. The shells were rammed into the breech by an electrical servomotor, but the charges were inserted by hand. In addition, though turret traverse was electric, gun elevation and depression was manual. The small turret meant that there was no room for fancy fire control equipment, but it did have simple scale-type sights to get the gunner onto the right elevation and traverse. These sights were replaced in the early 1970s by a relatively-primitive fire control computer called FACE. Along with a data-transmitting secure radio and another simple computer called AWDATS, the Abbot was able to have commands from the FDC be inputted directly into the FACE. There was no coaxial machinegun, though the commander had (at first) an L-4A4 Bren Gun, and later an L-7 machinegun. Though he had no cupola, his seat rotated by moving his body and the machinegun was on a track, making the loader able to fire at almost any ground target. The turret has a 360-degree rotation, and the gun elevates to +70

degrees and depresses to -5 degrees, making quite capable of direct fire.

The Abbot had a standard long-range radio and a short-range radio for general conversations; in addition, the Abbot had hookups for the use of field telephones (one line going to the FDC, and one or two going to adjacent guns). After the more flexible Clansman series of radios were installed, field telephone use tapered off, though the capability remained. In addition, the commander could speak into a bullhorn on the roof of the turret from his position (presumably to give and take orders in high-noise environments). Setup is similar to most such vehicles, with the driver on the front right, commander on the turret left, and a loader's hatch on turret right. The Abbot had no shortage of crewmen, but the small degree of automation present in the Abbot made this necessary; however, two of these crewmen ride in one of the ammunition carriers that travel with the Abbot. At the rear of the vehicle is a large door for crew entry and exit as well as ammunition resupply. The driver has a gas pedal and a pair of laterals to steer and brake, similar to the M-113 APC; the original engine was a Rolls-Royce K60 multifuel engine with 240 horsepower, but this was later replaced with a Cummins turbocharged diesel with the same horsepower, but mechanically less complex. The engine is on the left, so the driver had to be relocated to the front right. In addition to his loading duties, the on-board loader operates the long-range radios. A collective vehicular NBC system protects the crew. The transmission is automatic, and the Abbot was amphibious after raising a flotation screen; in water, the Abbot is propelled by track movement. Suspension is by torsion bars, with no shock absorbers.

Popular use of the Abbot includes the use of restored retired Abbots for civilian tank-driving adventures. The Scottish TV series *Gary: Tank Commander* features an FV-433 as "the Tank." An FV-433 was used in the final episode of the British TV series, *Spaced*. In the 2012 movie *The Dark Knight Rises*, two FV-433's comprise part of the National Guard's forces.

The "Value-Engineered" Abbot: Artillery on the Cheap

When India first ordered the Abbot, they were not the economic powerhouse that they are now and couldn't afford the best stuff; in addition, a lot of countries were snubbing India, since they dared to develop nuclear weapons. So when they ordered the Abbot, they asked that Vickers shave off the price as much as possible and still produce a working SP howitzer. This was the "Value-Engineered" Abbot. This Abbot had basically no power-operated features – the electrical turret traverse was deleted, as was the shell rammer. The collective vehicle NBC system was removed, the crew relying on their own personal NBC equipment. It has no night vision. The "Value-Engineered" Abbot had no provision for swimming. The sight was a simple dial sight, and the radios were basic ones that were essentially out of date. 68 of the 80 Abbots that India still uses are of this type. A further 20 are used by the British and kept at the BATUS in Alberta, Canada, for use as training vehicles.

Twilight 2000 Notes: The British Army still had about 40 Abbots in service in 1995 in the T2K timeline. In addition, those owned by private individuals were "borrowed" by the British Army; even some museum pieces were reactivated. The Indians, of course, used theirs, and the 20 "Value-Engineered" Abbots at the BATUS saw service with the Canadian Army against the Russians or Quebecois.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
FV-433 Abbot	\$327,721	D, G, A	400 kg	16.56 tons	4 (+2)	16	Passive IR (D, G)	Shielded
Value Engineered Abbot	\$157,871	D, G, A	435 kg	16.42 tons	4 (+2)	15	Headlights	Shielded
FV-433 Abbot (Late)	\$285,971	D, A	394 kg	16.8 tons	4 (+2)	16	Passive IR (D, G)	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor					
FV-433 Abbot	123/86	34/24/3	386	89	Trtd	T4	TF5	TS3	TR3	HF6	HS2	HR2
Value Engineered Abbot	124/87	34/24	386	88	Trtd	T4	TF5	TS3	TR3	HF6	HS2	HR2
FV-433 Abbot (Late)	121/85	34/24/3	386	90	Trtd	T4	TF5	TS3	TR3	HF6	HS2	HR2

Vehicle	Fire Control	Stabilization	Armament	Ammunition
FV-433 Abbot	+1	Nil	105mm L-13 L/30 Howitzer, Bren L-4A4 or L-7 (C)	40x105mm, 1200x7.62mm
Value Engineered Abbot	Nil	Nil	105mm L-13 L/30 Howitzer, Bren L-4A4 (C)	40x105mm, 1200x7.62mm
FV-433 Abbot (Late)	+2	Basic	105mm L-13 L/30 Howitzer, Bren L-4A4 or L-7 (C)	40x105mm, 1200x7.62mm

Harbin Type 83 Self-Propelled Gun/Howitzer

Notes: The Type 83 152mm SP Gun/Howitzer is the Peoples' Liberation Army's standard heavy howitzer, with the addition of a fume extractor and a large muzzle brake, as well as an autoloading system. It entered service in the early-1980s and is present in large numbers in the Chinese Army. The gun used on it is a version of the Type 66 152mm towed gun/howitzer, and in shape is very similar to the US M-109A2 except for the gun barrel and roadwheels (though the vehicle is in fact based on the SO-152 Akatsiya). Initial design work was done in Qiqihar, but final design and adjustments, as well as production, was carried out by Harbin. The gun is capable of firing standard 152mm howitzer rounds as well as a new RAP round known as the MP-152, and a Chinese copy of the Russian Krasnopol laser-guided round. Some 78 were built for the PLA and an unknown number for foreign armies and marines. The vehicle from first prototype to LRIP took from 1980-1981, then initial testing to Type standardization in 1983. The Type 82-152 was the first of the series built, and it was revealed in a parade in Beijing in 1983. The Type 83 chassis is also used as the basis for the Type 83 trench-digging engineer vehicle, the Type 762 425mm mine-clearing rocket system, and the PZT-89 tank destroyer.

The Type 83-152

The armament is centered around an adaptation of the Type 66-1 152mm L/45 Self-Propelled Gun/Howitzer, and is capable of direct as well as indirect fire missions. The Type 66-1 is designed specifically for use on vehicles, and is capable of mounting one of several lengths of barrels. The gun operation is largely automated, with one of the loaders being necessary to fix fuzes, load charges, and load certain special ammunition. Guns are laid using radio information relayed to the firing computer, requiring the gunner to simply press a few buttons and switches on his fire control panel to send the round downrange. Gun elevations goes from +62 degrees to 0 degrees, so direct fire is possible; however, the Type 83-152 does not normally carry antiarmor rounds. Indirect fire sights are provided as well as infrared night sights. Clusters of four-round smoke grenade launchers are at the bottom of the front turret corners. The commander has a pintle-mounted Type 88 heavy machinegun. A special rack carries a Type 69 RPG and four rounds, which are considered part of the basic weaponry of the vehicle. The Type 83-152 has inertial navigation and a mapping system with computer to give the driver instructions and make a low-accuracy non-FDC strike if necessary; such fire will be one level more difficult. The ammunition is replenished by large rear doors, which may also be used for crew ingress and egress.

Power is provided with the 520-horsepower turbodiesel WR4B-12V160LD engine coupled to an automatic transmission. Armor is of steel, but it is thin steel and provides minimal protection. The crew has a vehicular collective NBC system. The Type 83-152 ended production in 1990, after only 78 were built; production ended in favor of the Type 05 self-propelled howitzer; many analysts say that the Chinese basically considered the Type 83-152 a stopgap vehicle, and that they considered the vehicle obsolete shortly after its introduction.

The Type 83-130

The Type 83-130 has a chassis and turret nearly identical to the Type 83-152, and internally very similar, but the Type 83-130 is more a mobile field gun or tank destroyer than an SP Howitzer, as the Type 59 130mm gun is not normally considered a howitzer in most armies. (The Chinese classify it as a gun/howitzer, but its elevation of only 45 degrees greatly limits its indirect fire range, and its depression of -5 degrees lend it more to direct fire missions.) The fire control system is therefore more akin to a tank than an SP Howitzer, and the Type 83-130 has only incidental indirect fire capability.

The rear doors for ammunition resupply remain; the chassis is, in short, as common to the Type 83-152 as possible to simplify production. Used only in small numbers by the PLA, the Type 83-130 is most often sold as a kit to countries already fielding the Type 58 field gun or M-54 or M-46 Russian field guns and with them to be more mobile. Fire control includes better gun stabilization and better fire control computers, a laser rangefinder, and equipment.

Most details of the Type 83-130 conform to those of the Type 83-152, though the autoloader is replaced with a semiautomatic loading system, with the gun automatically ramming the rounds and charge and closing the breech, then popping it open once the gun comes to rest after its recoiling action. The 52-caliber gun (new barrels are fitted as part of the manufacture process, if the gun is not already L/52) is tipped with a large pepperpot muzzle brake, and recoil is further reduced with hydraulic shock absorbers, leaving only a small amount of recoil travel within the turret.

Production for the Chinese Army was sparing and few were produced for China. These were used for a few short years, but are now out of service in China. Greater production was achieved as an export system, and it has seen several sales to countries that wished their Type 56, M-54, or M-46 130mm towed gun/howitzers to be more mobile.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
Type 83-152	\$808,191	D, A	400 kg	30 tons	5	24	Passive IR (D, G), Image Intensification (G)	Shielded
Type 83-130	\$979,269	D, A	399 kg	30.9 tons	5	21	Passive IR (D, G), Image Intensification (G)	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
Type 83-	128/90	36/25	885	194	Trtd	T4	TF6 TS4 TR4 HF8 HS3 HR3

152	Type 83-130	140/98	37/27	885	165	Trtd	T4	TF6 TS4 TR4 HF8 HS3 HR3
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Vehicle	Fire Control	Stabilization	Armament	Ammunition
Type 83-152	+1	Basic	152mm L/45 Type 66-1 Gun/Howitzer, Type 88 (C), Type 69-1 RPG	30x152mm, 650x12.7mm, 4xType 69 Rounds
Type 83-130	+3	Fair	130mm L/52 Type 59 Gun/Howitzer, Type 88 (C), Type 69-1 RPG	38x130mm, 1050x12.7mm, 4xType 69 Rounds

NORINCO Type 70-I

Notes: The first Chinese indigenous self-propelled howitzer, design-wise very similar to the later Type 85. The Type 70 is based on a Type 63-I APC chassis, lengthened by one roadwheel. The Type 70 was a quick-and-dirty solution, meant to quickly mechanize Type 54 122mm field guns. It was therefore somewhat of a stopgap solution, and less than 200 of these conversions were built. They were never exported. Despite their being obsolescent at conception, they had a long service life; their last known appearance to the West was at the Tiananmen Square Protests.

The chassis is a straight conversion, with a roadwheel added and the vehicle lengthened appropriately. At the rear the field gun was mounted, in an open-topped superstructure with a large and heavy gun shield in front. The main gun is a development of the Russian M-30, a predecessor of the D-30. The crew ride inside of the vehicle during moves, but have their chest and above (abdomen and up for the gunner and AG) exposed when operating the howitzer. Sights are limited to the gun's telescopic sights and stadia reticule. The Type 70 was a rather rudimentary design, little improved over the idea of plopping a gun on top of an APC. At the corners of the glacis are clusters of four smoke grenade launchers, but these are a relatively recent (late 1970s) addition. The M-30, while able to fire most standard types of 122mm rounds, cannot employ the newer type of 122mm rounds, including smart rounds, base-bleed, and RAP projectiles. The Type 70-I also carries a small amount of antiarmor rounds for self-defense against vehicular threats.

The chassis is also little-modified for its role. Other than it's longer size, the hull is largely identical to the Type 63, though the driver's station has been moved to the front left and the engine to the front right. A small raised area is just ahead of the right gun shield; this has vision blocks to the right and front and slightly to the left side, meant to provide one crewmember (normally the assistant gunner) observation outside of the vehicle without exposing himself. The gun shield is thick and is AV3. The engine is the same 260-horsepower 6150L diesel of the Type 63 APC. This makes the larger Type 70-I underpowered.

The M-30 has been little-modified for its role; essentially, the gun was mated to the hull and little more was done than to do this. In the front left gun shield is a spring metal cover for the sights. Traverse is limited to 22.5 degrees to each side. Depression is -2.5 degrees, and elevation maximum +70 degrees. The M-30 can therefore be used for direct fire if required. At the rear of the fighting compartment is a pintle mount for a light machinegun. In addition, the door is retained from it's Type 63 relative, allowing for replenishment from an outside ammunition source.

The Type 70-I can be fitted with a flotation kit which includes pontoon floats on the sides and rear, the trim vane inherited from the Type 63 APC, and balloon floats attached to the wheels, as well as the switching on of a bilge pump. It takes 20 minutes to ready the Type 70-I for swimming.

The Type 85 howitzer (below) is a further development of the Type 70-I, primarily by basing it on a YW-531H APC chassis.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
Type 70-I	\$243,719	D, A	400 kg	15.3 tons	7	13	Passive IR (D)	Enclosed

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
Type 70-I	125/88	35/24/3	450	96	Std	T3	HF6 HS3 HR2

Vehicle	Fire Control	Stabilization	Armament	Ammunition
Type 70-I	None	None	122mm L/22 Type M-30 Howitzer, PK (R)	40x155mm, 1000x7.62mm

*The AV of the front third of the hull deck is 2, but for the rear two-thirds, the AV is 0.

NORINCO Type 85 Self-Propelled Howitzer

Notes: This is a self-propelled howitzer variant of the YW-531 armored personnel carrier, used by China. It has the industrial designation of YW-523. In this role, the basic APC chassis is topped with a fighting compartment housing a Chinese copy of the Russian D-30 122mm howitzer. It was decided in the early 1990s that the Type 85 SPH was not a successful design and it was pulled from service in favor of the improved Type 89 SPH. Before that, it was used primarily by Tibetan mountain troops and airborne artillery, along with small numbers of mechanized infantry, where its shortcomings became most apparent.

Type 85 SPH

The Type 85 SPH is an extended Type 85 APC chassis with an extra roadwheel on each side. It was designed to be an update of

the Type 70-I, and as such is similar in design to the Type 70-1, with the gun atop the vehicle unprotected by armor or a turret, instead having a thick forward gun shield. The Type 85 SP howitzer is based on the hull of the Type 85 APC, using a W-86 122mm howitzer, which itself is an improved version of a Chinese copy of the Russian D-30 howitzer.

The gun has a very limited traverse, no more than 22.5 degrees left and right. Elevation and depression are +70 and -3 making it a direct fire threat, though normally no antiarmor rounds are carried. The muzzle is fitted with a large multi-slotted muzzle brake, and the gun also has hydraulic recoil dampeners. The howitzer is mounted on a semi-open superstructure (low sides and a gun shield up front). The superstructure is normally covered with a large fitted tarp. For the most part, the crew is unprotected from small arms fire of shrapnel, though when operating the gun, the raised sides protect up to the head and chest (except the gunner, who must step up on a platform and his abdomen is also not protected when aiming the gun. When seated in the hull, the crew has the full protection of the armor (except for the open top). From the front, however, the crew has the benefit of the AV3 gun shield.

The driver is on the front left side, as is normal for the Type 85 chassis. The rest of the crew is in the superstructure, and normally sits in the hull when not operating the howitzer. There is no commander's position as such, just a seat in the hull where the commander usually sits. The rear ramp of the Type 85 APC remains, and is used for crew entry or exit or ammunition reloading. There is a commander's weapon and the small arms provided by the crew. The crew has a vehicular NBC pack to plug their protective mask hoses into.

Power is provided by a German-designed Deutz BF8L413F turbocharged diesel engine developing 320 horsepower, which is to the left of the driver. The transmission is automatic. The vehicle is amphibious, but only after a large amount of preparation; pontoons must be attached to the sides of the vehicle and balloons to the roadwheels, a trim vane lowered, and a bilge pump turned on, and this takes about 20 minutes. Without these pontoons and balloons, the Type 85 SPH is capable only of deep (2.5-meter) fording. On either side of the hull is a bank of four smoke grenade launchers.

Type 89 SPH

The Type 85 SPH was, in many ways, inadequate, the largest omission being the lack of a full turret for the howitzer and crew, and the resulting lack of side, rear, and overhead protection for the gun crew. The Chinese also saw the Russian 2S1 Gvosdika, and wanted something indigenously-built, but similar in capabilities. So far, the Type 89 SPH is used not only by the PRA and PLAMC, but by the Rwandan Army (a recent acquisition that is still being delivered as of December 2017).

As with the Type 85 SPH, the Type 89 SPH (also called the PLZ-89, and not to be confused with the Type 89 wheeled howitzer or Type 89 assault gun or Type 89 towed artillery piece) is based on a lengthened APC; in this case, the Type 89 APC, itself an improved version of the Type 85 APC. The driver is therefore on the front left, with the engine to his right. The Type 89 SPH has a full turret, mounted at the rear and extending forward half of the vehicle. The rear door from the Type 89 APC remains, and is used both for entry/exit and to resupply the vehicle with ammunition and other supplies. The commander is on the top left of the turret, with a pintle-mounted heavy machinegun and a manually-operated turret. The commander has all-around vision blocks, including one with a night channel.

The main armament is again a modified version of the D-30 122mm howitzer. This has fire control for direct and indirect fire, and the gun has a semiautomatic autoloader, requiring fuzes be attached by hand (usually done before a bombardment), and special ammunition and charges to be loaded by hand. The modified Type 86 howitzer employed on the Type 89 can fire most 122mm howitzer ammunition found in the world today. An inertial navigation system with a mapping computer allows the Type 89 SPH to undertake slightly-inaccurate missions without an FDC; such fire missions are one level harder. Secure radios and a mapping computer module allow fire directly from a FIST's coordinates if necessary. Modifications to the gun also include a reduction in length to 32 calibers to allow the Type 89 to be airdropped. For direct fire, the Type 89 SPH can fill the role of a tank destroyer to an extent, having computerized direct fire control equipment and night sights as well as telescopic sights. On the roof is an electronic day/night sight with channels for the gunner and commander.

The engine is a German-designed 12V150L turbocharged diesel engine developing 450 horsepower. This is coupled to an automatic transmission. On each side of the turret is a cluster of four smoke grenade launchers. The crew is protected by an NBC overpressure system with vacuum air extraction and recharge, and a vehicular collective NBC system when the hatches are open. The Type 89 also has a five-compartment automatic fire/explosion detection and suppression system. The Type 89 SPH is amphibious in the same way as the Type 85 SPH – with lots of preparation with pontoons and balloons.

The SH3

The SH-3 is an improved version of the Type 89 (though the electronics suite is somewhat abbreviated), built primarily for export; it's RL cost, as well as it's T2K cost, is lower than the Type 89, due to modernized systems. So far, Rwanda and Myanmar have ordered SH3s, but there is a lot of interest in the vehicle from Second and Third-World armies. It is notable that before its first exports to Rwanda, the Chinese stated that the SH3 was only an experiment and was not going to enter series production. The SH3 is also known as the WMZ-322 (its industrial designation). It is meant to be a lower-cost and updated version of the Russian 2S1 Gvosdika. The Chinese do not use the SH3, but do use a further updated version of it called the Type 07 (below) and have fielded it in large numbers.

The SH3 uses an updated version of the W-86, the PL-96 122mm L/32 howitzer. The barrel is tipped with a large multibaffle muzzle brake and a fume extractor. It can fire all sorts of Russian, Chinese, and Eastern European ammunition, including a Chinese version of the Russian Kitlov laser-guided shell and a new Chinese GPS-guided 122mm shell. Gun laying and fire are controlled by an advanced fire control computer which automatically calculates the gun's position, target's location, and a fire solution, and trains

the gun to the correct elevation and rotation of the turret. GPS, inertial navigation, and a mapping computer and module equip the vehicle. The SH3 is capable of conducting fire missions on its own, without the need for an FDC. The gun has an autoloader feeding from two magazines; there is also a bin for 10 special or non-standard projectiles such as antiarmor rounds. The rear door of the Type 89 is retained, and there are side doors in the turret, allowing for quick ammunition resupply, especially with a conveyor. Elevation is +70 and depression is -3, making direct fire possible; the SH3 normally carries a few antiarmor rounds for this purpose, and direct lay is possible.

Next to the commander's hatch is a pintle-mounted machinegun; the commander is in a cupola with all-around vision blocks and night channels for the three front blocks. The loader has a hatch next to the commander on the left, with three vision blocks to the front. The driver is in the front left, with the engine to his right; he three wide-angle vision blocks to the front and partially to the sides. The front block has a night vision channel, and the driver has a back up camera. The driver also has a panel that connects to the vehicle's mapping computer, and the driver and commander have access to the same information, including the mapping computer and GPS information. The SH3 also has a few perks – an air conditioner is an option (included in the stats below), and heater is standard. An Overpressure system is provided, along with a vehicular NBC backup for operation when the hatches are open.

The SH3 uses a licensed copy of the German Deutz BF8M1015CP turbocharged diesel engine developing 590 horsepower. The vehicle also has a 5kW APU for operations with the engine off. This is coupled to an automatic transmission. The chassis is highly-modified and though based on the Type 89, is almost two meters longer and has a different suspension. On each side of the turret is a cluster of four smoke grenade launchers. The crew is protected by an NBC overpressure system with vacuum air extraction and recharge, and a vehicular collective NBC system when the hatches are open. The Type 89 also has a five-compartment automatic fire/explosion detection and suppression system. The SH3 is amphibious in the same way as the Type 89 SPH – with lots of preparation with pontoons and balloons. The SH3 is airportable by medium and heavy-lift helicopters and air-droppable by medium and heavy-lift aircraft.

Twilight 2000 Notes: During the Twilight War, lots of Type 85 SPHs were built, despite their obsolescence – they were cheap and quick and easy to build. Liberal amounts of Type 89 SPHs were also employed, mostly of pre-war manufacture. The SH3 does not exist in any of the *Twilight 2000* timelines, though it does in the *Twilight 2013* timeline, and in the *Twilight 2013* timeline, the Pakistanis are using SH3s to supplement their Type 89 force.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
Type 85 SPH	\$364,784	D, A	400 kg	16.5 tons	5	13	Passive IR (D)	Shielded
Type 89 SPH	\$919,903	D, A	500 kg	20 tons	5	17	Passive IR (D, G), Image Intensification (G, C), Thermal Imaging (G, C)	Shielded
SH3	\$881,193	D, A	555 kg	24.5 tons	5	18	Passive IR (D, G), Image Intensification (G, C),	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
Type 85 SPH	166/116	46/32/5	885	149	Stnd	T4	HF8 HS3 HR3*
Type 89 SPH	156/109	43/30/4	885	167	Trtd	T4	TF6 TS4 TR2 HF8 HS3 HR3
SH3	165/116	46/32/5	975	219	Trtd	T4	TF8Sp TS5Sp TR3 HF10Sp HS4Sp HR4**

Vehicle	Fire Control	Stabilization	Armament	Ammunition
Type 85 SPH	Nil (+1 in Direct Fire)	None (Basic in Direct Fire)	122mm L/40 Type 86 Howitzer, Type 88 (C)	40x122mm, 1000x12.7mm
Type 89 SPH	+1 (+2 in Direct Fire)	None (Fair in Direct Fire)	122mm L/32 Modified Type 86 Howitzer, Type 88 (C)	40x122mm, 1000x12.7mm
SH3	+1 (+2 in Direct Fire)	Basic (Fair in Direct Fire)	122mm L/32 PL-96 Howitzer, Type 88 (C)	50x122mm, 2000x12.7mm

*Crew exposed from chest up when standing. Forward gun shield is AV3.

**HR and TR AV is 4. Belly armor is 5Sp.

Norinco Type 88

The Type 88

Also known by its industrial designation of PLZ-45, this is based on the ground-mounted WAC-21 gun/howitzer; the Type 88 is the self-propelled version of this howitzer. (The WAC-21 is itself based on an Austrian design.) At first it was designed specifically for export, and is used by Algeria, Bangladesh, Kuwait, and Saudi Arabia, but it also came to be used in small numbers by the PLA itself. In addition, the Pakistanis have recently made a sizable purchase of Type 88s, and the Kuwaitis have greatly increased their order of Type 88s. This vehicle looks very similar to the US M-109 series howitzer (except for the M-109A6 and A7 Paladin), but it is heavier, has a longer gun, larger turret and more roadwheels, which are irregularly spaced. It is rumored that the Chinese may be in a process of changing over to the 155mm Western-type howitzers, as they can use a wider variety of ammunition; and the Chinese can benefit from Western howitzer design improvements. The Type 88 saw first combat use when Saudi Arabia attacked Yemeni Houthi rebels in 2017.

The driver of the Type 88 sits in the front center of the vehicle behind the glacis plate. Hatches for the commander and one of the loaders are in the turret roof on the right and left side respectively; the commander has a manually-rotating cupola with all-around vision blocks and a heavy weapon mount, while the loader has no vision blocks and no weapon mount. Each side of the turret has a vision block with a firing port.

The howitzer is compatible with any Western or other 155mm ammunition, and the barrel length is an intermediate-length 45 calibers. The gun uses a slotted muzzle brake and a fume extractor. The Type 88 uses a semiautomatic loader; the rounds are fed from a magazine and automatically loaded at the push of a button, but any change from the order of the rounds in the magazine must be loaded by hand. The charges are loaded manually, as are special rounds such as the Chinese version of the Krasnopol. The magazine holds a total of 24 rounds, with six rounds being carried to the rear of the turret (these are usually antiarmor or special rounds). The Type 88 is capable of firing Western as well as Chinese 155mm rounds, except for special rounds such as the Copperhead and Excalibur. The commander is typically armed with a Type 88 heavy machinegun, but there are no provisions for aiming and firing from within the vehicle. On each of the turret are a cluster of four smoke grenade launchers. Before firing, two large spades are lowered into the soil behind the vehicle; turret traverse is limited to 30 degrees from front. Elevation maximum is 72 degrees and depression is -3 degrees, making the engagements of ground targets possible. When doing so, some vehicle systems, such as a ballistic computer and laser rangefinder, are available. A weak point is the amount of onboard ammunition carried, including fuzes and charges for the rounds; each Type 88 is typically followed by (amongst others) a PCZ-45 ammo supply vehicle. It can, however, fire a Chinese version of the 152mm Krasnopol CLGP. The Type 88 can fire the Krasnopol without registration of the target or the need for an FDC, needing only the target distance and direction as supplied by a FIST team or by map if the target is on the map.

Other combat equipment include inertial navigation, GPS, a system to allow an FDC to remote lay gun barrels directly (if the FDC has the right equipment), and an LCD to display information coming from the FDC, as well as small computer to help the plotting process along as well as provide a mapping system. The Type 88 can also take the information from FISTs in some circumstances and automatically lay the gun(s) on the right target solution. The crew is protected by a vehicular NBC common system. The Type 88 has a five-compartment automatic fire detection and suppression system.

The Type 88 is based on a new chassis unlike any other in PLA service, designed specifically for the Type 88, but also used on some later vehicles. The tracks are wide and have good off-road performance, and the power from the Type 88's 525-horsepower Deutz turbocharged diesel engine is decent for a vehicle of this weight. An 8kW APU powers the vehicle when the engine is not necessary. The armor is nothing to write home about, but the Type 88 has ERA lugs on the hull side, turret side, glacis, turret front, and the forward third of the turret deck.

The Type 88 has been superseded by the PLZ-05 155mm SP howitzer, which has a longer barrel and is physically larger vehicle.

The Type 05

This 155mm howitzer was built to replace the Type 59-1 and Type 83 self-propelled howitzers. Design work began in 2003, and the Type 05 entered service with the PLA in 2005. The Type 05 is a large vehicle, with a very large turret atop a substantial chassis. The chassis appears to be a modification of that of the Type 88. The turret appears to be a modified form of that of the Russian 2S19. So far, the Type 05 is only in Chinese service, though a version of it is offered for export. There have no export orders, however, and the Type 05 remains in service only with the PLA. It replaced the Type 88 in production, and uses a large amount of components of the Type 88. The Type 05 is also in the process of replacing the Type 83 self-propelled howitzer (see above).

Also known by its industrial designation of PLZ-05, the main gun of the Type 05 is a 155mm L/52 howitzer which is capable of firing most Western 155mm howitzer rounds as well as several 155mm rounds of Chinese make. The gun is a further development of the Type 88's gun, with an L/52 barrel, and a fully automatic autoloader for both the rounds in the magazine and the charges. (This allowed the amount of loaders to be reduced to one.) Special rounds as well as rounds which have been changed in the firing order in the magazine still must be loaded by hand, though the autoloader will load the charges. The autoloader of the Type 88 proved to be deficient in several ways, prompting the greatly-improved autoloader of the Type 05. Elevation maximum is +68 degrees and depression is -3 degrees, making the engagements of ground targets possible. When doing so, some vehicle systems, such as a ballistic computer and laser rangefinder, are available. The gun uses a slotted muzzle brake and a fume extractor. The Type 05's howitzer and gun equipment are capable of firing several types special rounds, including a cannon-launched UAV. The UAV unfolds helicopter blades for flight and has a small battery-powered engine that keeps the UAV flying for 10 minutes. The rest of the UAV looks like an extended-length 155mm shell, though the nose is blunt and has cameras that can see into the infrared or normal color vision, and registers its position by GPS. The UAV round is normally used for spotting purposes or to find targets for rounds like the

Krasnopol; the UAV also has a laser designator for this purpose. Rumors also say that the Chinese have developed a GPS-guided round for the Type 05, similar to the US Excalibur round. The Type 88 can fire the Krasnopol without registration of the target or the need for an FDC, needing only the target distance and direction as supplied by a FIST team or by map if the target is on the map. The integrated gun-laying and GPS system allows the Type 05 to operate without an FDC, directly taking fire missions from a FIST team or vehicle, or even the onboard computerized maps.

The driver is in the front left, with the engine to his right. The commander is on the right of the turret, in a manually-operated cupola with a pintle mount on it. The cupola has all-around vision blocks, one of which has a channel for night vision and one of which has a day channel for the image intensifier. The Type 05's commander has a Type 88 heavy machinegun on a pintle mount of the commander's cupola, though the mount can also use a 7.62mm or 14.5mm machinegun. The Type 88 machinegun is standard for most Type 05s, however. Two clusters of four smoke grenades are on each side of the turret. At the rear of the turret are two large doors for ammunition replenishment. The crew is protected by a vehicular NBC common system. The Type 88 has a five-compartment automatic fire detection and suppression system. The Type 05 has an integrated C4ISR system similar to the BMSs of Western vehicles.

Other combat equipment include inertial navigation, GPS, a system to allow an FDC to remote lay gun barrels directly (if the FDC has the right equipment), and an LCD to display information coming from the FDC, as well as small computer able to automatically lay the gun using its own equipment and a mapping module integrated with the GPS and inertial navigation.

The chassis is almost identical to that of the Type 88; however, the Type 05 has an 8V150 turbocharged diesel developing 800 horsepower, along with a fully-automatic transmission. Unlike the Type 88, the Type 05's turret can rotate a full 360 degrees. The upper part of most of the suspension is protected by armored track skirts, while for forward section protecting the drive sprocket is wider and thicker.

The PLZ-04 is essentially the same vehicle with an L/54 howitzer instead of the L/52 of the Type 05. As of December 2017, it still in limited production – just enough to send fully-functioning versions of the PLZ-04 to defense shows and demonstrate it to prospective buyers.

The PLZ-52

The PLZ-52 was designed to be an export version of the Type 05 (though the Chinese are willing to sell the Type 05 as well), for countries who can't afford the high price of the Type 05, but want an SP howitzer as good in quality as good as they can get. (Some analysts say the PLZ-52 and Type 05 are in fact the same vehicle – my research tells me that's wrong.) As of December 2017, no units have been sold, the PLA does not use the PLZ-52, and there are rumors that the Chinese are considering withdrawing the PLZ-52 from the market due to the dropping (real-world) prices of the Type 05's components and major systems. The first prototype was completed in 2007 and it has been offered for sale since 2012.

The PLZ-52 is basically similar to the Type 05 – just dumbed-down a bit. The PLZ-52 does not have GPS or the fancy mapping system of the Type 05, and has only a limited capability for self-directed fire; though it can generate fire solutions for itself if it has enough information, fire without an FDC's input will be one lever more difficult. The commander's machinegun may be a Type 88 or an M-2HB, depending on the intended customer – the multipurpose mount which can mount a 12.7mm, 14.5mm, or 7.62mm machinegun is not used. The hull and turret are more similar to the Type 88, though it is capable of full rotation. This takes away room for the fancy autoloader of the Type 05, and it uses the semiautomatic autoloader of the Type 88, though without the second loader crewmember, so the loader is a very busy loader, especially when being supplied by an ammunition source off-gun. It does have the APU, NBC system, and explosion/fire detection system of the Type 05. It also has an even more powerful 1000-horsepower engine with a fully-automatic transmission, as well as conventional driver's controls. This gives it tremendous zip and maneuverability (at the cost of fuel use); more than enough to keep up with friendly attacking forces and even acting as a credible *ad hoc* tank destroyer if armed with the appropriate rounds. It can use most of the rounds that a Type 05 can use, though rounds such as the Chinese GPS-guided round and the cannon-launched UAV, as well as a very few other rounds, are not useable by the PLZ-52. The PLZ-52 retains the four smoke grenade launchers on each side of the turret. The thermal vision camera is removed from the gunner's equipment, replaced by a 2nd generation image intensifier. The PLZ-52 has a BMS – but it lacks the vehicle state computer system of the Type 05.

Though the PLZ-52 is not up to the same level as the Type 05, it is still a potent and credible adversary.

Twilight 2000 Notes: The Type 88 does not exist in the *Twilight 2000* v1, 2, and 2.2 timelines, though it is in use of all the countries mentioned above except Algeria in the *Twilight 2013* timeline. The Type 05, Type 07, PLZ-04, and PLZ-52 do not exist in the *Twilight 2000* V1, 2, and 2.2 timelines, though they are in service in the *Twilight 2013* timeline.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
Type 88	\$1,098,527	D, A	500 kg	32 tons	5	23	Passive IR (D, G), Image Intensification (G, C)	Shielded
Type 05	\$1,574,369	D, A	400 kg	35 tons	4	26	Passive IR (D, G), Image Intensification (G, C), Thermal	Shielded

PLZ-04	\$1,578,593	D, A	368 kg	35.13 tons	4	26	Imaging (G) Passive IR (D, G), Image Intensification (G, C), Thermal Imaging (G)	Shielded
PLZ-52	\$1,192,874	D, A	443 kg	34.83 tons	4	24	Passive IR (D, G), Image Intensification (C), 2 nd Gen Image Intensification (G)	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
Type 88	122/85	34/24	885	194	Trtd	T5	TF6 TS5 TR4 HF8 HS4 HR3*
Type 05	159/111	44/31	885	297	Trtd	T5	TF12Sp TS3Sp TR3 HF10Sp HS4 HR3**
PLZ-04	158/111	44/31	885	298	Trtd	T5	TF12Sp TS3Sp TR3 HF10Sp HS4 HR3**
PLZ-52	192/134	53/37	885	372	Trtd	T5	TF12Sp TS3Sp TR3 HF10Sp HS4 HR3**

Vehicle	Fire Control	Stabilization	Armament	Ammunition
Type 88	+1 (+2 in Direct Fire)	Basic	155mm Modified L/45 WAC-21 Gun/Howitzer, Type 88 (C), Type 69-1 RPG	30x155mm, 800x12.7mm, 4xType 69 RPG rounds
Type 05	+1 (+2 in Direct Fire)	Basic (Fair in Direct Fire)	155mm Modified WAC-21 L/52 Gun/Howitzer, Type 88 or KPV or Type 80 (C), Type 69-1 RPG	30x155mm, 800x12.7mm or 700x14.5mm or 1350x7.62mm, 4xType 69 rounds
PLZ-04	+1 (+2 in Direct Fire)	Basic (Fair in Direct Fire)	155mm Modified WAC-21 L/54 Gun/Howitzer, Type 88 or KPV or Type 80 (C), Type 69-1 RPG	30x155mm, 800x12.7mm or 700x14.5mm or 1350x7.62mm, 4xType 69 rounds
PLZ-52	+1 (+2 in Direct Fire)	Basic (Fair in Direct Fire)	155mm Modified WAC-21 L/52 Gun/Howitzer, Type 88 or M-2HB (C), Type 69-1 RPG	30x155mm, 800x12.7mm or .50, 4xType 69 RPG rounds

* Hull and Turret deck armor is AV3.

**Hull and Turret deck armor is AV5; Floor armor is 6.

Norinco Type 07

Notes: The Type 07 (not to be confused with the Type 07 wheeled SP howitzer or the Type 07 towed howitzer) solves several problems within the PLA today. The Chinese, though they would like to move on to the 155mm guns, have millions of rounds of various types of 122mm howitzer rounds, and more, modernized types of 122mm rounds are being developed, with new ones seeming to be available every few months. The Chinese also have a large number of 122mm towed howitzers that they want to be more mobile, and be able to keep up with attacking forces and still be able to “shoot and scoot.” And finally, they wanted an SP howitzer that was cheaper for 2nd line units to use, and one that was lighter and quicker than their heavier counterparts, for use by 1st-line units who need quick, responsive fire support. The result, the Type 07, is sort of a Type 88 crossed with a Type 97 IFV and a Type 96 122mm howitzer. It has been recently offered for export, but so far it’s only users are the PLA. The Type 07 is also known by its industrial designations, WMZ-322 or PLZ-07.

The Type 07 was designed to replace the Type 89, Type 85, and Type 70 platforms. The hull is essentially that the Type 97 IFV, with a new turret mounting the 122mm howitzer and a larger fuel tank. The howitzer is essentially a modernized form of the Russian D-30 gun/howitzer, with a longer barrel and a semiautomatic autoloader. The barrel is equipped with a multi-baffle muzzle brake and a fume extractor. It also has a hydraulic recoil buffer. The gun has an elevation of +70 degrees and a depression of -3 degrees, making it capable of direct fire missions. It does not, however, carry many antiarmor rounds in a normal deployment. Turret rotation and firing capability is 360 degrees. The fire control system is advanced, on par with the Type 05, and the electronics suite is likewise the same as that of the Type 05, able to act as its own FDC, having a BMS, a GPS with inertial backup, and the other features of the Type 05s electronics suite. The Type 07 also carries a conveyor system externally strapped to the side, in case the resupplying vehicles do not have one. Many analysts have noted that the Type 07 is very similar in appearance to the Russian 2S1 Gvozdika SP howitzer.

The engine used is a BF8M1015CP 600-horsepower turbocharged diesel. The engine is in the front left of the hull, with the

transmission below the engine and driver; the entire powerpack is unitary and removed and replaced as a single unit, taking less than a half an hour with the appropriate equipment and personnel.

The Type 07 has a crew of five, including a commander, gunner, driver, and two loaders. The commander has a manually-operated cupola on the top of turret on the right side, with all around vision blocks and the front block having a night channel and an aiming stadia slaved to the direct fire computer. He has a Type 88 machinegun on a mount to his front. The loader's hatch to his left has no vision blocks or a weapon mount. There is a hatch on the lower rear primarily for ammunition resupply, and a smaller hatch on the back of the turret below the bustle rack. (It's a tight fit.) On each side of the turret, near the front, are two clusters of three smoke grenade launchers. NBC protection is by CARC-type paint and a vehicular NBC pack to which the crew can plug in their protective masks.

The standard Type 07A is not amphibious, but the Type 07B is equipped with a floatation kit consisting of a screen that raises above the top of the turret from above the tracks. Kevlar balloons are also attached to the roadwheels, and a bilge pump is switched on. This preparation takes 10 minutes, and the Type 07B is propelled in the water by its tracks. The Type 07B is not capable of swimming fast streams or rivers, and is definitely not able to handle surf conditions. The Type 07B may not fire its main gun while swimming – traverse and elevation are impossible while the screens are raised, as is using the gunner's sights, and firing in such a way would swamp the vehicle.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
Type 07A	\$1,425,472	D, A	577 kg	24.5 tons	5	21	Passive IR (D, G), Image Intensification (G, C), Thermal Imaging (G)	Shielded
Type 07B	\$1,439,727	D, A	577 kg	24.55 tons	5	22	Passive IR (D, G), Image Intensification (G, C), Thermal Imaging (G)	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
Type 07A	127/89	35/25	674	222	Trtd	T4	TF6Sp TS5Sp TR4 HF8Sp HS4Sp HR3*
Type 07B	127/89	35/25/4	674	222	Trtd	T4	TF6Sp TS5Sp TR4 HF8Sp HS4Sp HR3*

Vehicle	Fire Control	Stabilization	Armament	Ammunition
Type 07	+1 (+2 in Direct Fire)	Basic (Fair in Direct Fire)	122mm Type 96 L/32 Type 88 (C), Type 69-1 RPG	40x122mm, 1000x12.7mm, 4xType 69 rounds

* Hull and Turret deck armor is AV3.

Norinco SH1

This truck-mounted howitzer was developed primarily for the export market, though there are rumors that the PLA itself is interested in it for its light formations. Currently, however, the only users are Pakistan, who have 90, and Myanmar, who have an unknown number in service and on order.

The chassis used is a Wanshan WS5252 6x6 truck. The cab of this truck has been lightly armored, though the crew must operate the howitzer from the outside on the back of the vehicle. The 155mm howitzer is 52 calibers long, and is similar to many other such howitzers used on other SP howitzers. The howitzer on the SH1, however, has more beefy hydraulic dampeners to allow the chassis to take the firing of the gun. The gun has an elevation and depression of +70 and 0, and fires from the rear of the vehicle. The vehicle carries only 25 rounds with modular charges and has no sort of autoloader. (Normally, the SH1 is followed by at least two ammo carriers.) Before firing, a large spade is lowered at the rear of the vehicle. The AH1 gun system is fitted with a computerized fire control system, GPS with inertial navigation backup; it is theoretically capable of providing its own firing coordinates with information from a FIST, but normally it uses an FDC, as the FDC can control the entire battery and gun laying of the entire battery. The AH1 is capable of using any Chinese-made 155mm artillery shells.

The crew normally travels inside the cab, with two up front (the commander and driver) and three in the rear (the gunner and two loaders). There is a space behind the rear seat for personal items, rations, etc. The SH1 has an Overpressure system, but only inside the cab; while working on the gun, a vehicular NBC system is plugged into. Note that the rear area only has one long-range and two short-range radios; the other long-range, short-range, and medium-range radios are in the cab, connected to the cab by an exchanger and a communications box and hand mikes. The commander is equipped with a Type 88 heavy machinegun, though ammunition is limited.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
SH1	\$814,450	D, A	640 kg	22.5 tons	5	21	Passive IR (D, C)	Shielded (Cab)

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
SH1	155/78	43/22	277	164	Std	W(3)	HF3 HS2 HR2*

Vehicle	Fire Control	Stabilization	Armament	Ammunition
SH1	+1 (Indirect Only)	Basic (Indirect Only)	AH-1 155mm L/52 Howitzer, Type 88 Machinegun (C)	25x155mm, 400x12.7mm

*Cab Roof and Cab Floor AV is 3; hull floor is also AV3. The rear area sides and rear is AV0.

Norinco SH2

Notes: The SH1 is sort of little brother to the SH1, mounting a 122mm howitzer on a smaller (though similar in design) truck than the SH1. It is currently being tested by the PLAM and PLA Airborne forces. The SH2 is also being tested by the Pakistanis, Ghanans, Lebanese and Indonesians. However, production has not yet started and only prototypes and vehicles for field testing have been produced.

The howitzer used is a modified form of the W-86, the same as used on the Type 89 tracked howitzer; the barrel length is 38 calibers. The muzzle is tipped by a large multibaffle muzzle brake, further reducing recoil forces on the truck, Modifications are primarily in the area of improved hydraulic recoil dampeners and the mechanisms necessary to move and set it into position. The howitzer fires over the front of the vehicle. For this reason, elevation maximum is +70 degrees, but the depression maximum is +1 degrees. The gun may also be rotated up to 30 degrees off-center. The howitzer's mechanism includes two automatically setting spades for stabilization. Electronics are largely the same as the SH1, with a computerized fire control system, GPS with inertial navigation backup; it is theoretically capable of providing its own firing coordinates with information from a FIST, but normally it uses an FDC, as the FDC can control the entire battery and gun laying of the entire battery automatically. The AH1 is capable of using any Chinese-made 122mm artillery shells, including the Chinese version of the Russian Kitlov laser-guided projectile. The SH2 is able to get into action much faster than the SH1; if acting as its own FDC, the SH2 can drop the gun into position one minute after a halt and be on its way after firing six rounds in 3 minutes.

The truck is a smaller version of that of the SH1, based on an extended Chinese copy of the US HMMWV. The cab is armored, largely with bolt-on steel sheets and internal Kevlar sheets. It is powered by a turbocharged diesel developing 215 horsepower. The ammunition which can be carries on the howitzer is small, only 24 rounds; the SH2 is therefore followed by one or more ammo supply vehicles of the same type as the howitzer vehicle. The truck steers with its front and rear wheels.

The SH1 is equipped with a BMS, GPS, mapping module, and vehicle state displays. During movement, the crew travels in the cab, which also has a small space at the rear for personal equipment. Unlike the SH1, the SH-2 carries no other weapons other than the howitzer (except for the crew's small arms and other weapons), though the commander does have a hatch above him and forward vision blocks with a night channel. Note that the rear area only has one long-range and two short-range radios; the other long-range, short-range, and medium-range radios are in the cab, connected to the cab by an exchanger and a communications box and hand mikes. The power pack and transmission are a single unit, and are removed and replaced in one piece; the modular nature of the vehicle means that even changeout of major components can be done in about 30 minutes, if the right equipment is available.

A modified form of the SH2 is designated the SH5. It mounts a Chinese copy/modification of the US M-119 105mm howitzer. One difference is the large multibaffle muzzle brake and heavier hydraulic recoil dampeners; the muzzle brake is in fact a modified form of that on the SH2. It is otherwise the same as the regular SH2, except for weight differences, mechanism and computer differences; it can also carry a bit more ammunition. It fires US 105mm shells and their Chinese equivalents. The SH5 was developed for export sales to countries already using 105mm howitzers (whether mobile or towed).

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
SH2	\$676,296	D, A	584 kg	11.5 tons	5	9	Passive IR (D, C)	Shielded (Cab Only)
SH5	\$649,335	D, A	589 kg	11.3 tons	5	9	Passive IR (D, C)	Shielded (Cab Only)

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
SH2	149/75	41/21	202	79	Std	W(3)	HF3 HS2 HR2*
SH5	152/77	42/21	202	77	Std	W(3)	HF3 HS2 HR2*

Vehicle	Fire Control	Stabilization	Armament	Ammunition
SH2	+1 (Indirect Only)	Basic (Indirect Only)	Modified W-86 122mm L/38 Howitzer	24x122mm
SH5	+1 (Indirect Only)	Basic (Indirect Only)	Chinese Version of M-119 105mm L/37 Howitzer	28x105mm

*Cab Roof and Cab Floor AV is 3; hull floor is also AV3. The rear area sides and rear is AV0.

KT/ZTS SpGH Dana Vz-77

Notes: A joint development of the former Czechoslovakian firms of Konstrukta Trenčín and ZTS (now both located in Slovakia, though production continues at Tatra in the Czech Republic). Sales were quick and remain at decent levels; the Dana is currently used by the Czech Republic, Slovakia, Libya, Poland, and Georgia. Recently, several Middle Eastern countries have expressed interest in the Zuzana version, as has Thailand and Malaysia; Cyprus already uses a dozen Zuzanas. Three Danas were captured by the Russian Army during its conflict with Georgia in 2008; they have not been returned, and their fate is unknown. Production took place from 1981-1994, but now takes place only in lots ordered by customers. A wheeled chassis, even a heavy chassis like the Dana, is cheaper to maintain and cheaper to build (or buy), and with modern suspensions, the mobility hit off-road is not too bad. The Dana has seen combat use in South Ossetia and Afghanistan.

The Dana

The Dana is an extensively modified Tatra T-815 Kolos truck chassis with a turret in the center mounting a 152mm howitzer. Aside from the turret, the most extensive modification is the fully armored body and the engine that has been moved to the rear of the vehicle. The engine for the Dana is a Tatra turbocharged T930-34 253 345-horsepower diesel, with a 7kW APU to power the vehicle's systems with the engine turned off. The engine is in the rear, with the APU below it (cables lead to an outlet to attach external equipment if necessary). The engine is a Tatra T2-930-34 turbocharged diesel engine, developing 345 horsepower. The engine is designed to provide high torque for sloppy terrain and self-recovery.

The turret is a "split" turret, split down the center into two compartments by the main gun. The gun largely occupies the left half of the turret, along with the gunner and primary loader, along with the gun-laying controls (including direct fire sights) and the autoloader for the charges, an auxiliary magazine, and the gun recoil dampeners. The right side of the turret contains the primary magazine and the secondary loader. The gunner is on the right side, with a cupola (with no vision blocks) and a pintle mount for a heavy weapon. The loaders have a hatch on the left side of the turret, with no vision blocks or weapon. Each side of the turret also has a hatch large enough for loading of supplies or ammunition, and a conveyor belt may be hooked up to one or both of these hatches (though the Dana normally does not carry the conveyor belt). The front of the right side of the turret also has a similar hatch. The driver is on the front left side; he has front windows of bullet-resistant glass, as well as armored shutters with two wide-angle vision blocks in it. He also has a hatch above him, one of which can mount a night vision device. The driver operates the three hydraulic stabilizers, which must be lowered at the sides and rear before firing the gun. On the left is the commander's position; he has a similar arrangement of hatches, windows, and vision blocks. In addition, there is a small armored window on each side of the front compartment. The vehicle commander is seated to the right of the driver, and though he has a manually-operating cupola with vision blocks and one vision block with a night channel, he does not have a mounted weapon, being armed only with his assault rifle. Other crewmembers include two loaders, one of which primarily fixes the fuzes to the shells before placing them into the autoloader for firing. (The autoloader was innovative, as it was the first of its type to equip an SP howitzer, being able to load the gun regardless of gun angle or turret rotation.) The autoloader has an emergency manual backup, in which case the autoloader magazine is treated as merely a bin, with the ammunition manually loaded.

The gun is a 152mm L/37 gun. The turret may be traversed 112.5 degrees to the right and left of center. The gun has an elevation and depression of +70 and -4 degrees. The gun has a standard ROF of 4 rpm, though a burst rate may be maintained for five minutes, generating 8 rpm. If the autoloaders are out of action or special rounds must be used, ROF drops to 2 rpm. The primary magazines each hold 24 rounds, with bins on the turret floor for special rounds holding six rounds each. The 152mm howitzer in its basic form can fire most conventional 152mm rounds; improvements have given the Dana the ability to fire Krasnopol laser-guided projectiles. The gunner has a Czech version of the NSVT machinegun on a fully flexible pintle mount. Crew equipment includes 5 short-barreled assault rifles with 600 rounds and five RPG-75 rocket launchers (these are not included in the stats below); there are stowage points in the turret and the driver's/commander's position for them.

A small tunnel allows access from the front compartment to the turret, as long as the turret is facing forward.

The Dana uses a conventional panoramic telescope with a reticle (one for direct fire, and one for indirect fire). This is coupled to a fire control computer, which receives information from the FDC and automatically lays the gun for accurate fire from the Dana. A survey vehicle normally selects positions for a battery of Danas. There is no provision for the Dana for generating its own fire solutions; input from an FDC is necessary, or indirect fire will be random at best. The Dana family is equipped with an air conditioner for the turret and driver/commander's position. The driver has a backup camera, making a ground guide unnecessary. The Dana has an NBC Overpressure system with a vehicular NBC backup.

The Ondava

The development of the Ondava began in the late 1980s; the breakup of the Warsaw Pact basically ended the development of the Ondava, though some of the design was carried through to the Zuzana. The Ondava had a longer L/47 barrel for more range, a new 2-chamber muzzle brake, and a new, more efficient autoloader. The Ondava project ended with the fall of the Wall and the change to Eastern European countries to democracies. Technical experience gained on the Ondava project was carried over to the Zuzana and Modan projects.

The Modan

The Modan Vz-77/99 is a Slovakian upgrade of the Dana with longer range (it uses an L/47 barrel, like the Ondava), higher accuracy, and more automation. Computerization gives the Modan the ability to function as its own FDC, as well as generally greater

efficiency. (Modan batteries generally do not operate with an FDC, using a direct connection to the FIST.) GPS and an inertial navigation system, as well as a computerized mapping system and self-surveying systems, have been added. The Modan has a BMS system with vehicle state displays. A greatly-improved autoloader allows one of the loaders to be deleted, with the remaining loader merely required to fix and modify fuzes as necessary. The Modan uses the longer barrel of the Ondava. Though the commander does not have control of the thermal imager from his seat, he has a channel which allows him to see through the thermal imager (at whatever the gunner is looking at). The Modan can move into a firing position, square its position and firing data, fire three rounds (all taking two minutes), and be off again in one minute.

The Dana-M1 CZ

This is a progressive upgrade of the Dana, developed by Excalibur Army of Prague. The upgrades give the Dana-M1 a capability similar to that of the Modan, plus a new T3-930 diesel engine with doubled turbochargers for hot weather operation and a slight boost to 355.4 horsepower. Despite the Western arms embargo on Azerbaijan, this version was sold to Azerbaijan in 2011 (though they were not revealed until 2017).

The ShKH M-2000 Zuzana

This modification mates a NATO-standard 155mm L/45 gun to the Dana chassis. This is now the standard SP howitzer for the Czech Slovakian Army in NATO. The Dana has otherwise not been modified except in the gun, autoloader, and ammunition racks. The M-2000G Zuzana is designed for the Cypriot National Guard, and has different radios, two clusters of four smoke grenade launchers on each side of the turret, and an MG-3 machinegun instead of the NSVT of the other countries using the vehicle. A modified form, primarily to take into account manufacturing methods, is used by Slovakia, and is produced by ZTS Dubnica.

The ShKH Zuzana 2

The Zuzana was modified beginning in 2004 into the Zuzana 2. Initially known as the Zuzana A1 and then Zuzana XA-1, the Zuzana 2 is the latest development of the Zuzana, and is replacing the Zuzana in Czech and Slovakian service. It has an L/52 155mm gun and has a faster-traversing turret and easier communication between the halves of the turret. It has fire control equipment similar to the Modan, modified for use with the 155mm gun. It uses a Tatra T2B-928.70 engine developing 443 horsepower, and the gun system is able to fire all 155mm rounds, including laser and GPS-guided rounds, and even nuclear-warhead rounds.

The ShKH A40 Himalaya

This is essentially the Zuzana turret put on the chassis of a T-72M1 tank chassis; when first built, it was called the Zuzana M1. Virtually the entire gun system, including the APU, autoloaders, and magazines and bins for special ammunition have been mounted in and on the T-72M1 chassis. The armor of the turret has been strengthened, though it does not match the chassis' armor. The original version used a standard Zuzana turret, but the newer A-40M1 being offered for export uses the Zuzana 2 as a template and turret. The commander is moved to the turret roof to the former gunner's position, and he may be armed with an NSVT or M-2HB machinegun. The engine has been changed for Czech-made S-1000 780-horsepower engine, and has the APU and air conditioner and backup camera of other Dana-family guns. In addition, like most Indian vehicles, the Himalaya has a ration heater, with space for the entire crew. Unlike the Dana, the turret may be rotated through 360 degrees, and fired in any position. The transmission is "semiautomatic" – it is manual at its base, but hydraulically boosted and uses a synchromesh system to ease the workload on the driver. The T-72M1 chassis is heavy enough that hydraulic stabilizers are not necessary. The turret is a bit longer to take advantage of the greater carrying capacity of the T-72M1 chassis, and the autoloader magazines, charge magazines, and special round bins are slightly larger.

The A-40M1 is topped with the Zuzana 2 turret and equipped with the Zuzana 2's equipment inside the chassis. Computerization gives the A-40M1 the ability to function as its own FDC, as well as generally greater efficiency. GPS and an inertial navigation system, as well as a computerized mapping system, have been added. A greatly-improved autoloader allows one of the loaders to be deleted, with the remaining loader merely required to fix and modify fuzes as necessary. The commander can tap into the gunner's thermal imager through a sight elbow.

The Himalaya was originally designed for the Indian SP Howitzer competition; it did not win that competition, but is still being shopped around, at arms shows and private showings. The turret and systems are also being shopped around; the Czechs have made it known that the turret could be mounted on any vehicle of the appropriate size.

The ShKH DIANA

DIANA is an acronym, presumably in Czech, which I have not been able to find the meaning of. It is the latest iteration of the Zuzana. It uses the same turret, but is armed with an L/55 gun. It uses a new Polish tracked chassis that uses many components of the T-72 tank. The first prototype was revealed in 2015, and it has been making the rounds of arms shows and private showings. Like Himalaya, it was proposed for the Indian Army requirements, but is also being offered on the arms market; in addition, the Czech, Slovakian, and Polish Armies are reportedly interested. It has the improvements and characteristics of most of the Dana family. The magazine setup is a bit different; the DIANA has twin 40-round magazines, with another two 40-round charge magazines and two 10-round bins for special ammunition and its charges. Konstructa has plans in the works to increase the size of these magazines, but these are on the drawing board as of yet. The gun is capable of using all types of 155mm ammunition, including those that are still on the drawing board. The autoloader can use all four of the standard magazines and charge magazines, and the autoloader is improved

to allow a ROF of 13 rpm. In addition, 1000 more rounds more of machinegun ammunition are available, with the gun being able to be aimed, fired, and loaded from within the enhanced cupola. The cupola has all-around vision blocks, with the front three blocks having night vision channels and the center block having an aiming stadia and a ballistic computer. A total of eight smoke grenade launchers are carried, four on each side of the gun. The S-12U turbocharged diesel engine is more powerful than the T-72 at 839 horsepower, which it needs for the heavier setup. In addition to the chassis armor of a Polish modified T-72, it has enhanced protection for the turret. The commander is in the turret instead of in the front. The turret can rotate and fire in 360 degrees. Though the system is more complex, it has also been made easier to service and maintain. Otherwise, the improvements of the Dana family are present in the DIANA, including a BMS, vehicle state system, mapping computer and displays, ration heater, and the advanced fire control systems.

Twilight 2000 Notes: The Zuzana does not exist in the Twilight 2000 timeline, and the Ondava is very rare. Other versions do not exist in the *Twilight 2000* timelines, though the Modan, Dana-M1 CZ, and M-2000 Zuzana exist in the *Twilight 2013* timeline.

Merc 2000 Notes: The Zuzana exists, but has not had much export success. The Ondava has for the most part replaced the Dana in Czech service, though some countries have gone for the Slovakian Modan.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
Dana	\$754,870	D, G, AvG, A	500 kg	29.25 tons	5	18	Passive IR (D, G, C)	Enclosed
Ondava	\$802,728	D, G, AvG, A	495 kg	29.53 tons	5	21	Passive IR (D, G, C)	Enclosed
Modan	\$1,342,715	D, G, AvG, A	489 kg	29.89 tons	4	22	Passive IR (D, G, C), Image Intensification (G), Thermal Imaging (G)	Enclosed
Dana-M1 CZ	\$1,442,763	D, A	489 kg	29.89 tons	4	17	Passive IR (D, G, C), Image Intensification (G), Thermal Imaging (G)	Enclosed
M-2000 Zuzana	\$830,492	D, G, AvG, A	498 kg	29.34 tons	5	18	Passive IR (D, G, C)	Enclosed
M-2000G Zuzana	\$800,979	D, G, AvG, A	410 kg	29.3 tons	5	18	Passive IR (D, G, C)	Enclosed
Zuzana 2	\$1,500,988	D, A	688 kg	29.98 tons	4	21	Passive IR (D, G, C), Image Intensification (G), Thermal Imaging (G)	Enclosed
A40 Himalaya	\$917,200	D, A	488 kg	41.5 tons	5	45	Passive IR (D, G, C)	Shielded
A40M1 Himalaya	\$1,505,613	D, A	481 kg	42.14 tons	4	45	Passive IR (D, G, C), Image Intensification (G), Thermal Imaging (G)	Shielded
DIANA	\$2,076,580	D, A	406 kg	50 tons	4	29	Passive IR (D, G, C), Image Intensification (G, C), Thermal Imaging (G, C)	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
Dana	107/54	30/15	690	127	Trtd	W(4)	TF6 TS6 TR6 HF6 HS5 HR4
Ondava	105/54	29/15	690	128	Trtd	W(4)	TF6 TS6 TR6 HF6 HS5 HR4
Modan	105/53	29/14	690	130	Trtd	W(4)	TF6Sp TS6 TR6Sp HF6Sp HS5Sp HR4**
Dana-M1 CZ	121/61	33/17	690	131	Trtd	W(4)	TF6Sp TS6 TR6Sp HF6Sp HS5Sp HR4**
M-2000 Zuzana	107/54	30/15	690	127	Trtd	W(4)	TF6 TS6 TR6 HF6 HS5 HR4
M-2000G Zuzana	107/54	30/15	690	127	Trtd	W(4)	TF6 TS6 TR6 HF6 HS5 HR4
Zuzana 2	125/63	34/18	690	163	Trtd	W(4)	TF6Sp TS6 TR6Sp HF6Sp HS5Sp HR4**
A40 Himalaya	136/95	38/26	1000+400	290	Trtd	T6	TF28Sp TS12Sp TR7 HF138Cp HS20Sp HR12
A40M1	134/94	37/26	1000+400	294	Trtd	T6	TF28Sp TS12Sp TR7 HF138Cp

Himalaya								HS20Sp HR12
DIANA	124/87	35/24	1000+400	311	Trtd	T6	TF30Sp TF13Sp TF8Sp HF149Cp	HS20Sp HR12***

Vehicle	Fire Control	Stabilization	Armament	Ammunition
Dana	+1*	Basic*	152mm L/37 Howitzer, NSVT (G)	60x152mm, 2000x12.7mm
Ondava	+1*	Basic*	152mm L/47 Howitzer, NSVT (G)	60x152mm, 2000x12.7mm
Modan/Dana-M1 CZ	+2*	Fair*	152mm L/47 Howitzer, NSVT (G)	60x152mm, 2000x12.7mm
M-2000 Zuzana	+1*	Basic*	155mm L/45 Howitzer, NSVT (G)	60x155mm, 2000x12.7mm
M-2000G Zuzana	+1*	Basic*	155mm L/45 Howitzer, MG-3 (G)	60x155mm, 4000x7.62mm
Zuzana 2	+2*	Fair*	155mm L/52 Howitzer, NSVT (G)	60x155mm, 2000x12.7mm
A40 Himalaya	+1*	Basic*	155mm L/45 Howitzer, M-2HB (C)	60x155mm, 500x.50
A-40M1 Himalaya	+2*	Fair*	155mm L/52 Howitzer, M-2HB (C)	60x155mm, 500x.50
DIANA	+3 (+1 for Indirect Fire)	Fair (Basic for Indirect Fire)	155mm L/55 Howitzer, NSVT or M-2HB (C)	100x155mm, 1200x12.7mm or .50

*The Fire Control and Stabilization figures are for direct fire shots, and do not apply to indirect fire.

**HR and TR are AV 4. HF is AV 4Sp.

***HR AV is 5Sp. Floor AV is 7Sp.

BMY/Abu Zaabal SP-122

Notes: This is an Egyptian self-propelled howitzer that is basically a US M109 with the 155mm howitzer replaced by a 122mm D-30 howitzer. This was done because the Egyptian Army had a large number of towed D-30 guns that they wished to be more mobile. 124 of these vehicles were built between 1987 and 2000. It was never exported. The M109A2 base vehicles were obtained largely from surplus stocks in the US.

In this mounting, the turret has limited traverse; it is more of a casemate than a turret. While elevation and depression are from +70 to -5, traverse is manual and limited to 30 degrees left or right. The SP-122's turret has limited traverse because the D-30 does not have the hydropneumatic recoil dampeners of the 155mm howitzer normally used on this chassis, and the D-30 is not a perfect fit for the turret. The D-30 in this role has a direct-fire capability with sights appropriate to this purpose. The gun mechanism includes a mechanical semiautomatic loader which opens the breech automatically and ejects the spent shell after each shot; the gun, however, is loaded manually. The gunner has a modicum of night vision, but for the most part he is relying on IF sights, a telescopic sight for direct fire, and instructions from an FDC.

The turret roof has a manually rotating cupola (without vision blocks) on the right side with a pintle mount for a weapon, usually a DShK or M-2HB. The loader also has a hatch with a weapon mount (though the hatchway has neither a cupola nor vision blocks); this is normally occupied by a PKT, DShK, or M-2HB machinegun. Two clusters of four smoke grenade launchers are found one on each side of the turret. Each side of the turret also has a large hatch, useful for general loading of the vehicle or loading of ammunition. At the rear of the vehicle are two large doorways allowing the SP-122 to be loaded by automatic systems, conveyor systems, or piles of ammunition on the ground. (The SP-122 is compatible with the M992 FAASV. The Egyptians got some FAASVs when they bought M109s in early 2014.) Each crewmember also has an assault rifle (usually an AKMS). Two loaders are available; one normally fixes the fuzes to the howitzer rounds and pulls the correct round from the ammunition racks, while the other directly loads the gun and ensures the spent shells are kept out of the way of smooth operations. Normally, a large spade is lowered hydraulically at the rear of the SP-122 before firing commences. Other than modifications to fit the chassis and turret, the D-30 used on the SP-122 has a longer barrel than the standard D-30 and has a large, slotted muzzle brake.

As stated above, the SP-122 is based on the M109A2 chassis. The SP-122 uses a Detroit 8V-71T turbocharged diesel developing 405 horsepower. The driver is in the front left of the hull, with the powerpack to his right. The powerpack is a unified powerpack which can be removed in one piece and replaced in less than an hour. The transmission allows the SP-122 to be driven in manual or automatic mode.

Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
\$461,499	D, A	1 ton	23.18 tons	5	16	Passive IR (G)	Shielded

Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
140/98	39/27	511	150	Trtd	T4	TF8 TS4 TR4 HF10 HS3 HR3

Fire Control	Stabilization	Armament	Ammunition
+1	Basic	122mm D-30 L/40 Howitzer; DShK or M-2HB (C), DShK or M-2HB or PKT (L)	85x122mm; 500x12.7mm or .50; 500x12.7mm or .50 or 1000x7.62mm

Abu Zaabal T-122

Notes: Also known as the T-34/122 (not to be confused with the Syrian T-34/122, or the Turkish T-122 MRL), this was Egypt's first attempt at mechanizing the D-30. The D-30 was placed in a turret atop the chassis of a T-34 tank. The T-122 was sort of a kludge, though a reasonably effective one, and was not exported. The T-122 was used in the 1956 and 1973 Middle East Wars and continued in service, in ever-declining numbers, until the 1980s. Most have been relegated to ignoble ends like firing range targets. Some 30 such modifications were made

While the chassis has the armor levels of the T-34 tank, the turret is constructed from relatively thin armor plates bolted together. The turret has the lower part, and on steel posts, an armored roof; in between those two are several droppable armor panels (from just behind the gun on the left side around to just behind the gun on the right side), allowing the crew to get some fresh air and *relatively* cool air, as well as allowing fumes from the firing of the howitzer to escape. The D-30 howitzer used is more or less stock, taken off the ground-mounting carriage of a towed version of the D-30 and lightly modified to mount it inside the turret. The caliber length is the same (L/37), but a larger slotted muzzle brake is fitted. (This huge muzzle brake was in fact absolutely necessary – the modified turret and chassis could barely handle the much greater recoil of the D-30.) In the rear of the turret, there is a rack for 24 rounds and fuzes (most of the T-122's onboard supply). The gun may be depressed to below zero degrees, and it may engage ground targets; in fact, the T-122 was often used as an *ad hoc* tank destroyer in the 1956 and 1973 Wars.

The T-122 has two drums for extra fuel on either side of the vehicle, most T-122s carried these at the front of the deck instead of the rear, with metal hoses leading back to the engine. Some have been seen with the drums at the front of the hull deck, however. The details of the chassis have received little modification – in fact, little more than what was needed to mount the new turret and gun. The engine was the standard T-34 engine, the V-2-34 diesel engine developing 500 horsepower, coupled to a manual transmission. The vehicle is substantially heavier than the T-34 tank, eroding the performance of the T-34 chassis. The driver is in the front of the vehicle, near the top of the glacis; he has a large hatch for entry and exit or to pop open in non-tactical situations. The driver can

lower and lock this hatch, using two vision blocks in the hatch instead. Normally, the turret is manned with the commander, gunner, and one loader, with the other two loaders inside the lower turret or hull. There are no hatches in the turret roof and the T-122 has no pintle-mounted weapons, though one could lower the turret armor panels and fire away with personal weapons.

Twilight 2000 Notes: What was left of the "T-122 force" still in operable condition were placed into service; they never numbered more than 12, and most were destroyed during the Twilight War.

Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
\$420,182	D, A	200 kg	30 tons	6	24	Headlights	Enclosed

Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor		
136/95	38/26	790+360	148	Trtd	T4	TF10	TS5	TR3 HF50 HS17 HR10

Fire Control	Stabilization	Armament		Ammunition
+1	Basic	122mm D-30 L/37 Howitzer		40x122mm

AMX GCT-155 (AUF x)

Notes: The GCT-155 (Grande Cadence de Tir) was designed to replace all of the 105mm and 155mm self-propelled howitzers then in French service, and entered service in 1979; this occurred after almost 10 years of development and testing. It is normally known as the AUF 1 in French service and some other companies; in others, it is appended to the "GCT-155" as a model number. Before that, the first ones produced were actually bought by Saudi Arabia in 1977. Later production included vehicles for Iraq and Kuwait, though the Iraqi AUF 1s were received between 1983-85 and if they are operational in any sense of the word, now are probably suffering from a severe state of neglect. AUF 1s served in the Iran-Iraq War (where Iranian aircraft and superior counterbattery fire took quite a toll on them), in the Balkan States, and to a limited extent, in Iraq during the 2003 invasion. The French got 179 AUF 1s, which were later upgraded to AUF 1T/AUF 2 standards. (The French Army are only ones to have received the AUF 1T.) The production of the AUF 1/1T/2 are now complete, though Nexter (who inherited the design from AMX) has shown that it will pick up production in response to orders, as it did in 1996 for 20 vehicles. The primary component being marketed today is the AUF 2 (both in an update kit and in complete vehicle form), which is an advanced artillery system which can be mounted on the AMX-30, T-72, Arjun, and Leopard tanks. The Iraqi Army employed an unknown number of AUF 1s, though all were destroyed in the Iran-Iraq War, Desert Storm or Operation Iraqi Freedom. The Kuwaitis have 18, though they are all in storage, pending the arrival of new artillery systems or AUF 2 upgrade kits (depending upon what the Kuwaitis choose). The first production AUF 1s were actually delivered to Saudi Arabia, ahead of the French Army receiving theirs. AUF 1 and AUF 2 turrets have been seen mounted on T-72 and Arjun tank chassis; the T-72/AUF version is for export sales, while the Arjun-based AUFs were specifically built for the Indian Artillery System competition. (The Indians indicated that they intended to put the AUF 1 turret on Arjun or T-72MI chassis, but in the end no decision was made, and the next round of the Indian Artillery System competition took place without the French.) The French has indicated that the turrets can also be mounted on a Leopard 1 chassis, though no such models have been produced yet.

GCT-155 AUF 1s have seen combat with the French as part of IFOR, and in Saudi hands during Desert Storm. They were also used by the Iraqis against the Iranians, and against the coalition during Desert Storm and for a short period during Operation Iraqi Freedom. It should be noted that the AUF 1 is regarded by most military experts as being the first self-propelled howitzer to incorporate a working autoloader.

The AUF 1

The AUF 1 looks in many ways like the US M109; however, the AUF 1 is superior to the base M109 in almost every way. This includes a longer main gun, better electronics, heavier armor, and faster speed. The AUF 1 is the base version, which is capable of supplying quick, responsive fire support and is capable of using any Western 155mm round, and even Chinese rounds; its fire control computers require input from an FDC, but targeting information from a compatible FDC is funneled directly into the AUF 1 and turned into a firing solution. When buttoned up, the crew is protected by an NBC overpressure system with vehicular filtration backup; the AUF 1 can fire while completely buttoned up from its internal ammunition store. A 4kW APU can power the AUF 1 completely without turning on the engine, operating off of the vehicle's fuel supply. The AUF 1 also has an adequate heater and air conditioner.

The main gun is an L/40 variant of the M109's L/39 155mm; the French version, however, has a more compact muzzle brake and a fume extractor. Whether or not the AUF 1 has a commander's or loader's weapon is a bone of contention; AMX did not build any with external weapon mounts, but most of the countries (and/or units) that use the AUF 1 (and later versions) have added such mounts to the commander's hatch, loader's hatch, or both. The version I have detailed below has a choice of possible commander's weapons. It can be fed by a resupply vehicle, and mount a conveyor belt system to feed from a vehicle or ground pile. The magazines are loaded from outside the vehicle at the rear of the turret, and can be loaded with resupply rounds even as the gun is being fired. (Each magazine normally has six rounds of the same type, but this is not strictly necessary.) There are a total of seven magazines. Maximum elevation is 66 degrees, and depression -4 degrees. When fired, the breech moves back and opens automatically, with a manual override. Most of the vehicle ammunition is in racks at the rear of the turret, although 22 short-range propelling charges are located near and under the loader's seat. The gunner has the interesting ability to fire either single rounds or rounds in bursts of six (with one per phase being fired). Though the autoloader enables the AUF 1 to fire up to 6 rounds in 45 seconds, this fire rate cannot be maintained for more than two minutes (as it will damage the barrel and autoloader if kept up too long); normal fire rates are more like three rounds per minute. The AUF 1 uses a 40-caliber cannon barrel, which is tipped by a multibaffle muzzle brake. The gun is fed by a semiautomatic autoloader. The magazines store 42 rounds and charges; another 40 propellant charges are stored under the turret floor. There is a hatch in the rear of the vehicle to allow for replenishment through an outside source, and for crew ingress and egress.

The armor is of all-welded steel, with the driver on the front left, the commander in the turret on the left, the gunner below him, and the loader on the left turret. Reloading is done via a large hatch on each side which can also receive crew and equipment), and the conveyor belt. The commander's position normally has a pintle mount, and a manually-rotating cupola with all-around vision blocks. The commander has an elbow scope that allows him to see through the gunner's sights; the gunner has a x10 telescopic sight, an image intensifier, and other night vision devices, as well as a low-magnification (x3) telescope for close-up work. A sighting reticule and computer information is put into the gunner's sights. The GCT-155 has an automatic fire detection and suppression system, and an NBC overpressure system. Every minute, the turret is also flushed with fresh air and the discharge gasses from the gun expelled. The GCT-155 is equipped with a GALIX protection system; this is a grenade launcher system the tubes of which are fired manually and may be loaded with smoke, illumination, CS, or fragmentation grenades. The grenades are fired at an 11-degree angle, and are found (on the GCT-155) in clusters of five on either side of the turret. There are large baskets on the front of the turret; these are for storing crew equipment and extra ammunition for the crew's small arms or the commander's weapon. (GCT-155s in combat have

been seen with the baskets loaded with logs or steel or aluminum plates, or simply sandbags, to increase the protection on those surfaces.)

Power is provided by an HS-110 turbocharged multifuel engine developing 720 horsepower. The GCT-155 series uses an automatic transmission, along with conventional driving controls which are hydraulically-boosted. The chassis is a modified form of that of the AMX-30 tank.

The AUF 1T/TA

In 1988, production was switched to the AUF 1T standard, which is sort of a bridge between the AUF 1 and AUF 2. This gave the newer vehicle a 12kW APU (as opposed to the 4kW APU of the AUF 1). The AUF 1T's APU can power four guns or a gun and an FDC. The loading system became almost totally automatic, with automatic self-laying potential and fire control, giving the AUF 1T the able to act as its own FDC, with GPS aiding this (this is the CITA-20 system). The fire control system, includes automatic gun laying either by coordinates supplied by the fire control computer or an FDC, a ballistic computer applicable to indirect as well as direct fire, and a laser rangefinder for use in direct fire. The autoloader is fully automatic with fuzes being programmed by the ballistic computer with the round inside the gun.

The AUF 1TA replaces CITA-20 system with the ATLAS FCS, which includes a muzzle velocity radar and an upgraded turret and chassis. The gun has been replaced by an L/52 barrel. Two radios have been replaced by secure frequency-hopping radios, and two other long-range radios which are simply encrypted. All are data-capable. The automatic fire control system combined with burst fire capability allows the gun by itself to MRSI. The burst fire capability has been increased to 10 rounds. The AUF 1T essentially upgraded almost all turret components. Other enhancements, such as GPS unit with mapping computer, a small tank for drinking water (holds 40 liters) and a ration heater have been added. The APU has also been upgraded to a powerful unit developing 40 kW. A small radar set has been added; this can trigger the GALIX system or simply notify the soldiers of threats in the area. This radar has a range of 3 kilometers, can track up to five ground or air targets (the closest five are automatically detected), and is connected to a screen at the commander's position that display both data for the five targets and the disposition of the GALIX system.

Power for the AUF 1TA is by a version of the Mack E9-750. This version has double turbochargers, which are more reliable on steep side slopes than the HS-110 and HS-110-2. The output is rated at 750 horsepower, and the engine offers a greater lifespan and a longer operating life.

The AUF 2 gun system

The AUF 2 does not come with a base chassis; instead, Nexter supplies the turret and gun system of the AUF 1TA and mates it to an existing chassis. The French use the chassis of an AMX-30B2, and have converted 70 from the AUF 1 to the AUF 2 standard as of February 2018. Since most of the loading, gun, and computer and communications is in the turret, this is easier than one might think.

The gun is the L/52 howitzer, along with upgraded electronics based those of AUF 1/1T/TA (as appropriate). The autoloader is also upgraded, and makes the AUF 2 capable of 1-2 minutes of 10-per-minute fire. The gun and autoloader are also capable of firing smaller burst in order to perform MRSI fire, and the French (and several other countries) are developing modular propellant charge families that will be able to be used by the AUF 2. Radios are usually supplied by the using country; computerization and night vision is supplied by Nexter. The commander's/loader's weapon is generally supplied by the receiving country. The 40 kW APU is also installed as part of this package, and any modifications to the chassis necessary to fit the turret to the chassis or modify it to its new role are done. All told, the AUF 2 turret weighs 19 tons, but this is normally 2-6 tons less than the original tank weighed. The AUF 2 is normally equipped with a French version of a BMS (though Iraqi versions use a US BMS), along with extra data-capable radios for use by the BMS and the vehicle state computer; this is a total of three frequency-hopping long-range data-capable radios, two medium-range frequency-hopping radios, one of which is data-capable, and one short-range frequency-hopping radio. The GPS has an Inertial backup. The AUF 2 also has the other applicable improvements of the AUF 1TA. The possible combinations that Nexter is ready to modify right now is listed above; however, with the right offer, they may be willing to put this modification on other chassis. They will not be detailed here, at least for now. The chassis used by the French is a form of that of the AMX-30B2 tank (with repowering and a suspension upgrade), and it is that vehicle which is reflected in the stats below. The AUF 2 has the full armor protection of the AMX-B2's hull, but only a small increase in protection for the turret.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
AUF 1	\$712,334	D, G, AvG, A	400 kg	41.95 tons	4	27	Passive IR (D, G), Image intensification (G)	Shielded
AUF 1T	\$818,286	D, G, AvG, A	360 kg	42.09 tons	4	29	Passive IR (D, G), Image intensification (G)	Shielded
AUF 1TA	\$1,172,647	D, A	328 kg	42.23 tons	4	30	Passive IR (D, G), Image intensification (G)	Shielded
AUF-2	\$1,461,633	D, A	310 kg	42.95 tons	4	34	Passive IR (D, G), Image intensification (G)	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
AUF 1	130/91	36/25	970	278	Trtd	T6	TF17Sp TS6Sp TR4 HF21Sp HS5Sp HR3
AUF 1T	130/91	36/25	970	278	Trtd	T6	TF17Sp TS6Sp TR4 HF21Sp

AUF 1TA	130/91	36/25	970	278	Trtd	T6	TF17Sp	HS5Sp HR3 TS6Sp TR4 HF21Sp
AUF 2	128/90	36/25	970	277	Trtd	T6	TF20Sp	HS5Sp HR3 TS8Sp TR5 HF64 HS14Sp HR8*

Vehicle	Fire Control	Stabilization	Armament	Ammunition
AUF 1/1T	+1	Basic	155mm L/40 Howitzer; AAT-F1 (C) or MAG (C) or M-2HB (C) or NSVT (C)	42x155mm; 2050x7.62mm or 800x.50 or 800x12.7mm
AUF 1TA	+2	Fair (Basic Indirect Fire)	155mm L/52 Howitzer; AAT-F1 (C) or MAG (C) or M-2HB (C) or NSVT (C)	42x155mm; 2050x7.62mm or 800x.50 or 800x12.7mm
AUF 2	+3 (+2 Indirect Fire)	Fair (Basic Indirect Fire)	155mm L/52 Howitzer; AAT-F1 (C) or MAG (C) or M-2HB (C) or NSVT (C)	42x155mm; 2050x7.62mm or 800x.50 or 800x12.7mm

*The AUF 2 has belly armor of AV6Sp, and a roof armor of AV6. IR detection is one level more difficult.

GIAT Caesar

Notes: This is essentially a heavy howitzer put on a medium truck chassis. "Caesar" is actually a common name for the vehicle; the actual name is an acronym (CAESAR – Camion Equipe d'un Systeme d'Artillerie, or "truck equipped with an artillery system"). The Caesar was designed for airmobile and airborne units, as well as for export to countries who do not have the coin for full-sized SP artillery. Users include France, Saudi Arabia (perhaps the largest user of the Caesar), Indonesia, and Thailand; the Danish Army has also adopted the Caesar. The Lebanese received a military grant from the Saudis, and this will over the next few years, give the Lebanese 28 Caesar vehicles. The French have received their order, but are considering another order of 32 Caesars, this time mounted on a Tatra 8x8 chassis (a variant of the T815-7). This version is known as the Caesar 2. (The Caesar Mk 2 is a different vehicle; the primary change is a more heavily-armored cab and a V-hull) The Caesar is also being considered for use by the Australians, and are also being looked at by the Indians. Even the British and the US are considering the Caesar for their light, airmobile, and airborne units. Caesars were used by the French in Afghanistan and Mali, and recently, four Caesars were sent to the new Iraqi Army for use in the battle to take back Mosul from ISIS. The Thais used them in a border skirmish with Cambodia in 2011. Two Saudi systems were sold whole to the country, but the rest of their order of 78 are being assembled in Saudi Arabia. The French have indicated that they are willing to replace the 52-caliber gun with an L/39 gun for export; the vehicle's software is already able to handle the shorter gun. No orders for an L/39-equipped Caesar have been yet made.

Caesar 1

In French service, the Caesar is built on a Renault Sherpa 10 chassis; for Saudi Arabia, a Unimog U-2450L chassis is used. In both cases, the crew rides in the enlarged cab, which comes in armored and non-armored versions. In addition, the armor kit can contain a V-bottom for mine mitigation. Based on the Sherpa, the vehicle has a diesel engine with a power of 240 horsepower and a 6x6 suspension, and an automatic transmission. There are doors on either side of the extended cab, each with bullet-resistant windows. The windshield is likewise bullet-resistant. Based on a Unimog, you have basically the same type and size of vehicle, but the engine is 237 horsepower. The Unimog is a bit longer, but this does not affect vehicle layout, although it is lighter. The vehicle can be air-dropped or delivered by aircraft such as the C-130 or the G.222, or even a heavy-lift helicopter such as the Mi-26 or CH-47.

In either case, the armament of the Caesar is an L/52 155mm howitzer. You pretty much can't miss it when you look at the vehicle; it is exposed on the back of the vehicle (which, in the case of the Sherpa, is extended). The vehicle must deploy four hydraulic jacks, two at the sides of the rear and two at the rear, before firing (this takes 6 phases). A roll-out platform can also be deployed behind the gun, giving the crew a lift off the mud and the gunner a step up to his sights. Traverse for the gun is 15 degrees to either side of center; larger changes in deflection require repositioning of the vehicle. The rear of the gun can be raised, putting into traveling configuration or allowing a depression of 0 degrees for some direct fire shots. (However, ammunition for direct fire shots is not normally carried on the Caesar.) Elevation limit is 60 degrees. Unfortunately, the mounting allows only limited traverse; the Caesar can make a deflection change of only 15 degrees in either direction and otherwise, the crew must reposition the vehicle. There is almost no space on the Caesar for ready-use rounds; the Caesar is dependent on other trucks or vehicles for its ammunition supply. There is room for a 10kW APU.

Fire control is surprisingly advanced for such a vehicle, using the FAST-Hit computerized fire management. (Saudi Caesars use a Thales ATLAS fire control system, which is approximately equivalent to the FAST-Hit.) This system will automatically position the gun for a shot (as much as it can, see above), and will indicate whether the truck needs repositioning and tell the driver which direction to pull into a firing position to get the crew's shots. The Caesar is equipped with a SAGEM 30 GPS/Inertial Navigation system, which provides navigation information on a screen inside the cab. The Caesar also has a French-made BMS, the Thales C4I system; this system is used by most of NATO and Western nations and can be adjusted to work with other types of BMSs. (France is also willing to replace the entire BMS with one more to customer's liking, along with the navigation system and radios.) The Caesar needs no surveyed and calibrated firing positions and targets. The gun has a semiautomatic loading system; the system loads the round into the breech from a magazine and if the fuze is programmable, programs it; otherwise, the crew must set the fuze (on the round at the top of the magazine). The crew must index the amount of propellant charges the magazine loads into the gun, but the magazine loads them. (In a longer bombardment than the Caesar has rounds, the rounds and propellant charges may be fed into the magazine by

hand, while the magazine is feeding the gun; this lowers ROF to (2). All of this is controlled by the TOP (a French acronym for Gun Operation Terminal), which is a fully digital control computer for the Caesar. The gun can be fired from the magazine from within the cab, allowing shoot-and-scoot firing.

The cab has an NBC Overpressure system, though the rest of the vehicle has no NBC protection; crews are reliant upon their own masks and suits. The cab does, however, have a heater and air conditioner. The standard crew for a Caesar is 5; however, a crew of as little as three can operate the howitzer, and crews of as large as six can be carried and used. Armor consists of aluminum panels backed with Kevlar and carbon-fiber. Flexible Kevlar curtains can be raised on the sides of the gun platform, but this is not normally done as crews say they just get in the way. The cabs tend to be squared off, allowing easy installation of armor. The suspension is designed to lower almost to the ground, facilitating work with the howitzer.

Caesar Mk 2

In Saudi and Thai service, the users of the Caesar 1 have elected to go with the Caesar Mk2 standard. This can be supplied as a kit if necessary, and consists of thicker armor for the cab, stiffening panels for the side curtains that incidentally add another level of AV to the side curtain armor; and a bolt-on V-shaped hull. Though the V-shaped hull is not a full MRAP-type hull, it does mitigate some mine and IED damage. In addition, the cab has a hatch above the left-hand rear seat, and in front of the hatch is a pintle mount with a light machinegun. (There is, however, limited ammunition carried as part of the basic load.) The cab is a little longer, adding space behind the rear seat for personal gear and perhaps personal ammunition or ammunition for the top machinegun. Aside from some weight differences, the Caesar Mk 2 is otherwise like the Caesar 1 for game purposes.

Caesar 2

The Caesar 2 (not to be mistaken with the Caesar Mk 2) is the version of the Caesar that the French Army is upgrading to. The Danish have also chosen it as a light artillery vehicle. Currently the Caesar 2 is just beginning its service with France and Denmark; France received their first in 2015 and the Danes in 2017. This version is based on a version Czech of the Tatra T815-7, the T815-7MOR89. This is a large truck chassis capable of better off-road and road performance, and also able to carry much more onboard ammunition, a large, armored cab, a mine-protected hull, and has a high 8x8 suspension. The Caesar 2 can be airlifted by the C-130 or G.222, but no current heavy-lift helicopters can lift the Caesar 2. It is equipped with the same fire control suite as the Caesar, as well as the same side Kevlar panels (Including the back), but has a 15kW APU. It also includes the BMS, and personal accoutrements (such as air conditioning), as well as luxuries such as a refrigerated 40-liter water tank, ration heater, and a sort of HUD for the driver, displaying speed, RPMs, fuel state, distance travelled, and a section at the bottom of the windshield connected to the vehicle's IR headlights and Passive IR mounted in the grill. In addition to French use, the Caesar 2 is being offered on the international market.

The chassis is powered by a Cummins ISMe 420 30 turbocharged diesel engine developing 410 horsepower. The suspension is advanced, with a central tire pneumatic adjustment system and adjustable pneumatic shock absorbers. Not only do the shock absorbers give the Caesar 2 better performance off-road, they can raise or lower the ground clearance. The wheels are suspended individually, allowing each to move independently with the terrain. The gun is mounted at the rear of the vehicle; the center area has ammunition, charge, and fuze stowage, as well as room for equipment and excess personal gear and excess small arms ammunition stowage; it also houses in armored compartments the computer core and modules, including the BMS and GPS/Inertial navigation system along with the mapping module. Two long stabilizers are lowered, one on each side of the vehicle, before firing. The sides of the rear of the vehicle have light cranes, able to lift a pallet of 15 155mm rounds and their charges and fuzes to the height of the midsection of a crewmember standing on the gun next to one of the two magazines (about 900 kilograms).

In addition to the equipment listed above, the cab has an extended section which contains the water tank, ration heater, and two bunks. The cab has four doors with steps leading to each. The hull is a full MRAP hull, including suspended seats for the cab occupants.

Nexter (the company that produces the Caesar 2) has indicated that it is willing to mount the Caesar 2 gun and systems on another vehicle of similar size and cargo capacity, such as some Renault, Sisu, or MAN trucks, for example.

Twilight 2000 Notes: The Caesar 1 was placed into limited production in 1995 for use by French Forces. The Caesar Mk2 and the Caesar 2 do not exist in the *Twilight 2000 v2.2* timeline.

Merc 2000 Notes: This vehicle was viewed by some countries as an inexpensive alternative to heavier tracked guns.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
Caesar (Sherpa Chassis)	\$1,064,766	D, A	181 kg	19.75 tons	5	18	Headlights	Shielded
Caesar (Unimog Chassis)	\$1,064,756	D, A	176 kg	19.65 tons	5	18	Headlights	Shielded
Caesar Mk 2 (Sherpa Chassis)	\$1,083,106	D, A	181 kg	19.76 tons	5	19	Headlights	Shielded
Caesar Mk	\$1,082,030	D, A	176 kg	19.66 tons	5	19	Headlights	Shielded

2 (Unimog Chassis)	Caesar 2	\$1,219,620	D, A	630 kg	28.4 tons	5	20	Passive IR (D)	Shielded
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Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
Caesar (Sherpa Chassis)	109/54	30/15	220	88	Std	W(3)	HF6 HS3 HR3*
Caesar (Unimog Chassis)	108/54	30/15	215	87	Std	W(3)	HF6 HS3 HR3*
Caesar Mk 2 (Sherpa Chassis)	109/54	30/15	220	88	Std	W(3)	HF7 HS4 HR4**
Caesar Mk 2 (Unimog Chassis)	108/54	30/15	215	87	Std	W(3)	HF7 HS4 HR4**
Caesar 2	123/62	34/18	460	151	Std	W(4)	HF9 HS4 HR4***

Vehicle	Fire Control	Stabilization	Armament	Ammunition
Caesar 1	+1	Basic	155mm L/52 Howitzer	18x155mm
Caesar Mk2	+1	Basic	155mm L/52 Howitzer, AAT-F1 or MAG	18x155mm, 500x7.62mm
Caesar 2	+1	Basic	155mm L/52 Howitzer, M2HB	30x155mm, 750x.50

*Hull Armor is the AV for the cab sides, front, and rear; the entire vehicle has a floor armor of 4Sp while the cab roof has an AV of 3. The rear area has an AV of 0, though Kevlar curtains may be erected on a tubular frame to protect the sides. Kevlar curtains, if deployed, have an AV of 2.

** Hull Armor is the AV for the cab sides, front, and rear; the entire vehicle has a floor armor of 4Sp while the cab roof has an AV of 4. The rear area has an AV of 0, though Kevlar curtains and backing may be erected on a tubular frame to protect the sides. Kevlar curtains, if deployed, have an AV of 3. The hull is a semi-MRAP hull, with no antishock seats; see Rules for Vehicles for details.

*** Hull Armor is the AV for the cab sides, front, and rear; the entire vehicle has a floor armor of 6Sp while the cab roof has an AV of 4. The rear area has an AV of 0, though Kevlar curtains and backing may be erected on a tubular frame to protect the sides. Kevlar curtains, if deployed, have an AV of 3. The Caesar 2 has an MRAP hull with antishock seats for the crew in the cab.

GIAT Mk F3

Notes: The Mk F3, or Cn-155-F3-Am in French service (Canon de 155 mm Mle F3 Automoteur) was designed in the early 1950s to replace France's World War 2-vintage M-41 Gorilla SP howitzer. GIAT based the design on the AMX-13 light tank; at the time, it was the smallest 155mm self-propelled howitzer in service, and it looks sort of like a small version of the US M-107 and M-110 howitzers. The Mk F3 is light and has a low RL cost; however, it was criticized for lack of protection for its gun crew. In time, the Mk F3 was used by 10 Middle Eastern and South American countries; orders continued to be brisk, and the Mk F3 was full production and parts production for over 40 years. Over 600 Mk F3s were produced in the period 1962-1997; most post-1970s production was undertaken for export customers. Spare parts are still being produced by Nexter. The Mk F3 is still in active service in some South American countries, and Morocco.

With the Mk F3, what you essentially have is a turretless AMX-13 with the turret ring replaced by a traversing table, the idler wheel removed, and a 155mm howitzer mated to the top of the chassis. The gun is slightly offset to the right of the vehicle, and mounted at the rear of the vehicle. The original gun used was a short L/33 howitzer, but later, export operators had the gun replaced with an L/39 gun. Either gun is capable of a maximum fire rate of three rounds per minute. The original engine was a SOFAM 8Gxb 250-horsepower gas engine, but later this too was replaced by a 280-horsepower turbocharged Detroit Diesel or Baudouin diesel engine. The Mk F3 is not able to swim, but can conduct deep fording, to the point that it has only inches of freeboard available and the glacis has a splashboard to prevent the driver's compartment from being swamped. In order to center the gun's line of fire better, the standard idler wheel of the AMX-13 was removed and the fifth roadwheel acted as the idler wheel. This modification also meant that no hydraulic stabilizers were necessary. The tracks are normally all-steel, but rubber pads may be added in conditions where causing less damage to roads is necessary. The roadwheels are likewise steel, but have rubber rims on them.

The Mk F3 may have a crew of eight, but only two of them ride in the Mk F3. The others ride in one of the vehicles the Mk F3 moves with. The Mk F3 has almost no onboard space for ammunition, and the Mk F3 is usually accompanied by 2-4 AMX-VCA's and AMX-VCI's carrying the rest of the crew, ammunition, and sometimes extra ammunition handlers. Most of these vehicles will also be towing trailers with more ammunition and equipment. A RATAAC artillery radar vehicle is normally also part of the mix. If necessary, the rest of the gun's crew can cluster themselves on the deck of the Mk F3, hanging on to whatever they can find, but the French Army does not recommend this; in addition, they'd have to dodge any rounds or shrapnel that comes their way. The driver is the front left of the vehicle, steering with tillers. The engine is to his right, and behind the driver is the commander's position (with a split hatch

opening to the left and right). He does not have a weapon mount, as it would interfere with the gun crew when they are working; however, he does have an unmounted machinegun to use. The commander and the driver operate the radios, with help from the rest of the crew when the gun is in firing position. The driver has three vision blocks to the front; the center one can be removed and replaced by a night vision block. The commander has three vision blocks (two to the front and one to the left side). One each side of the upper hull are removable stowage lockers, four per side. The only other seat is for the gunner, which he uses when the gun is being fired, and is to the rear and left of the howitzer. Mounted on the hull roof to the front of his position is a loudspeaker, and the front of the vehicle has a winch with a capacity of 18 tons and 400 meters of cable. The cable can be led out the front and the rear. Armor protection is thin, able to stop small arms fire and shrapnel, but not much more. There is no provision to automatically put out fires on the vehicle, and there is nothing like a vehicle collective NBC system; they must rely on fire extinguishers and their own masks and MOPP gear.

Twilight 2000: This vehicle was in heavy use during the Twilight 2000 timeline; by 2000, they could be found in Western Europe, most of South America, and large parts of the Middle East.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
L/33 Gun, Gas Engine	\$144,938	G, A	300 kg	17.41 tons	2 (+6)	13	Image Intensification (D)	Enclosed
L/39 Gun, Gas Engine	\$151,153	G, A	263 kg	17.56 tons	2 (+6)	15	Image Intensification (D)	Enclosed
L/33 Gun, Diesel Engine	\$144,953	D, A	271 kg	17.52 tons	2 (+6)	17	Image Intensification (D)	Enclosed
L/39 Gun, Diesel Engine	\$151,053	D, A	250 kg	17.67 tons	2 (+6)	18	Image Intensification (D)	Enclosed

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor*					
L/33 Gun, Gas Engine	123/86	34/24	450	139	Trtd	T3	TF2	TS2	TR2	HF4	HS2	HR2
L/39 Gun, Gas Engine	132/92	37/26	450	156	Trtd	T3	TF2	TS2	TR2	HF4	HS2	HR2
L/33 Gun, Diesel Engine	132/92	37/26	450	104	Trtd	T3	TF2	TS2	TR2	HF4	HS2	HR2
L/39 Gun, Diesel Engine	131/92	36/26	450	104	Trtd	T3	TF2	TS2	TR2	HF4	HS2	HR2

Vehicle	Fire Control	Stabilization	Armament	Ammunition
L/33 Gun, Either Engine	None	None	155mm L/33 Howitzer	4x155mm
L/39 Gun, Either Engine	None	None	155mm L/39 Howitzer	4x155mm

*The "turret" is actually the howitzer, and the Turret AV does not actually protect anyone.

Rheinmetall M109A3G

Notes: This is an upgraded version of the M109A3 modified for the German Army. The Germans basically took M109A3s which were becoming obsolete, bought them on the cheap, then retooled and updated them so well that they were considered quite modern until the PzH2000 was introduced. M109A3Gs were exported to only one other country (Norway), though some of the technology was exported to other countries using the M109. The M109A3G has essentially become a vehicle more advanced than its parent M109A3.

One of the first things the Germans did with the M109A3 was to replace the gun barrel with a new L/45 barrel, tipped with a state-of-the-art muzzle brake and with an improved fume extractor on the barrel. The barrel is also strengthened so that it does not wear as fast and can go a little more between cleanings during fire missions. This gun was paired with improved fire control, so that it can simply receive instruction data by data-capable radio and have it fed directly into the fire control computer, increasing the speed at which the gun can get into action. Another fire control computer was installed to give the M109A3G a better chance of hitting a target in direct-fire mode. The M109A3G has an autoloader, further quickening the fire rate, along with a two new onboard magazines storing 22 of the gun's capacity of 36, as well as the required fuzes and powder bags for those 22 rounds. The gun has new manual elevating and traversing gears; these are used when fine-tuning one's aim to a more exact solution than one gets from the computer and electric drives. Fire control information are displayed on an LCD screen, with another for the commander that also displays the information from the driver's screen and some information about the state of the vehicle. As with most German vehicles, the commander's weapon has been replaced by an MG-3, and new storage schemes for the machinegun's ammunition allows the M109A3G to carry massive amounts of machinegun ammunition. The turret traversing and actuation machinery are based on that of the Leopard 1 tank rather than the standard M109 mechanisms.

The turret of the M109A3G, like all M109s, has a limited traverse of 30 degrees right or left. The turret houses the commander, gunner, and the two loaders. The turret has large doors in either side, as well as one in the back of the turret (for ammunition resupply; it opens directly on the back of the internal magazine). There is another door in the rear lower hull for crew and equipment entry and for quicker ammunition resupply if necessary. The front right deck ahead of the turret has the driver with a hatch that has vision blocks to the front and right; one may be removed and replaced with a night vision block. The commander has a manually-rotating cupola with all-around vision blocks and an elbow joint that allows him to see through the gunner's scope and night vision gear. The gunner has telescopic direct fire sights, an indirect-fire sight, and some night vision gear. The driver has conventional controls, and the engine is a modified version of the M109A3's engine, one that develops 405 horsepower and is turbocharged, coupled to an automatic transmission. The engine and transmission are combined into a power pack, which can be removed in the field with the appropriate equipment in 30 minutes, and installed in an hour. The M109A3G has had a 5kW APU installed into it to run the vehicle's systems when the engine is off and to conserve fuel. An interesting feature is that all the doors and hatches have locks; another one is that the commander has auxiliary controls that allow him to drive the M109A3G. On each side of the turret, near the top, are a bank of four smoke grenade launchers. The smoke grenades are fired by the commander or gunner electrically. The turret has a ventilation system that forcibly sucks out fumes and propellant particles, simultaneously replacing with fresh air from the outside (and can be turned off in an NBC environment).

A special consideration is the conversion of all mechanical, gun, and computer measurements to metric standards instead of US measurements.

M109A3G w/KUKA AHK

In 1998, the Germans started retrofitting the M109A3G with the KUKA AHK (Ammunition Handling Kit). This called for the addition of a semiautomatic autoloader to the turret of the vehicle, between the magazines at the rear of the turret and the breech of the gun. In addition, the two magazines were split into six, with potentially each magazine being loaded with a different type of magazine. Propellant charges are also autoloaded, according to what's necessary to achieve the required range. However, fuzes must still be affixed and set by the loader. The installation includes a module that takes the information from the fire control computer and selects the required number of charges; the gunner's panel includes buttons to select the magazine(s) to load the gun from. The AHK includes an electrically-driven hoist and an automatic power rammer. The AHK can also continue to fire while fresh rounds and charge bags are being reloaded into the back of the turret. The two loaders standing on the back of the turret during a fire mission to help the rounds from the magazine to the gun are no longer required, reducing the necessary crewmembers. Despite the seemingly large amount of changes, the AHK can be requires only minor modifications to the hull, turret, and electrical system. Stowage boxes for assorted gear have been added to the turret front on either side of the gun and at the hull rear.

The AHK retrofits began in 1998, and 262 retrofits were completed in 2000. The German Army also has an option to buy another 262 AHK units, for converting M109A3Gs currently in storage or for M109A3Gs that are being sold for export (or have already been sold). The retrofitted vehicles the German Army used were phased out in 2007, along with unmodified M109A3Gs, in favor of the PzH2000.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
M109A3G	\$692,530	D, A	500 kg	25 tons	6	17	Headlights	Shielded
M109A3G w/AHK	\$764,725	D, A	500 kg	26 tons	4	17	Headlights	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor					
M109A3G	133/93	37/26	511	150	Trtd	T4	TF8	TS4	TR4	HF10	HS3	HR3
M109A3G w/AHK	129/91	36/25	511	153	Trtd	T4	TF8	TS4	TR4	HF10	HS3	HR3

Fire Control	Stabilization	Armament	Ammunition
+2	Fair	155mm L/45 Howitzer, MG-3 (C)	36x155mm, 10000x7.62mm

Rheinmetall PzH2000

Notes: Perhaps the most advanced mobile artillery system in the world today, the PzH2000 (Panzerhaubitze 2000, or Armored Howitzer 2000) began to replace the M109A3G in German service in 1998, and by 2007, had replaced the last M109A3G in German service. (The M109A3G soldiers on in Norwegian service.)

The PzH2000 evolved out of the former multinational SP70 program, which ended in 1986 after producing only a handful of prototypes, which no one agreed on. The PzH2000 is known for its lack of need for an FDC along with very high shelling rates – as high as 3 rounds in 9 seconds and 10 rounds in 56 seconds. It is also quite adept at MRSI fire missions. Using special experimental rounds, the PzH2000 has been able to shell targets as far away as 60 kilometers. In addition to Germany, the PzH2000 is used by the Netherlands, Lithuania, Greece, Italy, and Qatar; Croatia is also negotiating for the PzH2000, and the US, Finland, Australia, and Sweden have tested the PzH2000, but elected for other designs. The PzH2000 was used in combat in Afghanistan by Germany and the Dutch. The German Army's compliment was originally 154 in active service (reduced from an original request for 450 vehicles), but 31 are now in storage due to the high RL cost of operating the PzH2000. The Italians operate the next largest contingent of PzH2000, with the Italians using 70 which are license-produced by OTO-Melara. The Dutch originally ordered 57 units, but they had put into service only 39, demanding that Rheinmetall upgrade the remaining vehicles before they would accept them, and this has not happened as of March 2018.

The German Navy experimented with mounting the turret of the PzH2000 on F220 frigates (the test ship was the *Hamburg*), but the recoil was found to be too excessive and the weight of the turret too much (the turret alone weighs slightly more than 16.5 tons). F220 frigates were armed with 76mm guns, while the F125 class was armed with a new OTO-Melara 127mm gun.

The PzH2000 is a huge vehicle; this is partially the result of all the electronics, computers, and navigational aids; for the most part, however, it is the result of the sheer amount of ammunition carried, enough to carry on a pretty decent bombardment before the ammo carriers arrive. (Rheinmetall is currently working on a resupply vehicle similar in concept to the US M992.) Down in the guts of the gun and the turret, ammo is not only autoloaded; the proper fuze is selected by the autoloading program and a short, narrow conveyor sends the fuze to the loader responsible for fuze attachment. The autoloader also retrieves the proper round in response to a touch on an LCD panel by the gunner. The LCD is touch-capacitive, so only a bare finger will actuate it. The gun is a Wegmann-designed L/52 155mm howitzer; the elevation limit is +65 degrees, and the depression limit is -2.5 degrees. This gives the PzH2000 a chance at ground targets and direct lay if necessary, and the PzH2000 can actually engage ground targets while moving at about half speed. The PzH2000 is able to use any 155mm NATO-howitzer-compatible round, including Chinese copies and the new US-made Excalibur GPS-guided round. The gun uses a new German-designed modular propellant charge system, designed specifically for use with the PzH2000's autoloader and fire control computers; traditional bagged charges may also be used, but the loaders must load them into the gun by hand and the autoloader cannot handle them, halving fire rate. The turret can revolve 360 degrees and fire from any direction the turret is turned to; the turret covers almost a third of the hull top. The fire control system is capable of self-directed fire, and in response to crew or FDC input, automatically turns the turret and trains the gun to the correct elevation; once the magazine is loaded, only the gunner and assistant gunner are needed if the vehicle is in automatic firing mode. The autoloader is so fast that crews require training because when the gunning is in automatic mode, the assistant gunner and loaders have less than five seconds to get their hands and arms out of the way or they stand a good chance of having them injured. The fire control system includes a laser rangefinder/designator, which is used in direct-lay operations or when engaging vehicles. The chassis is heavy enough that no jacks or supports are necessary when firing, regardless of turret angle. The barrel is chrome-plated and includes an advanced muzzle brake, modified from the M109A3G's muzzle brake. On the glacis is a phased array radar which measures the muzzle velocity of each round as it exists the barrel, to allow the crew to adjust for climatic conditions and wind, as well as barrel droop. The commander's cupola is armed with a medium or light machinegun; one example is given below.

The hull contains the driver on the front left side, behind a splashboard (the PzH2000 cannot swim, but can ford almost completely up to the level of the chassis top). Major components were taken from the Leopard 2; when seen from the side, the PzH2000's Leopard 2 heritage is obvious (though it is elongated by one roadwheel). No less than three long-range secure data-capable radios equip the PzH2000, along with a medium-range and short range secure radios for general communication. To accomplish its self-FDC capability, the PzH2000 has a large amount of computer; these computers also take care of navigational needs, providing maps, data on enemy and friendly positions, and the state of the vehicle. This information gets distributed to the LCD screens of the appropriate crewmember, and controls if necessary. Night vision is copious aboard the PzH2000, especially for the gunner (and the commander through his elbow scope. Power is provided by an MTU 881 Ka-500 turbocharged diesel developing 986 horsepower, a level of power provided or surpassing many modern main battle tanks. The fuel tank is split into three cells, each its own fire/explosion detection and suppression system, and destruction of one cell does not necessarily mean the loss of the other cells. The driver has conventional controls as well as an automatic (with a manual backup). There are also separate fire/explosion detection and

Suppressions for the turret, driver's compartment, engine compartment, and transmission. The gunner is in the turret, with a loader's hatch above him; the loader's hatch also has a manually-rotating cupola, ringed by vision blocks, like the commander's cupola. He does not have night vision devices (though in Afghanistan, many crews added a shielding to the commander's position and a shielded weapons mount to the loader's cupola). The hatches open to the rear, providing a sort of shield to the rear of the commander or loader. Eight smoke grenade launchers are on the PzH2000, four on each side of the turret; they are fired by the commander or loader from a switch panel on their cupolas. The crew has an NBC overpressure system with a collective vehicular backup, as well as an air purifier, air conditioner, and heater. The turret rear as well as the hull rear have large doors to allow crew entry as well as equipment loading; the turret doors open directly into the magazine to allow quicker replenishment of ammunition. Finally, a 10kW APU is installed, running off vehicle fuel, which runs the systems while the engine is off. The PzH2000 is equipped with a full NATO-compatible BMS as well as a vehicle state monitoring system, and another small computer module has every tech manual or bulletin on it as well as an operator's manual. The PzH2000 is NBC protected, right down to the anti-chemical paint.

The PzH2000 is equipped with lugs for ERA on the glacis, side skirts, turret front, turret sides, and the first quarter of the turret roof.

Dutch PzH2000s

The Dutch, in particular, have been critical about the PzH2000's performance, particularly in Afghanistan. They have even mothballed most of their PzH2000s until they can find an answer to the PzH2000's perceived shortcomings. Their criticism generally lies in the PzH2000 and the weather encountered in Afghanistan; the Dutch say that the PzH2000 does not handle dust well, as well as high temperatures and very low temperatures. A particular problem is that Dutch crews occupying a position found they needed to keep the gun barrel (and mind you, this is an L/52 barrel – it's not what you could call short) in the shade, or much of the initial shots of a barrage would be off target. In addition, they found that the gun barrel contracted excessively in very cold conditions, again, initial fire from the gun would be inaccurate. (This could be partially alleviated by applying warming packs or blankets to the barrel for a time before shooting.) They found the need to apply appliqué armor, especially to the turret roof and hull floor. The NBC system, air conditioning system, and heating system were found to be inadequate in the Afghan conditions, as Rheinmetall designed them with Europe in mind and didn't think of where else they might be deployed. The Dutch are also dissatisfied that the PzH2000 is air-transportable by only the very largest cargo aircraft, aircraft that the Dutch don't have in their Air Force. (This is a limitation that stopped the PzH2000 from being chosen by several countries.) Finally, the tracks were very hard on muddy Afghan roads, and their PzH2000s got stuck on more than one occasion.

German PzH2000 Upgrade

In 2013, the Germans retrofitted its PzH2000s with noise-cancellation headphones for the crew, changing the short and medium-range radios for long-range data-capable radios (for a total of four long-range data-capable radios). The radios have automatic countermeasures for MIJI interference. An inertial navigation backup was installed for the land navigation system. Applique armor was added to the hull and turret. Engine modifications give the PzH-2000 somewhat more horsepower, and simplifies maintenance somewhat. Speed-wise, the increased horsepower is largely negated by the increased weight.

Twilight 2000 Notes: Comparable to the US M109A6 Paladin, the PzH2000 was in short supply in the Twilight War.

Merc 2000 Notes: Budget cuts resulted in the PzH2000 production being cut by almost two-thirds.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
PzH2000	\$1,682,226	D, A	500 kg	55.33 tons	5	28	Passive IR (D, G), Image Intensification (G)	Shielded
PzH2000 (Dutch Upgrade)	\$1,714,274	D, A	500 kg	55.96 tons	5	37	Passive IR (D, G), Image Intensification (G)	Shielded
PzH2000 (German Upgrade)	\$1,779,814	D, A	500 kg	55.58 tons	5	34	Passive IR (D, G), Image Intensification (G)	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
PzH2000	142/100	40/28	970	365	Trtd	T6	TF17Sp TS12Sp TR11 HF21Sp HS11Sp HR8*
PzH2000 (Dutch Upgrade)	141/99	39/27	970	369	Trtd	T6	TF20Sp TS15Sp TR11 HF26Sp HS14Sp HR9**
PzH2000 (German Upgrade)	143/100	40/28	970	371	Trtd	T6	TF19Sp TS14Sp TR11 HF25Sp HS13Sp HR8*

Fire Control	Stabilization	Armament	Ammunition
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+2	Fair	155mm Wegmann L/52 howitzer, MG3 or MAG (C)	60x155mm, 2000x7.62mm
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*Most PzH2000s have a hull floor AV of 8Sp, and a roof AV of 6Sp.

**The current Dutch variant of the PzH2000 has a hull floor AV of 9Sp, and a roof AV of 8. However, original Dutch versions of the PzH2000 used in Afghanistan in 2009 or earlier do not have these armor upgrades. These have the same AVs of the standard version of the PzH2000 as well as the other stats.

Rheinmetall AGM-Derived Vehicles

Notes: This entry is more a loose collection of artillery vehicles based on the PzH2000's systems and gun, rather than a specific vehicle and variants of it. The vehicles here are based, more or less depending upon the vehicle, on the PzH2000's systems and gun, but on a smaller, lighter chassis. Though some of these vehicles are still prototypes, demonstrators, or vehicles ready to field-test, KMW is already receiving interest from several countries. This is because they are much less expensive in RL cost, and because they are smaller and lighter (and much more easily transported) than the massive PzH2000.

Artillery Gun Module (AGM)

Actually an acronym for Artillerie Geschutz Module, which means the above) the AGM is, as the name indicates, a gun module which can be fitted to virtually any chassis; the primary version Rheinmetall is using at present is on an M270 MRLS chassis. It can be put on a tracked or wheeled chassis, the latter requiring a heavy truck which is 6x6, 8x8, or 10x10. KMW's literature shows projected mountings on various MBT chassis and heavy MAN and Iveco trucks. Rheinmetall says they are able to tailor the AGM for almost any type of chassis that a country may desire to be made over into an artillery vehicle. The turret module and gun weigh 12.5 tons. The AGM is distantly-related to the MONARC ship-based gun module mentioned above, but of course is also very much different (especially in shape and armor protection).

Artillery Gun Module (AGM)/M270 MLRS

The AGM uses lightweight aluminum armor instead of steel, a smaller crew, and an advanced autoloading system, but the same electronics and gun of the PzH2000. The autoloader is based on the PzH2000's autoloader. The result (at least on the MLRS chassis) is an SP artillery vehicle over one-half the weight and almost one-half the size of the PzH2000. The AGM can be carried in less space on ships, carried on smaller tank transporter vehicles, used on LHC-type hovercrafts, and even air-portable in a wide selection of aircraft operating now and air-droppable. The AGM is armored, and the rest of the vehicle is armored at the same time. (The armor is light, but a little better than similar-sized armored vehicles, especially on top and the floor.) An applique armor kit has been devised. The MLRS-chassis uses a remote gun module that is controlled by the crew inside the cab, similar to the way the MLRS already operates, with the firing and control systems changed to be able to control the gun remotely. The fire control panels are derived from those of the PzH2000, which are themselves almost identical to the standardized NATO fire control systems. The AGM module is in a turret, which can be completely rotated through 360 degrees. The elevation and depression limits are the same as the PzH2000, though the depression is limited to +3 degrees if the turret is rotated to the front. The turret and gun are self-contained, operating by themselves once commands from the crew are given it. The rear of the vehicle has two doors on the front on either side of the gun, allowing the magazines contained in the front of the turret and hull to be replenished, and is fitted with a lifting system fitted to carry the rounds up to the turret and put them into the magazines. The magazines, unfortunately due to the design, cannot be continuously replenished for a long, uninterrupted bombardment. (I have not seen any information that would indicate whether or not the AGM needs stabilizing jacks or spades to fire, though it seems likely that they would be needed for such a light vehicle unless some very advanced recoil buffering is used.)

The AGM is able to use any 155mm NATO-howitzer-compatible round, including Chinese copies and the new US-made Excalibur GPS-guided round. The gun uses a new German-designed modular propellant charge system, the same as on the PzH-2000, with a modified autoloader and fire control computers; traditional bagged charges may also be used, with the new the autoloader able to handle them, but halving fire rate. The turret can revolve 360 degrees and fire from any direction the turret is turned to; the turret covers almost a half of the hull top. The fire control system is capable of self-directed fire, and in response to crew or FDC input, automatically turns the turret and trains the gun to the correct elevation. The autoloader is so fast that crews require training because when the gunning is in automatic mode, the assistant gunner and loaders, if they are in the turret, have less than five seconds to get their hands and arms out of the way or they stand a good chance of having them injured. The fire control system includes a laser rangefinder/designator, which is used in direct-lay operations or when engaging vehicles. The 155mm howitzer is the same as used on the PzH2000, though the breech and its mechanisms are slightly modified to use the new autoloader. The gun is capable of firing up to eight rounds per minute for short bursts, or 2-3 rounds per minute for a normal rate bombardment. The AGM can fire MRSI missions, using up to five rounds for one MRSI salvo. If necessary (usually due to damage to the turret, autoloader, or controls), there is room in the turret for the gunner and assistant gunner to enter the turret and conduct fire missions manually. The gunner and assistant gunner are the only crew needed to operate the gun and turret, whether from the cab controls or inside the turret. There is a door on the back of the turret so that, if necessary, the crew can enter the turret, whether to conduct fire missions manually or to conduct maintenance.

The MLRS chassis is fitted with a new, more powerful engine, giving the AGM excellent speed and maneuverability. The new engine is a Cummins VTA-903T, a turbocharged diesel engine with 550 horsepower. The transmission is fully automatic, and the controls are conventional with a power boost (or functioning without it if damaged). The tracks can also be operated using controls for

pivot steering. Forging up to 1.2 meters can be conducted. The driver has conventional controls as well as an automatic (with a manual backup). There are also separate fire/explosion detection and suppressions for the turret, crew compartment, engine compartment, and transmission. There are currently no smoke grenade launchers, though launchers on either side of the turret may be included in a future update.

The crew is equipped with a full NBC Overpressure suite with a vehicular NBC backup, to which mask hoses can be attached. The crew also has a heater and air conditioner, though again the air conditioner is a compact model that shows up easily on IR/thermal observation. (This is not as obvious as the APU, however, as the exhaust is at the back of the cab between the cab and the turret.) The cab is extended at the rear, housing the computers and electronics (except the fire control panel) and a 30-liter drinking water tank (insulated, though not chilled). This rear area also has room for crew personal equipment, small arms, and ammunition and something like couple of light rockets or a small case of grenades. The AGM is fitted with a compact APU, with 8kW of power, and operating off the vehicle's fuel tanks. The APU is under armor at the rear of the vehicle. (A disadvantage of this APU's compact design is that it runs hotter than most under-armor APUs, and creates a hot spot for IR/thermal detection on the point outside the armor where it is located.) The cab is accessed through armored doors on either side of the cab; the driver is on the left side, the gunner in the middle, and the AG on the right side.

Currently, the AGM is only fitted with night vision equipment in the turret, which may be accessed by the cab through a downlink panel. Projected updates for about 2020 call for a HUD-type display similar to the Caesar 2, HUD display, showing a thermal night vision picture, navigation information, speed, RPMs, fuel, and a few other items reflecting on the windshield. (See French SP Artillery.) Future updates also include a weapon mounted in front on a power-rotating cupola above the AG's position; the weapon may be sighted, aimed, and fired from inside the closed cab through a downlink viewer (though not reloaded, though the AG may link up to three belts together with the mount). The navigation system of this upgrade has an Inertial Positioning backup for the GPS. Four Smoke Grenade launchers are found on either side of the turret.

AGM/Donar

The Donar is a variant of the AGM, using the same turret as the AGM/MLRS, but mounted on the chassis of an ASCOD 2 multiple-use fighting vehicle chassis. It was introduced at Eurosatory in 2008, the same show at which the AGM/MLRS was introduced in 2004. As with the AGM/MLRS, the Donar is being offered for export, though Donar at present (as of Mar 18) exists as a fully-functioning prototype and demonstrator, and ready for field tests. However, the IDF has shown considerable interest in the Donar, and is even participating in its design process and contributing scientist and engineers. They are also supplying military personnel for the field tests. (The Israelis have already stated that if they buy the Donar, they will seek a license for Elbit to produce the design in Israel.) The name, "Donar", refers to the old German pagan god of thunder. For export purposes, especially to Scandinavian and some eastern NATO countries, the name "Thor" is used.

As stated above, the Donar's turret is identical to that of the AGM/MLRS. The crew compartment and remote control panel is also similar to the AGM/MLRS, including downlinked night vision, telescopic vision, and sights. The crew sits in a forward cab, with large bullet-resistant windows to the front (which may be covered with armored shutters, and smaller windows in the doors, which too may be covered with armored shutters. The front shutters have vision blocks within them.

The Donar uses the more powerful MTU 8V-199-TE22 engine used by the Ulan variant of the ASCOD, which develops 720 horsepower. The Donar also has the same compact 8kW generator under armor as the AGM/MLRS above. The turret has an additional piece of night vision equipment, a thermal imager borrowed from the ASCOD and integrated into the Donar's fire control and observation system. The output of the night vision/observation suite of the turret may be fed to a downlinked monitor in front of the gunner's position inside the cab.

For the gun capabilities, see the AGM/MLRS; they are nearly the same, except when the gun is facing forward, it has a depression limit of zero degrees. The crew also benefits from a NBC Overpressure system with vehicular backup, a small air conditioner, a 40-liter insulated drinking water tank, and a heater, inside an extension in the back, where the crew may also put their personal equipment, small arms, and ancillary equipment.

For most other specifics, see the AGM/MLRS above.

The Donar may also benefit from the 2020 upgrades, with the same set as that of the AGM/MLRS. KMW indicates that it is willing to mount the L39 gun on the Donar upon request.

Boxer RCH-155

This version of the AGM is based on the chassis of Boxer APC, new to service and just in the past few years having been sold, topped with the Armored Gun Module turret. This makes the RCH-155 a bit tall and top-heavy, but gives it the mobility on roads of a wheeled vehicle, as well as the less-expensive chassis, transmission, and drive train. As with the AGM MLRS, the gun is contained in a special turret module, having modifications only as necessary to mate it with the Boxer chassis. The modifications are easily done, as the Boxer is designed to take modular turrets and OWSs. The Germans and the Dutch are reportedly interested in the RCH-155, but no orders have been made yet.

In the RCH-155, the crew is seated behind the engine and transmission, with the driver on the right, gunner in the center, and assistant gunner on the left. Each has a hatch to enter and exit the vehicle on the front deck (the crew is in the front of the vehicle, behind the powerpack.) Like the other vehicles in this family, the crew is in a sealed compartment, and have NBC Overpressure protection with a vehicular NBC backup, an air conditioner, a heater, and a space to the rear of the crew compartment, containing room for their personal gear, small arms and ancillary weapons, extra ammunition, and a 40-liter drinking water tanks that is not

refrigerated, but is insulated. The compartment also contains most of the vehicle's electronics, except those that are required to be in the turret to make use of them. The crew, like the other AGM vehicles, has a downlinked control set for the gun and can view through the turret using a monitor that shows the view through the turret's night vision and telescopic sights, as well as its aiming reticule.

The 155mm Wegmann L52 gun is capable of an elevation of +65 degrees, and a depression of -25 degrees, when facing in any direction. It is fed by the same advanced autoloader as the other AGMs, and the magazines are reloaded the same way. The turret has an access door on the back for crew entry, if needed.

The Boxer chassis has steel armor on the outside; however internally it is actually a type of composite armor on some of the surfaces – not as thick as found on tanks, but helpful when hit. The turret, however, is aluminum armor, as is standard for the AGM. However, KMW has been experimenting with mounting MEXAS composite applique, to give the turret armor matching the hull. The hull armor is modular and can be replaced in the field when damaged or by more effective armor. The turret armor requires applique. The shape of the vehicle, especially in the hull, present a reduced radar signature to enemy radar detection and radar crews trying to detect the RCH-155 have a -4 chance. The RCH-155 also has a reduced IR signature and the chance of IR detection is one level harder. The standard 8 kW APU is buried inside the fuselage with only a cooled exhaust pipe and air intake exposed to the outside, so it does not have the increased heat signature of the other members of the AGM family.

The RCH-155 is powered by an uprated version of the Boxer MRAV's MTU 8V199 TE20 turbocharged diesel, developing 804 horsepower and complying with EURO 3 pollution-control standards. (This means little in T2K terms, except that the vehicle smokes much less than most diesel-powered vehicles). The suspension is considerably beefed up, so that spades or blades need not be lowered to fire the howitzer. The RCH-155 is the heaviest of the AGM vehicles developed so far, primarily due to the size of the RCH-155 and the steel layers or armor on the hull; however, the powerful engine mitigates this, and the RCH-155 is quite speedy and maneuverable. It has a central tire inflation system, allowing to cope with problem terrain such as swamps, deep snow, sand, and mud; the vehicle also has antilock brakes and puncture-resistant tires. On the upgraded version, the driver has an actual thermal camera which connects to a flat-panel inside the driver's compartment.

AGMs that are not upgraded with additional armor can be fitted with lugs for ERA on the glacis, hull sides, turret sides, and turret rear.

For other AGM-specific devices, see previous AGM entries and the PZH2000.

Other-Armed AGMs

KMW has indicated that it is willing to replace the L/52 ordnance of the AGM with L39 ordnance; in addition, they are willing to replace the entire gun with a longer-range 105mm gun. The 105mm gun has not yet been announced; I have used a possible 105mm replacement below in the stats. These variants are found at the end of the stats. They use the same electronics as the AGM, with fire control computers adjusted for the new shorter howitzers, and the lesser-caliber gun if necessary.

For mocking up the stats on a 105mm-howitzer-armed AGM, I used the stats of an M119A3/L119A3 Light Gun, and assumed that it is properly modified to be used on in the AGM module. It turns out that, with a little research, that little modification would actually be needed to fit the M119/L119 gun to the AGM, and these modifications would primarily be in the shock-absorption system, the recuperators and recoil/reloading system, and the magazines. (And of course, the removal of the gun trails and axles and wheels and suchlike). The A3 version already has a digital sighting system including a rangefinding laser and a computer to give the gun crew coordinates, so producing an interface with the AGM module shouldn't be too difficult. Of course it does not have the range or throw weight of a 155mm Wegmann L/52 gun, but it does a reasonably-long barrel that gives it decent range. The weight of the gun itself is only 630 kilograms. The gun can be readied to fire in as little as 1-2 minutes (and probably ten times faster on a mobile platform like the AGM series). The six magazines in the AGM's turret hold seven rounds apiece instead of five, due to their smaller size.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
AGM/MLRS	\$998,172	D, A	565 kg	27 tons	3	17	Passive IR (AG, Downlink to Cab), Image Intensification (G, AG, Turret; Downlink to Cab)	Shielded
AGM/MLRS (Upgraded)	\$1,104,619	D, A	418 kg	28.06 tons	3	17	Thermal Imaging (D), Passive IR (AG, Cab), Thermal Imaging, Image Intensification (G, AG, Turret; Downlink to Cab)	Shielded
Donar	\$1,054,278	D, A	645 kg	31.5 tons	3	18	Passive IR (AG, Downlink to Cab), Thermal Imaging, Image Intensification (G, AG, Turret; Downlink to Cab)	Shielded
Donar (Upgraded)	\$1,219,872	D, A	498 kg	32.56 tons	3	19	Thermal Imaging (D), Passive IR (AG, Downlink to Cab), Thermal Imaging, Image Intensification (G, AG, Turret; Downlink to Cab)	Shielded

RCH-155	\$1,086,112	D, A	797 kg	35 tons	3	24	Passive IR (AG, Downlink to Crew), Image Intensification (G, AG, Turret; Downlink to Crew), LLTV Backup Camera (D)	Shielded
RCH-155 (Upgraded)	\$1,221,715	D, A	650 kg	36.17 tons	3	25	Thermal Imaging (D), Passive IR (AG, Downlink to Crew), Thermal Imaging, Image Intensification (G, AG, Turret; Downlink to Crew), LLTV Backup Camera (D)	Shielded
AGM/MLRS (L39 Gun)	\$974,778	D, A	703 kg	26.45 tons	3	17	Passive IR (AG, Downlink to Cab), Image Intensification (G, AG, Turret; Downlink to Cab)	Shielded
AGM/MLRS (Upgrade, L39)	\$1,081,225	D, A	556 kg	27.51 tons	3	17	Thermal Imaging (D), Passive IR (AG, Cab), Thermal Imaging, Image Intensification (G, AG, Turret; Downlink to Cab)	Shielded
Donar (L39 Gun)	\$1,030,884	D, A	783 kg	30.95 tons	3	18	Passive IR (AG, Downlink to Cab), Thermal Imaging, Image Intensification (G, AG, Turret; Downlink to Cab)	Shielded
Donar (Upgraded, L39 Gun)	\$1,196,478	D, A	518 kg	32.01 tons	3	19	Thermal Imaging (D), Passive IR (AG, Downlink to Cab), Thermal Imaging, Image Intensification (G, AG, Turret; Downlink to Cab)	Shielded
RCH-155 (L39 Gun)	\$1,062,718	D, A	935 kg	34.45 tons	3	24	Passive IR (AG, Downlink to Crew), Image Intensification (G, AG, Turret; Downlink to Crew), LLTV Backup Camera (D)	Shielded
RCH-155 (Upgraded, L39 Gun)	\$1,198,321	D, A	670 kg	35.62 tons	3	25	Thermal Imaging (D), Passive IR (AG, Downlink to Crew), Thermal Imaging, Image Intensification (G, AG, Turret; Downlink to Crew), LLTV Backup Camera (D)	Shielded
AGM/MLRS (105mm Gun)	\$780,641	D, A	1.05 tons	24.15 tons	3	15	Passive IR (AG, Downlink to Cab), Image Intensification (G, AG, Turret; Downlink to Cab)	Shielded
AGM/MLRS (105mm Gun, Upgraded)	\$887,088	D, A	903 kg	25.21 tons	3	16	Thermal Imaging (D), Passive IR (AG, Cab), Thermal Imaging, Image Intensification (G, AG, Turret; Downlink to Cab)	Shielded
Donar (105mm Gun)	\$836,747	D, A	1.13 tons	28.65 tons	3	16	Passive IR (AG, Downlink to Cab), Thermal Imaging, Image Intensification (G, AG, Turret; Downlink to Cab)	Shielded
Donar (105mm, Upgraded)	\$943,194	D, A	983 kg	29.71 tons	3	17	Thermal Imaging (D), Passive IR (AG, Downlink to Cab), Thermal Imaging, Image Intensification (G, AG, Turret; Downlink to Cab)	Shielded
RCH-105	\$868,581	D, A	1.28 tons	32.15 tons	3	23	Passive IR (AG, Downlink to Crew), Image Intensification (G, AG, Turret; Downlink to Crew), LLTV Backup Camera (D)	Shielded
RCH-105 (Upgraded)	\$975,028	D, A	1.13 tons	33.21 tons	3	24	Thermal Imaging (D), Passive IR (AG, Downlink to Crew), Thermal Imaging, Image Intensification (G, AG, Turret; Downlink to Crew), LLTV Backup Camera (D)	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
AGM/MLRS	158/111	44/31	617	204	Trtd	T4	TF6 TS4 TR3 HF6 HS4 HR3*

AGM/MLRS (Upgraded)	155/109	43/30	617	212	Trtd	T4	TF10Sp TS7Sp TR4 HF13Sp HS5Sp HR4**
Donar	158/111	44/31	860	267	Trtd	T3	TF6 TS4 TR3 HF17Sp HS10Sp HR7**
Donar (Upgraded)	154/108	43/30	860	276	Trtd	T3	TF10Sp TS7Sp TR4 HF24Sp 11Sp HR8***
RCH-155	177/89	49/25	614	294	Trtd	W(4)	TF6 TS4 TR4 HF25Cp HS15Cp HS8Sp****
RCH-155 (Upgraded)	172/86	48/24	614	304	Trtd	W(4)	TF10Cp TS8Cp TR6Sp HF31Cp HS19Cp HR11Sp*****
AGM/MLRS (L39 Gun)	160/82	40/28	617	202	Trtd	T4	TF6 TS4 TR3 HF6 HS4 HR3*
AGM/MLRS (Upgrade, L39)	157/79	40/28	617	205	Trtd	T4	TF10Sp TS7Sp TR4 HF13Sp HS5Sp HR4**
Donar (L39 Gun)	160/112	45/31	860	264	Trtd	T3	TF6 TS4 TR3 HF17Sp HS10Sp HR7**
Donar (Upgraded, L39 Gun)	158/111	44/31	860	261	Trtd	T3	TF10Sp TS7Sp TR4 HF24Sp 11Sp HR8***
RCH-155 (L39 Gun)	179/90	50/26	614	291	Trtd	W(4)	TF6 TS4 TR4 HF25Cp HS15Cp HS8Sp****
RCH-155 (Upgraded, L39 Gun)	174/87	49/25	614	301	Trtd	W(4)	TF10Cp TS8Cp TR6Sp HF31Cp HS19Cp HR11Sp*****
AGM/MLRS (105mm Gun)	158/111	44/31	617	193	Trtd	T4	TF6 TS4 TR3 HF6 HS4 HR3*
AGM/MLRS (105mm Gun, Upgraded)	155/109	43/30	617	197	Trtd	T4	TF10Sp TS7Sp TR4 HF13Sp HS5Sp HR4**
Donar (105mm Gun)	160/112	45/32	860	264	Trtd	T3	TF6 TS4 TR3 HF17Sp HS10Sp HR7**
Donar (105mm, Upgraded)	156/109	44/31	860	272	Trtd	T3	TF10Sp TS7Sp TR4 HF24Sp 11Sp HR8***
RCH-105	179/90	50/26	614	290	Trtd	W(4)	TF6 TS4 TR4 HF25Cp HS15Cp HS8Sp****
RCH-105 (Upgraded)	174/87	49/24	614	300	Trtd	W(4)	TF10Cp TS8Cp TR6Sp HF31Cp HS19Cp HR11Sp*****

Vehicles	Fire Control	Stabilization	Armament	Ammunition
AGM (MLRS)/Donar	+2	Fair	155mm L/52 Wegmann Howitzer	30x155mm
AGM (MLRS) Upgraded	+2	Fair	155mm L/52 Wegmann Howitzer, MG3 (AG)	30x155mm 2000x7.62mm
Donar (Upgraded)	+3	Fair	155mm L/52 Wegmann Howitzer, MG3 (AG)	30x155mm 2000x7.62mm
RCH-155	+2	Fair	155mm L/52 Wegmann Howitzer	30x155mm
RCH-155 (Upgraded)	+3	Fair	155mm L/52 Wegmann Howitzer, MG3 (AG)	30x155mm 2000x7.62mm
AGM/MLRS (L/39)	+2	Fair	155mm L/39 Howitzer	30x155mm
AGM/MLRS (Upgraded, L39)	+2	Fair	155mm L/39 Howitzer, MG3 (AG)	30x155mm 2000x7.62mm
Donar (L/39 Gun)	+2	Fair	155mm L/39 Howitzer	30x155mm
Donar (Upgraded, L39)	+3	Fair	155mm L/39 Howitzer, MG3 (AG)	30x155mm 2000x7.62mm
RCH-155 (L39)	+2	Fair	155mm L/39 Howitzer	30x155mm

Gun) RCH-155 (Upgrade, L39 Gun)	+3	Fair	155mm L/39 Howitzer, MG3 (AG)	30x155mmm 2000x7.62mm
AGM/MLRS/Donar (105mm Gun)	+2	Fair	105mm L/40 L119A3 Howitzer	42x105mm
Donar (105mm, Upgraded)	+3	Fair	105mm L/40 L119A3 Howitzer, MG3 (AG)	42x105mmm 2000x7.62mm
RCH-105	+2	Fair	105mm L/40 L119A3 Howitzer	42x105mm
RCH-105 (Upgraded)	+3	Fair	105mm L/40 L119A3 Howitzer, MG3 (AG)	30x155mmm 2000x7.62mm

*Floor and roof AVs, for the cab as well as the turret, are AV4Sp for the roof and 6Sp for the floor.

**Roof AV is 5Sp, and floor AV is 7Sp, including the top of the cab and turret.

***Roof AV is 6Sp, and floor AV is 8Sp, including the top of the cab and turret.

****Roof AV is 6Sp, and floor AV is 8Sp, including the top of the hull and turret. The hull roof area in front of the turret but before the glacis, however, has an AV of 15Sp. The rear hull face has an AV of 8Sp, except for the door, which is 5Sp (25% chance of hitting the door from a rear-quartering shot).

*****Roof AV is 7Sp, and floor AV is 9Sp. Including the top of the turret and hull. The hull roof area in front of the turret but before the glacis, however, has an AV of 15Sp. The rear hull face has an AV of 11Sp, except for the door, which is 6Sp (25% chance of hitting the door from a rear-quartering shot).

DRDO/Denel Bhim

Notes: When the Indians began searching for a new self-propelled artillery system, it seemed everyone was in. The South Africans has a G-6 turret on a T-72 hull (which they called the T-6), the Russians had their 2S19 with a 155mm gun, the Germans had their PzH-2000 – the list went on and on, and due to the size and specific requirements of the package, competition was heavy. The South Africans tried again, though, and presented an Arjun chassis topped with their T-5 turret. The Indians, seeing the possibility of being able to build the vehicle in their own country, reacted positively to the design and purchased manufacturing rights and equipment from Denel. The new vehicle was called the Bhim after a hero from Indian folklore (Bhima). This also dealt with the mounds of design work the Indians did on the Arjun; since the Indians decided to go primarily with the T-90S for their tank needs, the Bhim development allowed the Arjun factories to remain open, especially since Arjun production ended in 2008 after a rather abortive run.

Note that the Bhim was ready as early as 1998, but blacklisting of Denel by the Indian government over a bidding scandal delayed manufacture for almost 10 years.

The resulting Bhim does in fact look something like a PzH-2000 or 2S19; this makes sense, since they are all tank chassis with SP howitzer systems atop them in large turrets. The Bhim is essentially as modern an artillery system as any of the first-name SP artillery systems in the world today. Having the T-6 turret, the Bhim is armed with a Denel L/52 155mm howitzer, replete with a full system of electronics and computer controls which unites GPS, mapping, blue/red force tracking, and the ability to function as its own FDC; it is also capable of 5-round MRSI firing. The initial burst is 8 rounds per minute for 3 minutes; an extreme rate burst rate of 3 rounds in 15 seconds, and a sustained rate of 8 rounds per minute. The gun is fed by a "limited capacity" autoloader; 20 rounds may be in the autoloading system at once, though others may be continually fed into the autoloader. Due to the high mountains and cliffs of the Kashmir area, gun elevation design was a prime consideration; Maximum elevation is an astounding +78 degrees, and depression -6 degrees. The turret also has a fast slew rate; if the gun is raised to max elevation, it can turn at 6 revolutions per minute. The turret and gun have 360-degree rotation and fire. The front of the turret on each side has a large door for ingress and egress, and a large door in the rear of the turret and the hull. The Bhim carries a conveyor which is hooked to vehicle power to allow the Bhim to feed from a ground pile, crates, vehicles, etc. (India is considering acquiring or building a dedicated ammunition support vehicle to work with the Bhim.) The gun has a muzzle brake and a fume extractor.

The vehicle, though not heavily-armored by many standards, is well armored for an SP artillery vehicle. Given the current state of affairs with mines and IADs, top and belly armor are strengthened. The Bhim has an NBC overpressure system, with a collective vehicular backup. All over the hull and turret are large equipment boxes for storage of gear and equipment. As stated, the Bhim has a mapping system; interfaced computers onboard join the GPS (with inertial backup), the mapping computer, and fire control computers. They also have a secondary role of reporting on the state of the Bhim.

The hull is a modified form of the Arjun's hull, and has the MTU-838 Ka-501 turbocharged diesel developing 1400 horsepower and coupled to an automatic transmission. Furthermore, a 10kW APU is provided to power the gun when the engine is off, including the conveyor belt (which, if given another power source, can also be powered by that system). Unlike most such systems, the APU is located in the turret on the right side instead of being in the hull. The driver is in the front right hull with the engine to his left; the commander and loader have hatches in the roof of the turret, the commander on the left and the loader on the right. The commander has a manually-operated cupola with all-around vision blocks; the loader merely a hatch. The commander also has a pintle mount, usually used by an Indian-built version of a MAG. On both sides of the turret are banks of four smoke grenade launchers.

Track design posed a special problem for the designers of the Bhim. Himalayan roads can be muddy, rutted, snowy, and slushy. Then again, parts of India resemble trackless deserts. The treads are, therefore, a middle ground between wide tracks and normal or narrow tracks.

Twilight 2000 Notes: This vehicle does not exist in the Twilight 2000 timeline.

Merc 2000 Notes: The Indians decided to buy a modified 2S19 model (with a 155mm gun) from Russia instead of the Bhim.

Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
\$1,895,010	D, A	550 kg	54 tons	4	25	Passive IR (D, G), Image Intensification (G, C)	Shielded

Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor*
172/120	42/30	1610	514	Trtd	T6	TF16Sp TS10 TR8 HF20Sp HS8Sp HR6

Fire Control	Stabilization	Armament	Ammunition
+2	Fair	155mm Denel L/52 howitzer, M-2HB (C)	50x155mm, 2000x7.62mm

*Turret Deck and Hull Deck AV is 4; Hull Floor AV is 6Sp.

DRDO M-46 Catapult

Notes: During the 1990s Indo-Pakistan wars, India had a large number of M-46 130mm field guns that they wished to be more mobile, and a number of Vijayanta tanks that they wished to retire from service. Rather than buy more self-propelled guns from an outside source and junking the Vijayantas, they combined 400 of these weapons into single self-propelled howitzers. These first saw action in Kashmir in 1996. Though it is supposed to be replaced by the Bhim, Bhim production has been slow and the Catapult

soldiers on. The Catapult is also known as the Vijayanta/130mm and Vijayanta/M-46. Some 170 such conversions were done; only about 100 are still operational officially; it's possible that only 20 are still operational.

The vehicle retains the driver's position, but the center of the vehicle has an open area for the gun and crew, with a frame that has a metal roof for overhead protection. This metal roof normally is covered with sandbags or extra pieces of wood or metal, but the sides are open. The Vijayanta is generally modified to serve its new role; the most obvious modification is the addition of a seventh roadwheel to the chassis and the accompanying lengthening of the chassis by a little over half a meter. The overhead roof covers the gun, and the gun extends partially into the former turret of the Vijayanta chassis. The suspension has a unique hydraulic locking system which is used to help absorb recoil when the gun is fired. The ad hoc nature of the chassis means that the gun has a maximum elevation of 45 degrees and a depression of -2.5 degrees. Traverse is extremely limited, as only 12.5 degrees left or right. The gun faces and fires over the rear of the vehicle. The low depression means that the Catapult can function as a tank destroyer if required, and a small number of rounds for such a purpose are generally carried by the Catapult.

The Catapult uses an earlier version of the engine of the Bhim, a turbocharged diesel. The driver is on the front right side with the engine to his left; the rest of the crew are in the hull or in the raised gun section. There are no other weapons except for the gun, and the crew's small arms. Hull armor is actually fairly heavy for such a vehicle, but the armor of the raised section (which is represented by the "turret" section below) is virtually nonexistent. The hull looks almost like a US M-88 Hercules ARV. No other crew amenities or protection are supplied, other than a hot plate and water/ration heater.

Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
\$373,739	D, A	500 kg	40 tons	5	14	Passive IR (D)	Shielded

Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor		
137/96	34/24	1000	284	Std	T6	TF3	TS2*	TR2* HF38 HS13 HR7

Fire Control	Stabilization	Armament	Ammunition
+1	Basic	130mm M-46 Gun/Howitzer	40x130mm

*The "turret" AV ratings are a bit strange for the Catapult. The side and rear ratings are only 50% likely to hit the metal of the superstructure; otherwise, TS and TR are 0. The TF rating is the gun shield and a bit of an extension on each side, but applies in all cases to TF hits. TR, HR, and belly AV are 4.

BMY/IDF M109AL Dohér

Notes: The Israelis have been using the M109 since the early 1970s, starting with essentially unmodified M109A1s and A2s. These are called Rochevs in the Israeli Army. The Israelis have retained these in service for use by training units, but they are no longer in front line use. The Dohér is an upgraded Rochev, introduced in 1993 to active service and in 1997 to reserve forces. (They are still in the process of being replaced by the Dohér in reserve forces; the Rochev has been completely replaced by the Dohér and Sholef in active IDF service.) The Dohér has been brought up to M109A5 levels, and then a bit more. Israel has upgraded at least 429, and possibly as many as 530. Most of the modifications from the M109A5 standard were designed and carried out by IDF depot-level maintenance. The Israelis are also in the process of modifying the Italians' M109s to the Dohér standard.

The Dohér's 155mm howitzer has been lengthened to L/45, along with fire control equipment and computers that allow it to fire within 25 seconds (5 phases) of a halt if the target location is known. The Dohér also has GPS with inertial navigation backup and mapping software for its computers to allow it to work with the minimum amount of information from FIST teams or FDCs. (It is not quite capable of acting as its own FDC, but can react very quickly to FDC instructions and directly from FISTs.) The Dohér has a limited autoloader that reduces the need for handling the heavy shells and powder bags of the 155mm howitzer, though it is not a full autoloader. The travel lock on the Dohér is electrical; formerly, the driver had to guide the weapon into the travel lock and close it, then open the lock again when it reached the fire position. (There is a noticeable box on the underside of the travel lock, which is the electrical motor for the travel lock mechanism.) The commander has a cupola with all-around vision blocks and a weapon mount. Unlike the typical M109, the hatch may be opened and locked in the slit position, giving the commander a modicum of sight without exposing completely to enemy fire. There is a loader's hatch that has a mount for a machinegun, but no cupola or vision blocks. Night vision is added and better direct fire sights and stabilization are provided. On each side of the turret is a cluster of five smoke grenades.

Appliqué armor has been added, and the Dohér has the ability to lay a smoke screen by injecting diesel fuel into its exhaust, a capability the M109 lacks. Another, major upgrade is the integration of counterbattery radar into the vehicle; the Dohér can carry out such counterbattery fire without needing direction from a dedicated counterbattery unit if the enemy battery is within 19 kilometers. The radar is found in a dome on the left front of the turret. The crew has an NBC Overpressure system as well as collective system backup; in addition, an air filtration system has been added to keep firing fumes from building up inside the vehicle, and this can operate even in an NBC environment. The rear of the turret and hull have doors for ammunition replenishment as well as crew entry; doors are also found on each side of the turret. Above the turret doors is a large basket for equipment storage; this basket wraps around partially to each side, though the right side of the basket is occupied with an 8kW APU and an air conditioner. As a result, the left side of the basket extends further along the side of the turret. Also on each side of the turret are two large equipment on the right side and one on the left, and pairs of smaller ones are found attached to the left and right rear of the turret basket. On each side of the turret at the front are two more small baskets; these are normally used for crew equipment and gear. Furthermore, on the rear side on each side of the vehicle are a pair of large equipment boxes. Hydraulic jacks are added to the rear of the vehicle to stabilize it when firing.

The engine is a 440-horsepower 8V71T turbocharged diesel; Israeli versions have been upgraded to an automatic hydropneumatic suspension.

M109I7 Spark Update

Though the Dohér was a significant upgrade to the M109 Rochev, by the early 2000s even more upgrades had been designed in various parts of the West for self-propelled howitzers. The Israelis either licensed some of these upgrades, or developed their own versions (particularly in the area of electronics and digital updates). The result was the M109I7 Spark version of the Dohér, and is primarily a product of IMI with considerable assistance from Rheinmetall of Germany. The update program for the Dohér has been spotty; though the Israelis would like to upgrade most of her Dohérs, the simple fact is that there are newer, more advanced, more capable, less expensive, better-protected, and more fuel-efficient self-propelled howitzers – both Israeli-designed and foreign-designed. Many of these can be easily license-produced by the Israelis, and some are inexpensive enough that the Israelis can buy them outright, lease them, or gain them through foreign aid programs (the latter especially through the US). Therefore, the Dohér upgrade program, which started in 2011, has been very slow, and most likely, will never be more than a minority vehicle in the IDF; probably less than 50 Dohérs have been upgraded to the Spark standard.

The Spark upgrades are largely digital, to the fire control, self-generation of fire coordinates, and improvements for direct fire shots. However, some improvements are externally evident, most notably the new Rheinmetall-designed 52-caliber barrel and a new gun mechanism inside the turret. (The Spark can also be fitted with an L/39 Gun; Israel is not doing this, but the Spark is also presented on the international market as an upgrade for M109s that have an L/39 or shorter gun.) The new barrel also has a large, muzzle brake also of Rheinmetall design, along with a bore evacuator to reduce fumes from the propellant from being back-discharged into the turret. The new gun also has a new, sliding breech and the gun is fed by the AMF autoloader system, similar to the autoloader of the PzH2000. The gun is capable of using programmable and smart rounds, such as Copperhead and the Israeli equivalent of the US Excalibur projectile, called the TopGun round, as well as almost all foreign-designed 155mm rounds and a host of Israeli-designed rounds. The gun, using its new FCS, is capable of fancy fire missions like MRSI fire.

The fire control system is designed largely by Rheinmetall, but tailored to IDF requirements and built using Rafael components. It offers 90% of the PzH2000's capabilities, but technology advances have meant that this fire control system is (supposedly) only 20% the cost of that of the PzH2000's fire control system. (There have been numerous cost overruns.) The FCS, allows the gunner to select the type of round to be fired, which is then fed into the gun by the autoloader from magazines installed in the vehicle; some

special rounds must still be set up by the loader, but programmable rounds and most fuzes are set by the FCS using a radio link. As mentioned, fire missions like MRSI can be fired, as well as automatic barrages set by the gunner; once he sets the round type and length of barrage, the crew need do nothing else other than stay out of the way of the autoloader and gun breech. In barrage mode, three rounds may be fired in 15 seconds, or six rounds in a minute. (The short barrage is normally used to allow the Spark to “shoot and scoot”.) A laser rangefinder and a ballistic computer have been added for direct-fire shots.

The chassis is almost identical to that of the Doher, with only modifications for the new engine and transmission and beefed-up transmission. The engine itself is an Israeli design developing 460 horsepower and offering more torque for difficult terrain driving. A new transmission is also installed to match the capabilities of the new engine. Though most of the recoil of the more powerful gun is handled by the gun mechanism itself, the transmission has also been made stronger to also be able to take up the greater recoil. The Spark has a BMS system integrated with the electronics, as well as a vehicle state system. It has a backup camera for the driver.

Twilight 2000 Notes: The M109L comprised only about 20% of active units in the Twilight 2000 timeline; reserve units did not have any.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
Doher	\$1,084,232	D, A	500 kg	28.2 tons	6	20	Passive IR (D, G, C), Image Intensification (G), Counterbattery Radar	Shielded
Spark (L/52 Gun)	\$1,738,928	D, A	388 kg	29.72 tons	4	24	Passive IR (D, G, C), Image Intensification (G), Counterbattery Radar	Shielded
Spark (L/39 Gun)	\$1,706,875	D, A	422 kg	29.58 tons	4	23	Passive IR (D, G, C), Image Intensification (G), Counterbattery Radar	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
Doher	129/91	36/25	511	162	Trtd	T4	TF11 TS6 TR6 HF14 HS5 HR4
Spark (L/52 Gun)	117/82	32/23	511	170	Trtd	T4	TF11 TS6 TR6 HF14 HS5 HR4
Spark (L/39 Gun)	117/82	32/23	511	169	Trtd	T4	TF11 TS6 TR6 HF14 HS5 HR4

Vehicle	Fire Control	Stabilization	Armament	Ammunition
Doher	+2	Fair	155mm L/45 Howitzer, M-2HB (C), MAG (L)	45x155mm, 500x.50, 2000x7.62mm
Spark (L/52 Gun)	+2	Good	155mm L/52 Howitzer, M-2HB (C), MAG (L)	36x155mm, 1000x.50, 4000x7.62mm
Spark (L/39 Gun)	+2	Good	155mm L/39 Howitzer, M-2HB (C), MAG (L)	36x155mm, 1000x.50, 4000x7.62mm

Soltam M50

Notes: This is another modification of the Sherman (an M4A4, specifically) tank chassis by Israel, this time to carry a French-designed Obusier de Modele 50 155mm howitzer. This vehicle was first introduced in the late 1950s, and was in reserve status by 2000. Most of them never made it outside of Israel's borders during wartime. The layout is similar to the Ambutank, but the rear area is open-topped and taken up by the howitzer and ammunition. These vehicles have been long out of service; most of them were scrapped or turned into range targets by 2010; none were exported.

This is a relatively short-ranged howitzer; the barrel is only L/30. However, this, ironically, allows the M50 top have a secondary role of tank destroyer, though it has no turret and only extremely-limited traverse. The howitzer is mounted at the rear of the open-topped hull. The M50 Howitzer has so many baffles in its muzzle brake it almost looks like a pepperpot brake at first glance. A hydropneumatic recoil dampener takes up most of the shock from the firing of the howitzer. Maximum elevation is +69 degrees, and

depression is about -1 degrees; however, traverse is limited to about 23 degrees to the right or left. The front of the vehicle next to the driver has a travel lock that is engaged and disengaged by the driver or one of the loaders.

The fighting compartment is open-topped and has only a small modicum of armor on the sides and rear (or the front, for that matter). The rear half is built up on the sides, and there are armored doors at the rear. The front half of the superstructure has no frontal armor, and is designed to give the gun crew more room to work.

The driver is in his customary Sherman position on the front left side; due to the mounting of the howitzer and its ammunition carriage, the engine has been relocated to the front of the vehicle, to the right of the driver. Some half of the total amount of ammunition carried is in ready racks. The vehicle commander has a hatch on the left side behind and above the driver; this is a simple cupola, with a weapon mount in the front of him, usually behind an AV2 gun shield. This has been seen with one heavy machinegun, two heavy machineguns, one medium or light machinegun, of two light machineguns. The rest of the crew have foldup seats in the fighting compartment and may engage with small arms if necessary.

Power is by a diesel engine instead of a gasoline engine, developing 460 horsepower, and this is mated to a manual transmission. The M50 was tested with L/33 and L/39 gun barrels, but this did not go beyond one demonstrator model of each version, as it was felt that other, more updated guns were better proceeded with. These versions, however, are included below for general interest, though it must be reiterated that they were never actually production vehicles or used in combat.

Soltam L-33 Ro'em

Notes: The Ro'em (Thunder Maker) may be seen as a later iteration of the M50, as they are both built on M4 Sherman chassis (in the case of the L-33, the M4A3E8), have a superstructure instead of a turret, and numerous details are also the same, most notably the gun-mounting mechanism. However, the L-33 is also very different than the M50, being of an entire later generation, and used far longer into the IDF's history than the M50. The L-33 was designed in the early 1970s as the IDF began to realize that there was not enough SP artillery in the IDF arsenal, there was little time or money to procure other, foreign designs, not enough industry infrastructure then in Israel to design a whole new gun, and that they had plenty of Sherman tanks just begging to be modified. However, while the Ro'em was heavier and a little slower than the M50, the Ro'em has a little more armor and a longer main gun than the M50 (though still a bit stubby, considering the new L/39 gun designs that had become all the rage in the world at that time), and production far exceeded the M50, with the L-33 being used as late as the 1982 Lebanon War.

The gun itself in an L/33-length 155mm howitzer. At the time, it was felt that the new L/39 designs would be too heavy for the Sherman chassis. (However, in the late 1970s, Soltam did experiment with an L/39 gun, and it proved satisfactory, with a marked increase in range. However, conversions of the L/33 version were well underway, and it was felt that it would be too costly to switch at the time, since newer M109 designs were also coming into IDF service at the time of the experiments. Nonetheless, I have included an L/39 version, the L-39, for general interest.) Some 200 conversions were done in total, though they are no longer in active or reserve status, and are now found only in museums, private collectors, an ignoble end as range targets, and I'm sure I saw one near The Whale at NTC in 1987!) The main gun has an elevation limit of 52 degrees and a depression limit of -4 degrees; it *is* capable of direct fire engagements, but it is not really set up for those. Without a turret, traverse is limited to 30 degrees to the left or right of front center. Ammunition supply is copious, with 60 rounds total being carried, with 16 in the ready-use position. There are enough crewmembers to keep the ready-use ammunition replenished, however. The L/33 howitzer has the ability to fire all types of Western, US, European, or South Korean "standard" 155mm ammunition, but it cannot use more modern types such as rocket-assisted, base-bleed, extended-range, and other more modern types of rounds. (It is, however, capable of firing a Copperhead CLGP round, provided that someone is in the area of the target to guide the round.) When traveling, the barrel is kept in a barrel lock that is manually-positioned by the crew. The gun has a pneumatic lifting/loading mechanism, a semiautomatic breech block, and a flick rammer, all of which allow for higher rates of fire than one would anticipate for such a seemingly-simple vehicle. In addition, the gun is tipped by a large double-baffle tank-type muzzle brake and a bore extractor on the barrel.

The driver is at the front left of the vehicle, with the rest of the crew inside the partially-closed-topped superstructure in back. Each has a simple fold-down seat. On each side of the superstructure is a large door with a vision block in it for crew access. At the front right, a medium machinegun was positioned on a pintle mount. There are no smoke projectors onboard. Transmission is manual and controls are by laterals and a gas, brake, and clutch pedal. The driver has three large bullet-resistant windows to his front and sides, and his position is on a raised cupola-like area on the left front. The commander is in the right front on a raised platform, and a double hatch above his position, which has overhead armor.

The engine is the same as on the M50, a Cummins VTA-903 V8 diesel developing 460 horsepower.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
M50	\$440,732	D, A	500 kg	31 tons	6	25	Headlights	Enclosed
M50 (L/33 Gun)	\$449,282	D, A	499 kg	31.03 kg	6	25	Headlights	Enclosed
M50 (L/39 Gun)	\$465,382	D, A	498 kg	31.09 kg	6	25	Headlights	Enclosed
L-33	\$540,481	D, A	552 kg	41.5 tons	8	27	Headlights	Enclosed
L-39	\$568,361	D, A	536 kg	41.56 tons	8	27	Headlights	Enclosed

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
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M50	126/88	35/24	820	171	Std	T5	HF9* HS4 HR3
M50 (L/33 Gun)	126/88	35/24	820	171	Std	T5	HF9* HS4 HR3
M50 (L/39 Gun)	126/88	35/24	820	171	Std	T5	HF9* HS4 HR3
L33	104/73	29/20	636	171	Std	T5	HF11 HS5 HR4**
L33	104/73	29/20	636	171	Std	T5	HF11 HS5 HR4**

Vehicle	Fire Control	Stabilization	Armament	Ammunition
M50	None	None	155mm L/30 Howitzer, 2xMAG or 2xM-2HB or M1919A4 (C)	47x155mm, 2000x7.62mm or 2000x.30-06 or 1000x.50
M50 (L/33 Gun)	None	None	155mm L/33 M68 Howitzer, 2xMAG or 2xM-2HB or M1919A4 (C)	47x155mm, 2000x7.62mm or 2000x.30-06 or 1000x.50
M50 (L/39 Gun)	None	None	155mm L/39 M71 Howitzer, 2xMAG or 2xM-2HB or M1919A4 (C)	47x155mm, 2000x7.62mm or 2000x.30-06 or 1000x.50
L-33	+1	Basic	155mm L/33 M68 Howitzer, M1919A4 (C)	60x155mm, 1000x.30-06
L-39	+1	Basic	155mm L/33 M71 Howitzer, M1919A4 (C)	

* The front of the superstructure has no armor and is AV0. The glacis and bottom of the front are what's AV9. Enemy gunners have a 30% chance of front shots going through the gap in armor.

**The front of the L-33 also has a gap in its superstructure's frontal armor – it's about three times as wide as the gun projecting out of the opening. (This allows for traversing the gun.) Unfortunately, this leaves it vulnerable to some frontal hits; enemy gunners have a 15% chance to hit this gap, hitting AV0 and the warhead probably exploding inside the superstructure.

The roof armor of the L-33 also has a gap – the front third of the superstructure is open, to allow for elevation of the gun and give the crew a little more working room. Roof armor hits have a 25% chance of hitting AV0 and going directly inside the superstructure.

Soltam M72

Notes: Since the conversion of a Sherman into a self-propelled howitzer has met with unanticipated success, the IDF approached Soltam with a proposition to convert some its older or more battered Centurion tanks into self-propelled howitzers. These were to be approximately equivalent to the Sherman-based Ro'em. In 1986, Israel converted some of its older Centurion (Mk 5) tanks to carry a turret mounting a 155mm howitzer. There were only a few of these conversions, however, as a decision was made to concentrate on the development of a new SP howitzer, the Sholef (q.v.). Those that were converted were placed in reserve status, becoming museum pieces (if they were lucky) or range targets.

As stated, these vehicles had the same basic role as the Ro'em, carrying 155mm howitzers and having basic equipment for their missions. The gun on the M72, however, was in a turret instead of simply a built-up superstructure (the turret was kind of large, however). Two designs of guns were tested, differing primarily in barrel length. Some extra gear, such as data-capable secure radios, a connection between one of the long-range radios and the indirect fire ballistic computer, a dock for a laptop, and a viewer that could display the maps of the likely engagement area, and then a little overrun (lessening the need for paper maps).

The new turret is of all-welded RHA steel armor; this turret forms the primary fighting compartment and houses the commander, gunner, and two loaders. The guns were updated versions of the same as on the Ro'em, 155mm L/33 and L/39 howitzers. The L/33 was on the prototype, but the M72 was envisioned to be produced with an L/39 gun, once full production took place. The prototype also had a weapon mount for the loader, which was eliminated on the production version. The prototype also had a large suite of night vision equipment, again much of which was removed from the production version. The turret allows for reasonably precise hydraulic control and very fine final positioning under a special fine manual control. The production version added a gyrocompass and a transponder. The gun has a maximum elevation of +65 degrees and depression of -3 degrees. Unusually, the travel lock for the gun barrel is on the rear of the hull and travel configuration is with the gun over the rear deck. The travel lock is electrical and no crew member needs to manually actuate the travel lock.

Secondary armament consists of a heavy machinegun for the commander, and a lighter weapon for the AA machinegunner (who is normally one of the loaders). In addition, a cluster of five smoke grenade launchers is found on each side of the turret.

Armor is pretty decent for a vehicle of its type, and the turret has a door on each side for crew and equipment entry. As the forward part of the each side of the turret are ports for small arms. The crew has the protection of an NBC overpressure system with a collective NBC backup. They are also protected by ballistic nylon antispall blankets around the turret and turret basket, as well as around the driver's compartment. The driver's hatch is in the center front of the vehicle and has wide-angle vision blocks to his front, with one turned halfway to the right and one turned halfway to the left. The center block can be viewed using a night vision channel.

A weakness of the M72 was the engine it inherited from the Centurion Mk 5; it has a Rolls Royce Mk IVB 650-horsepower engine, which was fired by gasoline instead of what most armored vehicles at that time used, which was diesel, and was not really suited for what was a heavy vehicle at the time. This gave the M72 high fuel consumption. Most likely, had development continued, it would have received a diesel engine. The M72 did, however, benefit from the Centurion's large fuel tanks, giving it decent range despite the high fuel consumption. The M72 also inherited a powerful 15 kW APU from the Centurion Mk 5; this also used gasoline and ran off the vehicle's own fuel supply. The driver also inherited the Centurion's balky transmission.

In the end, the M72 program was halted in favor of the acquisition of updated versions of the M109 and new vehicle development

such as the Sholef and the Rascal.

Twilight 2000 Notes: Some 50 of these conversions were undertaken before and during the Twilight War, showing the value on which the IDF placed on artillery and the need for much of it.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
M72 (L/33)	\$865,715	G, A	500 kg	45 tons	5	26	Passive IR (D, C, G). Image Intensification (G, C)	Shielded
M72 (L/39)	\$956,831	G, A	500 kg	45.25 tons	5	23	Passive IR (D, C), Image Intensification (G)	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
M72 (L/33)	111/78	31/22	1037	361	Trtd	T6	TF16 TS12 TR8 HF20 HS10 HR6
M72 (L/39)	111/77	31/22	1037	361	Trtd	T6	TF16 TS12 TR8 HF20 HS10 HR6

Vehicle	Fire Control	Stabilization	Armament	Ammunition
M72 (L/33)	+2	Basic	155mm L/33 M68 Howitzer, M-2HB (C), MAG (L)	60x155mm, 800x.50, 4250x7.62mm
M72 (L/39)	+2	Basic	155mm L/39 M71 Howitzer, M-2HB (C)	60x155mm, 1400x.50

Soltam ATMOS 2000 (SPWH 2052)

Notes: The ATMOS 2000 (Autonomous Truck-MOunted howitzer System) is a modified Rascal gun module mounted on a heavy truck. (The IDF official designation is the SPWH 2052, but IDF troops still refer to it as an "ATMOS".) The truck chassis itself is a modified Czech Tatra T815 VVN heavy truck, which itself is license-produced in India. The ATMOS 2000 has all the latest artillery technology on a platform that is much lighter and less expensive than the Sholef. Israel is marketing the ATMOS 2000 hard, with at least a dozen countries being interested; the IDF already plans to replace at least part of its Doher force with the ATMOS 2000, and started doing so in 2017. There are six foreign operators of the ATMOS 2000, and in 2019, Poland plans to start license-production of the ATMOS 2000. India is currently evaluating the ATMOS 2000 for their uses (though, doesn't it seem that the Indians have been evaluating self-propelled howitzer designs for about the past 20 years now, rejecting almost all candidates...) Such light wheeled truck-chassis-based howitzers are much lighter, cheaper, easier to maintain, and easier on roads than most tracked-chassis howitzers, and can travel much faster on roads and other hard or level surfaces. They do not require tank transporters to help them travel quickly and economically. Of course, the downside is the almost complete lack of armor protection for the gun crew and the ammunition store.

As stated above, the gun module is based on that of the Rascal. The "Rascal portion" of the chassis is enlarged over the Rascal; it is designed to carry more onboard ammunition, the fighting crew during fire missions, and the crew's personal gear and rations inside of the fighting compartment. The main gun is a Soltam-designed 155mm L/39, L/45 or L/52 howitzer, and can fire any 155mm ammunition in the world. As an option, the truck chassis may be fitted with a Russian M-46 130mm gun, including appropriate ammunition racks, and computers programmed with appropriate software and information for the M-46 gun. Soltam has indicated that it will install the gun module on a suitable truck of the customer's choice, or mount other types of ordnance upon request.

Before firing, hydraulic spades must be lowered at the rear. The ATMOS 2000 has the necessary equipment to act as its own FDC, and the equivalent of Blue/Red Force Tracker technology. The fire control suite includes a GPS, a mapping system and display, advanced IF fire control, direct fire control, and an artillery ballistic computer, all integrated into the ATMOS 2000's communications system. It is in fact a modification/update of the Sholef's fire control package, able to autonomously use even FO data from UAVs and UGVs, or stationary autonomous observation equipment. When pulling into a fire position, the ATMOS 2000's systems automatically use the GPS or inertial navigation system to obtain a position and that of the target, calculates fire coordinates, and, if switched on, automatically loads a round of ammunition of the crew's choice. The fire control system also indexes the first target and moves the gun to the correct elevation and traverse once a halt has been made and the spades lowered. The autoloader is derivative of the Sholef's, requiring only 2 men to operate, and even attaching the fuzes to the rounds (chosen by the crew, of course). The ATMOS 2000 is capable of direct fire in emergencies. 32 "normal" 155mm rounds are carried near the gun on either side, a further eight rounds, normally of special types of ammunition, are contained in bins a little further from the gun, as are charges and fuzes. The gun has an elevation range of 0-70 degrees, and a traverse of 25 degrees in either direction.

The ATMOS 2000 has a partially-automatic autoloading system; this autoloader can access the three rounds furthest to the rear on each side, and otherwise acts as a semiautomatic autoloader, with the loaders hand-loading the autoloader, which inserts the round and charges into the breech, rams them, then closes the breech. Nonetheless, it is not as quick on the draw as a more complicated howitzers, requiring 1.5 minutes for first round outgoing and a sustained rate of fire of only three rounds per 20 seconds (though the fire rate can be increased to 3 per 16 seconds for a length of time equal to the sum of the loaders' constitutions divided by four). The

loader and loader/driver are on the rear of the truck with the gun during fire missions; the commander and gunner stay in the cab, firing and monitoring the gun via LCD panels and controls in the cab. They communicate with the rest of the gun crew via intercom headphones and by an LCD panel that displays the current fire mission and the state of the gun, as well as information on the target.

Above the commander's position is a hatch with a manually-rotating cupola and all-around vision blocks, and a weapons mount. All four crewmembers man the gun during fire missions, and ride in the cab during movement; there is room for three crewmembers to sleep inside the cab if necessary, or as an alternative, two more crewmembers or passengers. Only one crewmember is required to fire the gun; however, the crew includes a loader and the driver doubles as a loader. MRSI missions of five rounds are also possible. The commander doubles as an assistant gunner. The ATMOS 2000 has C3 technology which have displays in the fighting compartment and in the cab, for use by the gunner, commander, and driver, which provides as necessary the state of the vehicle, gun, ammunition, fuel, and any possible damage or malfunction. The crew has NBC overpressure in the cab and collective NBC for the fighting compartment and for emergencies in the cab. The cab has air conditioning and heating and a ration heater for up to four ration packs at once, or it can simply heat water.

Being a being a modification of the Tatra T815 VVN, the chassis has some abilities that the standard Tatra vehicle does not have. The vehicle's suspension is 6x6, and can run at $\frac{3}{4}$ speed with the two center wheels shot out. However, the chassis has run-flat, puncture resistant tires. Power is provided by a turbocharged 315 horsepower V-12 diesel engine; the powerpack is unitary and can be pulled and installed in one operation. A 10kW APU allows the vehicle to operate for a time without the engine on; priority for the APU's power is given to the gun's autoloading system. The tires are heavy-lugged and designed for use off-road; the wheels have independent suspension. An extended exhaust pipe and modified air intake gear means that the ATMOS 2000 can ford up to 1.4 meters deep (but cannot swim). The ATMOS 2000 can be air-transported by C-130 or G.222 aircraft, or even airdropped.

The vehicle has armored plates and lockers in the sides of the vehicle that extend up to the head level of the working crew; this armor and lockers only extend halfway from the rear of the vehicle. The rear has an armored tailgate that protects from rear-quarter small arms shots and shell splinters, but rises only to the abdomen level of the working crew.

ATROM

The Romanians use a version of the ATMOS gun system – their version uses the same gun module and basic setup in the rear, but the base chassis is instead a Romanian-designed ROMAN 26.360 DFAEG 6x6 truck chassis. The Romanian truck is also modified in a manner similar to the modifications carried out to the ATMOS 2000's Tatra truck chassis. Procurement and mass production are currently on hold due to budgetary difficulties, but the Romanians insist that they do intend to produce the ATROM for their Army. The ATROM uses an L/52 gun as standard, but as the ROMAN truck is a somewhat smaller truck, the ATROM carries only 32 rounds of ready ammunition. Engine power, however, is much higher, as the type of ROMAN truck chassis used has a MAN 2866 LF 24 360-horsepower turbocharged diesel. It is a 6x6 truck, and except for its shorter length, looks very similar to the chassis of the ATMOS 2000. Due to its shorter length, it is a little lighter than it's ATMOS 2000 counterpart; combined with a high-output engine, this makes the ATROM quick on its feet (or rather, tires) and the ATROM can drive at a pretty good clip, especially on roads or hard-packed surfaces. As stated, the ROMAN chassis is modified similar to the ATMOS 2000's Tatra platform, with an extended exhaust pipe and intake, it has run-flat, puncture-resistant tires, and the ATROM can run with the center tires shot out at $\frac{3}{4}$ normal speed. The ATROM uses a crew of five instead of four, with the extra crewmember being an assistant gunner who, when the gun is firing, is stationed at the gun (with the actual gunner in the cab). The ROMAN truck has a large armored windshield and side windows that provide protection equal to the armor, and these may be covered by steel shutters with vision slits in them; when these are in place, the windows have 1 more point of armor, with 1/3 of frontal shots and 1/10 of side shots hiding the shuttered windows.

Thai ATMOS 2000 (Jajaki)

The Thai iteration of the ATMOS 2000 is a little different from the standard ATMOS 2000. First, the cab is more heavily-armored than the standard ATMOS 2000; from the front, in some circumstances, it is capable of stopping .50 BMG and 12.7mm Russian rounds. The Thai Army's and Marine's standard barrel length for their ATMOS 2000s is L/39. These systems are license-produced in Thailand. The Thais call their version of the ATMOS 2000 the Jajaki. As the standard gun on their versions is an L/39, the vehicle is a little lighter than the standard L/52-equipped ATMOS 2000, though heavier than a standard ATMOS 2000 equipped with an L/39 gun.

Kryl

Poland will begin producing this version of the ATMOS gun system under license by HSW in 2019, with first fielding taking place in 2020. Trials have been underway since early 2015. It is intended to eventually replace the 2S1 Gvosdika tracked self-propelled 152mm howitzer, and the Dana 152mm wheeled SP howitzer. Both of these systems are out of date and showing their age; in addition, the Polish Army want at least some lighter howitzer vehicles for use on the country roads that crisscross Poland's farmland and small country towns. It is being adopted instead of the Polish-designed Krab SP 155mm howitzer, which is also a much-heavier tracked howitzer system with less comprehensive fire control systems. (8 Krabs, however, are in use by the Polish Army as of the time I write this (late May 2018), though further deliveries have been greatly curtailed.) The Polish intend to eventually have 170 Kryl systems. The Kryl uses a Jelcz 663.32 6x6 truck as a base chassis, with an MTU 6R106TD21 320-horsepower turbocharged diesel mated to an automatic transmission, with power-assisted controls for the driver. The engine has been moved forward on the chassis, allowing the Poles to lower the overall height of the vehicle (it is normally under the cab). Like the ATROM, the Kryl uses a crew of five. The Jelcz truck has the improvements of the ATMOS 2000 chassis: an extended exhaust pipe and intake, run-flat, puncture-resistant tires, and the ability to drive at $\frac{3}{4}$ speed with the center tires shot out. It also has a central tire inflation system, giving it a bit

more mobility off-road. The Jelcz truck is much smaller, and there is pace for only 18 ready-use rounds, though a total of 30 rounds may be carried, with the other rounds being kept in their shipping crates. The main gun has a much higher depression limit of 15 degrees when facing forward, though the elevation limit remains 70 degrees, and traverse is somewhat improved at 37.5 degrees in either direction. This means that the Kryl is not capable of direct fire if the gun is facing with a traverse of less than 5 degrees in either direction of front. The Kryl uses L/52 ordnance. Despite the use of a smaller truck, the Kryl is heavier than the other ATMOS 2000 variants; this is primarily due to heavier armor on the cab and ready-use ammunition bins, though it is also because the Jelcz truck chassis is simply heavier than most trucks of the same class. The Kryl prototypes have gun modules built in Israel and truck chassis built in Poland; however, in serial production, the gun module will also be built in Poland under license by HSW.

Twilight 2000 Notes: Not available in the T2K timeline,

Twilight 2013 Notes: Accelerated development and production makes this vehicle available in small numbers in a T2K13 timeline, though only in the ATMOS 2000 L/39, ATMOS 2000 L/52 and Jajaki versions. The ATMOS 2000 L/45, ATROM, and Kryl are not available in the T2K13 timeline.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological**
ATMOS 2000 L/39 Gun	\$1,291,542	D, A	1.15 tons	21.94 tons	4-6	16	Passive IR (D)	Shielded
ATMOS 2000 L/45 Gun	\$1,306,615	D, A	1.13 tons	22 tons	4-6	16	Passive IR (D)	Shielded
ATMOS 2000 L/52 Gun	\$1,330,983	D, A	1.06 tons	22.3 tons	4-6	16	Passive IR (D)	Shielded
ATMOS 2000 130mm Gun	\$1,121,696	D, A	1.16 tons	21.91 tons	4-6	13	Passive IR (D)	Shielded
ATROM	\$1,208,445	D, A	1.17 tons	22 tons	5	18	Passive IR (D)	Shielded
Jajaki	\$1,243,880	D, A	985 kg	22 tons	4-6	19	Image Intensification (D), Backup LLTV (D)	Shielded
Kryl	\$1,197,475	D, A	880 kg	23 tons	5	17	Image Intensification (D), Backup LLTV (D)	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
ATMOS 2000 L/39 Gun	136/64	41/19	460	118	Std	T5	HF3 HS2 HR2*
ATMOS 2000 L/45 Gun	136/64	41/19	460	118	Std	T5	HF3 HS2 HR2*
ATMOS 2000 L/52 Gun	136/64	41/19	460	118	Std	T5	HF3 HS2 HR2*
ATMOS 2000 130mm Gun	136/64	41/19	460	118	Std	T5	HF3 HS2 HR2*
ATROM	146/69	44/20	455	134	Std	T5	HF3 HS2 HR2*
Jajaki	136/64	41/19	460	118	Std	T5	HF6 HS4 HR4***
Kryl	131/64	36/18	480	118	Std	T4	HF4 HS3 HR3****

Vehicle	Fire Control	Stabilization	Armament	Ammunition
ATMOS 2000 L/39 Gun	+2	Fair	155mm Soltam L/39 Howitzer, MAG (C)	40x155mm, 2000x7.62mm
ATMOS 2000 L/45 Gun	+2	Fair	155mm Soltam L/45 Howitzer, MAG (C)	40x155mm, 2000x7.62mm
ATMOS 2000 L/52 Gun	+2	Fair	155mm Soltam L/52 Howitzer, MAG (C)	40x155mm, 2000x7.62mm
ATMOS	+2	Fair	130mm M-46 L/52 Gun/Howitzer, PKM	40x130mm, 2000x7.62mm

2000			(C)	
130mm Gun				
ATROM	+2	Fair	155mm Soltam L/52 Howitzer, PKM (C)	32x155mm, 2000x7.62mm
Jajaki	+2	Fair	155mm Soltam L/39 Howitzer, M-60D	40x155mm, 2000x7.62mm
			(C)	
Kryl	+2	Fair	155mm Soltam L/52 Howitzer, UKM-2000 (C)	30x155mm, 2000x7.62mm

*Hull armor on the ATMOS 2000 and ATROM is a bit complicated. The armor figures listed above are largely for the vehicle's cab. The fighting compartment is open, and therefore offers little protection; however, the rear half of the vehicle, where the ammunition is stored, is contained within AV2 lockers that can also protect the crew if they crouch behind it, or offer some protection when returning fire with their small arms. The cab's roof has AV4, as does the floor; in fact, the floor of the entire vehicle has an AV of 4Sp.

**The Radiological protection listed above is for the cab only. The Radiological rating in the fighting compartment is "Open."

***Hull armor layout on the Jajaki is similar to that of the ATMOS 2000 and ATROM, except that the cab roof has AV5, the floor of the entire vehicle is AV6Sp, and the armored ready-ammo lockers have AV3.

****Hull Armor layout on the Kryl is similar to the ATMOS 2000 and ATROM, except that the cab roof has AV5, the floor of the entire vehicle has AV5Sp, and the armored ready-ammo lockers have AV3.

DRDO Mobile Gun System (MGS)

Notes: After nearly ten years of scandal involving Bofors illegally underbidding other companies' designs, the Indians have finally chosen an Indian-modified and manufactured version of the Bofors FH77 field howitzer, called the Dhanush. They also, however, wished that at least some of the Dhanush's be self-propelled, but still light in weight, so that one could be delivered slung from a heavy-lift helicopter or more from their new C-17 aircraft. To this end, they have paired the Dhanush with a Tatra T815-7MOR89 8x8 truck, with an armored cab and armored sides. (Again, this truck will be license-produced in India.) This system was first unveiled as Defexpo in April of 2018, is only initial field testing, but is also available for export. It is similar to other such systems now making the rounds of the world export market. This system is the fifth self-propelled artillery system that the Indians have "officially" adopted in the 20 years since the Indians issued their initial requirements for a new SP howitzer system.

The MGS uses an FH77 with an 155mm L/45 gun, heavily-modified for use on a truck chassis. The gun fires from a cupola on the rear of the truck that is able to traverse up to 25 degrees in either direction, and is capable of elevation of +75 degrees and depression of -2 degrees. The gun has a fire control suite based on that of the Bhim, including the GPS/mapping solution/blue/red force tracking of the Bhim. It therefore can function as its own FDC, though it takes about five minutes to get the howitzer in firing position after a half, and three minutes to go back to traveling order after the last shot is fired. This includes lowering and raising of stabilizing jacks at the rear of the chassis. The Dhanush fires from a small tray-shaped autoloader, capable of holding five rounds – half of the rest are on the cupola, and the other half are carried on the remaining truck bed. The gun can fire its five rounds rapidly in a MRSI burst, or in a spread burst; it can also fire three rounds in 30 seconds from the autoloader or one round within 5 seconds of setup, then shoot and shoot or conduct more fire missions. The autoloader takes 7 minutes to fill (with standard-type ammo), and in addition special rounds like CLGP-type rounds or HEAT rounds or other special rounds that do not fit in the autoloader or are not normally used in a fire mission may be fed directly into the breech of the Dhanush, and may be fired at the rate of one round per three minutes.

The Dhanush itself is a modified FH77; modifications include those necessary to fire Indian-made ammunition, a wider muzzle brake (initial FH-77s had a problem with rounds striking the muzzle brake when firing Indian-made ammo), and modifications to facilitate manufacture in DRDO facilities.

As the MGS can carry only 23 rounds onboard, the vehicle will likely have to be followed by one or more ammunition-carrying vehicles if a long bombardment is called for.

As stated above, the Tatra truck is modified by adding a modicum of armor and a cupola for the gun and gunner on the rear of the vehicle. The cupola is on the rear of the truck, and overhangs the rear edge by one-third of the way. Though the truck normally carries a load of 23 shells, the unused portion of the rear of the truck can carry some 6 shells, fuzes, and charges in their packing crates, assuming other large cargoes are not carried. The cab carries the crew for the gun, including the driver, commander, gunner, and loader, with the gunner and loader going back to the rear of the vehicle when firing the gun.

The Tatra T815-7MOR89 chassis has a 410-horsepower Cummins ISMe 420 30 turbodiesel engine. In addition, a compact 10kW APU is mounted on the cupola near the front for use when the engine is turned off or emergency power is needed. The truck is Czech-designed, but license-produced in India, except for the first 5 chassis, which will be used as "trainer" vehicles. This version of the T815 has simplified maintenance and operation over earlier T815s, including a unitary powerpack, automatic transmission, power steering and brakes (with backups), and antilock brakes. The tires are not only run-flat tires, but are puncture-resistant. The cab is extended to carry the enlarged crew and the mission computers, as well as the additional radios required (though one long-range radio is in the cupola). Armor is at a minimum, though it is proof against most small arms and shell splinters. The wheels have independent suspension, increasing the vehicle's off-road mobility. The chassis also has variable ground clearance mechanisms as well as a central tire inflation system. The cab has air conditioning and heating systems. Many parts of the T815-7MOR89 chassis are compatible with parts of the other members of the T815-7 series.

The Indian Army has also stated a need for such a system with an L/52 barrel, as well as a lighter version with an L/39 barrel, both of which would be modified versions of those of the Nexter Caesar truck-mounted howitzer (of course, license-produced in a modified form in India). Whether these variants will be built remains to be seen.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
MGS (L/45 Gun)	\$1,153,953	D, A	457 kg	23.5 tons	4	17	Headlights	Shielded*
MGS (L/52 Gun)	\$1,167,520	D, A	420 kg	23.65 tons	4	17	Headlights	Shielded*
MGS (L/39 Gun)	\$1,142,467	D, A	488 kg	23.38 tons	4	17	Headlights	Shielded*

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor**
MGS (L/45 Gun)	143/76	40/21	420	153	Trtd	W(6)	TF3 TS4 TR4 HF4 HS3 HR3
MGS (L/52 Gun)	142/76	40/21	420	154	Trtd	W(6)	TF3 TS4 TR4 HF4 HS3 HR3
MGS (L/39 Gun)	144/77	40/21	420	152	Trtd	W(6)	TF3 TS4 TR4 HF4 HS3 HR3

Vehicle	Fire Control	Stabilization	Armament	Ammunition
MGS (L/45 Gun)	+2	Fair	155mm Bofors L/45 Dhanush howitzer, MAG (C)	23x155mm, 1000x7.62mm
MGS (L/52 Gun)	+2	Fair	155mm Nexter L/52 Caesar howitzer, MAG (C)	23x155mm, 1000x7.62mm
MGS (L/39 Gun)	+2	Fair	155mm Nexter L/39 Caesar howitzer, MAG (C)	23x155mm, 1000x7.62mm

*The cab of the MGS is shielded and has an NBC Overpressure system. The cupola does not have such protection and is only Enclosed; the gunner and loader must use protective masks and MOPP suits. The armor of the bed of the MGS rises only to one meter in height, exposing the torso, chest, head, and arms of anyone standing up in there. Radiologically, the bed is Open.

**The cab roof has an AV of 4; the entire truck (except the cupola) has a Hull Floor AV of 4Sp.

DRDO/Denel Bhim

Notes: When the Indians began searching for a new self-propelled artillery system, it seemed everyone was in. The South Africans has a G-6 turret on a T-72 hull (which they called the T6), the Russians had their 2S19 with a 155mm gun, the Germans had their PzH-2000 – the list went on and on, and due to the size and specific requirements of the package, competition was heavy. The South Africans tried again, though, and presented an Arjun chassis topped with their T-5 turret. The Indians, seeing the possibility of being able to build the vehicle in their own country, reacted positively to the design and purchased manufacturing rights and equipment from Denel. The new vehicle was called the Bhim after a hero from Indian folklore (Bhima). This also dealt this the mounds of design work the Indians did on the Arjun; since the Indians decided to go primarily with the T-90S for their tank needs, the Bhim development allowed the Arjun factories to remain open, especially since Arjun production ended in 2008.

Note that the Bhim was ready as early as 1998, but blacklisting of Denel by the Indian government over a bidding scandal delayed manufacture for almost 10 years.

The resulting Bhim does in fact look something like a PzH-2000 or 2S19; this makes sense, since they are all tank chassis with SP howitzer systems atop them in large turrets. The Bhim is essentially as modern an artillery system as any of the first-name SP artillery systems in the world today. Having the T6 turret, the Bhim is armed with a Denel L/52 155mm howitzer, replete with a full system of electronics and computer controls which unites GPS, mapping, blue/red force tracking, and the ability to function as its own FDC; it is also capable of 5-round MRSI firing. The initial burst is 8 rounds per minute for 3 minutes; an extreme rate burst rate of 3 rounds in 15 seconds, and a sustained rate of 8 rounds per minute. The gun is fed by a “limited capacity” autoloader; 20 rounds may be in the autoloading system at once, though others may be continually fed into the autoloader. Due to the high mountains and cliffs of the Kashmir area, gun elevation design was a prime consideration; Maximum elevation is an astounding +78 degrees, and depression -6 degrees. The turret also has a fast slew rate; if the gun is raised to max elevation, it can turn at 6 revolutions per minute. The turret and gun have 360-degree rotation and fire. The front of the turret on each side has a large door for ingress and egress, and a large door in the rear of the turret and the hull. The Bhim carries a conveyor which is hooked to vehicle power to allow the Bhim to feed from a ground pile, crates, vehicles, etc. (India is considering acquiring or building a dedicated ammunition support vehicle to work with the Bhim.) The gun has a muzzle brake and a fume extractor. The Bhim has 50 howitzer rounds onboard, 20 of which are carried in the autoloader’s twin magazines, 25 in five magazines in the rear of the turret, and five in a bin for ammunition which is outsized or has special requirements and cannot be loaded into the autoloader.

The vehicle, though not heavily-armored by many standards, is well armored for an SP artillery vehicle. Given the current state of affairs with mines and IEDs, top and belly armor are strengthened. The Bhim has an NBC overpressure system, with a collective vehicular backup. All over the hull and turret are large equipment boxes for storage of gear and equipment. As stated, the Bhim has a mapping system; interfaced computers onboard join the GPS (with inertial backup), the mapping computer, and fire control computers. They also have a secondary role of reporting on the state of the Bhim.

The hull is a modified form of the Arjun’s hull, and has the MTU-838 Ka-501 turbocharged diesel developing 1400 horsepower and coupled to an automatic transmission. Furthermore, a 10kW APU is provided to power the gun when the engine is off, including the conveyor belt (which, if given another power source, can also be powered by that system). Unlike most such systems, the APU is located in the turret on the right side instead of being in the hull. The driver is in the front right hull with the engine to his left; the commander and loader have hatches in the roof of the turret, the commander on the left and the loader on the right. The commander has a manually-operated cupola with all-around vision blocks; the loader merely a hatch. The commander also has a pintle mount, usually used by an Indian-built version of a MAG. On both sides of the turret are banks of four smoke grenade launchers.

Track design posed a special problem for the designers of the Bhim. Himalayan roads can be muddy, rutted, snowy, and slushy. Then again, parts of India resemble trackless deserts. The treads are, therefore, a middle ground between wide tracks and normal or narrow tracks.

Like many vehicles that fell by the wayside of the seemingly-endless Indian SPA replacement program (and armor replacement in general), the DRDO/Denel Bhim’s production was stopped after only about 30 units were produced, and as the Indian Artillery Mafia wanted more capabilities, electronics, a better autoloader, etc. Like most SPAs “chosen” by the Indian Army, the Indians seem to have pointed their eyes elsewhere, while several countries and companies attempt to meet their requirements, which are always changing. The Bhim may again make an appearance in the production schedule, or may fall by the wayside, with existing Bhims

being used (since they are in low-rate service anyway), scrapped, or modified into other vehicles, with turret placed onto yet other vehicles. Supposedly, 140 Bhims are to be produced. Whether these are to be married with Arjun or T-72M1 chassis is less certain. I think the Indian arms update process is at best chaotic, and at worse crazy and schizoid.

Abbot/Bhim

The Indians also have a good supply of British-made Abbot SP artillery guns. Some at the Indian MoD felt, with the Abbotts' chassis getting long in the tooth, but still having decent turrets which could be upgraded, that a combination of the Bhim's chassis (an Arjun Mk I tank) and an upgraded Abbot turret would make a cheap and easy-to-make SP howitzer that could fulfill certain needs for the Indian Army. Several prototypes were produced; the end result was an Arjun chassis (the Bhim's chassis) topped with a modernized Abbot chassis, containing most of the Bhim's electronic artillery systems, and some other upgrades such as magazines and a modified form of the Bhim autoloader. The most obvious upgrade is the replacement of the 105mm main gun with an L/39 155mm howitzer, complete with modern recoil recuperation mechanisms. The Abbot/Bhim was pictured as a smaller, more mobile SP howitzer able to "shoot-and-scoot" faster, commence fire missions faster, and be present near the battle front area, therefore not needing a longer-ranged gun. It has most of the electronics of the Bhim, though modified for the new gun. A modified version of the Bhim autoloader is though, as the turret is smaller, the gun is fed by a 10-round internal magazine and four 5-round magazines in the rear of the turret, along with 10-round-capacity bin to allow the Abbot/Bhim to carry more specialized rounds. The new gun retains the old gun's elevation and depression limitations of +70 and -5 degrees. The turret has had added two doors, one on each side, and the new magazine, with its own doors in the back; it can feed from the same conveyor system as the Bhim. For game purposes, the Abbot/Bhim has the same electronics suite as the Bhim except for the blue/red forces tracker, though a special transponder allows the Abbot/Bhim to be tracked by friendly forces with such equipment.

The Indian MoD is still sort of hemming and hawing about whether to put the Abbot/Bhim into service as an intermediate frontal SP howitzer. The light weight does make the Abbot/Bhim a very agile and speedy fire support vehicle with that high-power engine and low weight, though one of the criticisms laid about it is that the Abbot/Bhim may have a problem with outrunning its supply lines, and that a new support vehicle may be required to support the Abbot/Bhim. On the other hand, it would provide nearly-immediate, fast fire support. But like most armor projects and competitions of the Indian Army today, it may fall victim to the Indian MoD's screwy competition and acquisition process.

Bhim/Ajeya

Another possibility the Indians have mentioned is using the hulls of their older T-72M1 (which the Indians call the Ajeya) tanks with Bhim turrets on top. This would make a vehicle which does not have the speed or agility of the Arjun chassis, but it would be a chassis which is mechanically less complex and one with which the Indians have much more experience with.

It should be noted that the Ajeya is a bit different from the stock T-72M1, some of which applies to the Bhim/Ajeya. The engine is replaced with the superior V-84 840-horsepower V-84-1 engine. The V-84-1 is a multifuel engine; it can use diesel (meant to be the primary fuel), gasoline, jet fuel, benzene, kerosene, and even liquid rocket fuel which does not require refrigeration. This means that the engine compartment is larger than that of earlier T-72s. Forging capability has been made safer, though 10 minutes of preparation over and above the time for erection of the snorkel are required for deep fording. An automatic fire/explosion detection/suppression system has been installed to help to protect the crew, particularly against hits to the main gun ammunition.

The Ajeya uses the Polish PT-91 tank's night vision, day vision, and fire control suites. For the Bhim/Ajeya, this means in game terms that the driver has an Image Intensification viewer and a backup camera, as well has a link to the GPS/mapping system and vehicle state computer. The Ajeya uses GPS instead of the Russian GLONASS system, and the Bhim/Ajeya, like the Bhim, has Western radios of Israeli make. The Ajeya hull can also carry a few more rounds of ammunition and the associated charges and fuzes, in a space next to the driver, where in a standard Ajeya main gun ammunition is carried.

Like the Ajeya and T-72M1, the hull is well-protected and has the plastic/aluminum sandwich side skirts of the T-72M1, and the hull's radiation is actually superior to the Bhim turret (not enough to measure in game terms). The turret in this combination is the same as the standard Bhim turret, though modifications have been made to the turret ring to mate it to the Ajeya hull. A five-compartment automatic fire detection/suppression system has been added.

Twilight 2000 Notes: None of these vehicles exist in the Twilight 2000 timeline.

Merc 2000 Notes: The Indians decided to buy a modified 2S19 model (with a 155mm gun) from Russia instead of the Bhim.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
Bhim	\$1,450,721	D, A	550 kg	54 tons	4	30	Passive IR (D, G), Image Intensification (G, C)	Shielded
Abbot/Bhim	\$1,102,657	D, A	475 kg	41 tons	4	28	Passive IR (D, G), Image Intensification (G, C)	Shielded
Bhim/Ajeya	\$1,499,997	D, G, AvG, A, (And	500 kg	44.06 tons	4	25	Passive IR (G), Image	Shielded

	Others)	Intensification (D, G, C), Thermal Imaging (G), Backup CC Camera (D)
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Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
Bhim	176/123	49/34	1610	520	Trtd	T6	TF16Sp TS10 TR8 HF20Sp HS8Sp HR6*
Abbot/Bhim	222/155	62/43	1610	520	Trtd	T6	TF10Sp TS6Sp TR4 HF20Sp HS8Sp HR6**
Bhim/Ajeya	137/96	38/27	1200+400	312	Trtd	T6	TF16Sp TS10 TR8 HF46Sp HS20Sp HR9***

Vehicle	Fire Control	Stabilization	Armament	Ammunition
Bhim	+2	Fair	155mm Denel L/52 howitzer, MAG (C)	50x155mm, 2000x7.62mm
Abbot/Bhim	+2	Fair	155mm L/39 howitzer, MAG (C)	40x155mm, 1250x7.62mm
Bhim/Ajeya	+2	Fair	155mm Denel L/52 howitzer, MAG (C)	54x155mm, 2000x7.62mm

*Turret Deck and Hull Deck AV is 4; Hull Floor AV is 6Sp.

**Hull Deck Armor is AV 4; Hull Floor AV is 6Sp.

***Turret Deck AV is 4.

DRDO M46 Catapult

Notes: During the 1990s Indo-Pakistan wars, India had a large number of M-46 130mm field guns that they wished to be more mobile, and a number of Vijayanta tanks that they wished to retire from service. Rather than buy more self-propelled guns from an outside source and junking the Vijayantas, they combined 400 of these weapons into single self-propelled howitzers. These first saw action in Kashmir in 1996. Though it is supposed to be replaced by the Bhim, Bhim production has been slow and the Catapult soldiers on. The Catapult is also known as the Vijayanta/130mm and Vijayanta/M46. Some 170 such conversions were done; only about 100 are still operational officially; it's possible that only 20 are still operational.

The vehicle retains the driver's position, but the center of the vehicle has an open area for the gun and crew, with a frame that has a metal roof for overhead protection. This metal roof normally is covered with sandbags or extra pieces of wood or metal, but the sides are open. The Vijayanta is generally modified to serve its new role; the most obvious modification is the addition of a seventh roadwheel to the chassis and the accompanying lengthening of the chassis by a little over half a meter. The overhead roof covers the gun, and the gun extends partially into the former turret of the Vijayanta chassis. The suspension has a unique hydraulic locking system which is used to help absorb recoil when the gun is fired. The ad hoc nature of the chassis means that the gun has a maximum elevation of 45 degrees and a depression of -2.5 degrees. Traverse is extremely limited, as only 12.5 degrees left or right. The gun faces and fires over the rear of the vehicle. The low depression means that the Catapult can function as a tank destroyer if required, and a small number of rounds for such a purpose are generally carried by the Catapult.

The driver is on the front right side with the engine to his left; the rest of the crew are in the hull or in the raised gun section. There are no other weapons except for the gun, and the crew's small arms. Hull armor is actually fairly heavy for such a vehicle, but the armor of the raised section (which is represented by the "turret" section below) is virtually nonexistent. The hull looks almost like a US M-88 Hercules ARV. No other crew amenities or protection are supplied, other than a hot plate and water/ration heater.

The Catapult Mk 2

In 2012, the Indian MoD decided to keep the Catapult on a while longer (current estimates are that it will remain in service for at least ten more years). However, mobility was a question, as well as the antiquated electrical system of the first-generation Vijayantas being used as the chassis and the desire to add more electronics like GPS, mapping modules, more radios, fire control computers, etc. This resulted in the M46 Mk 2, also known as the Catapult Mk 2. This version retains a modified form of the Catapult's superstructure (most turret modifications were made to provide room for the extra equipment), married to an early-marque Arjun chassis. The conversions are just beginning and are not expected to be completed until at least 2020. The Mk 2 borrows a large amount of its electronics suite from the Bhim, including GPS with mapping module, vehicle state computer, extra radios, fire control and fire mission computers, and a complete electrical overhaul system. The hull also has the Arjun's MTU-838 Ka-501 turbocharged diesel developing 1400 horsepower with an automatic transmission. The Mk 2 is equipped with a conveyor belt which may be used to carry projectiles from a resupply vehicle or from a ground pile. The chassis also carries the same 10kW APU as the Bhim. The superstructure remains externally similar, including its semi-open top covered by steel plate to protect against artillery bursts. The additional hull floor protection is seen on the Mk 2. At the front right corner is a pintle mount for a machinegun or AGL. Currently, the Indian Army intends to make some 40 of these conversions. The autoloader of the Bhim has been installed, minus the rear-turret magazines.

The Catapult Mk 3

Currently (as of late 2018 when this was written) the Indians are in the process of modifying and rebarreling their 130mm field guns to turn them into 155mm L/45 field howitzers. By 2020, the Indians expect these modifications to be included in the Catapult Mk 2 (and with the Catapult Mk 1 being upgraded to the Mk 2 standard in the process). This turns the Catapult Mk 2 into a credible long-range artillery platform.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
M46 Catapult	\$437,469	D, A	500 kg	40 tons	7	20	Passive IR (D)	Enclosed***
M46 Mk 2 Catapult	\$711,661	D, A	500 kg	44.5 tons	5	25	Passive IR (D), 2 nd Gen Image Intensification (G)	Enclosed***
M46 Mk3 Catapult	\$935,025	D, A	500 kg	45.36 tons	5	25	Passive IR (D), 2 nd Gen Image Intensification (G)	Enclosed***

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
M46 Catapult	105/74	29/20	1000	198	Std	T6	TF3 TS2 TR2 HF38 HS13 HR7*
M46 Mk 2 Catapult	203/142	56/40	1610	509	Std	T6	TF3 TS2 TR4 HF20Sp HS8Sp HR6**
M46 Mk3 Catapult	199/139	55/39	1610	519	Std	T6	TF3 TS2 TR4 HF20Sp HS8Sp HR6**

Vehicle	Fire Control	Stabilization	Armament	Ammunition
M46 Catapult	+1	Basic	130mm M-46 Gun/Howitzer	40x130mm
M46 Mk 2 Catapult	+2	Basic	130mm M-46 Gun/Howitzer, M2HB	40x130mm, 500x.50
M46 Mk 3 Catapult	+2	Fair	155mm Denel L/45 Howitzer, M2HB	40x155mm, 500x.50

*The "turret" AV ratings are a bit strange for the Catapult. The side and rear ratings are only 50% likely to hit the metal of the superstructure; otherwise, TS and TR are 0. The TF rating is the gun shield and a bit of an extension on each side, but applies in all cases to TF hits. TR, HR, and belly AV are 4.

**The superstructure takes hits as the standard Catapult above, but the roof AV is 5 and the floor 6Sp.

***Most of the crew has little more than protective masks and MOPP suits with extra-long hoses, but the driver has full NBC Overpressure protection.

Komatsu Type 74

Notes: Some 20 of these Japanese vehicles were built – however, the Type 74 was never considered more than a stopgap vehicle, since a decision was made to concentrate on production of the Type 75 self-propelled howitzer instead. Therefore, they were produced from 1975-78. Only 17 Type 74's remain in service as of the time I write this (mid-June 2018) are stationed as the 2nd Artillery Regiment at Asahikawa, Hokkaido. There are no plans for future upgrades or future builds, and their days on active duty are probably numbered. It's short gun and lower throw weight means that the howitzer is not nearly as effective as most howitzers in service these days.

In appearance, the Type 74 is similar to the British Abbot SPH. This is only superficial, as there are numerous differences on the exterior and the interior is not like the Abbot at all.

The crew has a conventional layout; the driver is in the front right, the engine to his left; the driver has three wide-angle frontal vision blocks, as well as a rotatable periscope piercing his hatch. On the right of the turret, there is a medium-sized door in the turret. On the roof, there are two hatches; one is the commander's cupola, with all-around gun shields, vision blocks and a mount for a heavy weapon. The other hatch is a simple hatch for a loader. There is no turret-mounted bustle rack, just tie-down points for gear.

The gun is derived from the old US M-1 105mm howitzer, but with the addition of a muzzle brake and fume extractor. It is built by Japan Steel Works. It does not have modern accouterments such as mapping computers or an autoloader, and has only one loader due to internal space being at a premium. It does, however, have data-capable radios that convert FDC data to coordinates for use by the gun, through a small, hand-held FC computer.

The engine is actually a repurposed Mitsubishi 4ZF diesel, which is a modified version of a commercial medium truck engine, and is not turbocharged or supercharged despite the high elevation of most of the Japanese Islands. It develops 300 horsepower. The chassis shares many components with the Type 73 APC. The transmission is manual. The ride is decent cross-country, as the vehicle is light and the suspension includes three shock absorbers. The vehicle is amphibious with 3 minutes of preparation. Armor is rather thin from most angles and can sometimes be penetrated by medium rifle rounds, or assault rifle rounds from some angles. Armor and external construction is largely of aluminum.

Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
\$189,978	D, A	550 kg	16.5 tons	4	15	Headlights	Shielded

Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
132/93	37/26/4	410	89	Trtd	T4	TF3 TS3 TR3 HF8 HS3 HR2

Fire Control	Stabilization	Armament	Ammunition
+1	Basic	105mm L/32 Howitzer, M-2HB (C)	30x105mm, 650x.50

Mitsubishi Type 75

Notes: This is currently the standard Japanese self-propelled howitzer, though it is in the process of being supplanted by the Type 99. Production did, however, cease in 1988. The Type 75 replaced in production, rather abruptly, the limited-run Type 74 SP howitzer (above), and is still the JGSDF's primary SP howitzer, at least until production of the Type 99 ramps up. Development of the Type 75 actually began in 1969, before work on the Type 74 had begun. The Type 75 shares many automotive components with the Type 74 tank, which was developed at the same time. The Japanese still use 201 of these vehicles, outnumbering the Type 99 by a large margin. Though very different internally, the Type 75 has a marked external resemblance to the American M109 series. The Type 75, like most Japanese weapons, has never been exported (the Japanese constitution prevents the export of military gear).

The Type 75 has a conventional layout for such a vehicle, with the driver on the front right, and the radio operator right behind him. The rest of the crew is in the turret. The commander and gunner are in the right of the turret, and the commander has a manually-rotating cupola with all-around vision blocks and a gun mount. The two loaders are on the right side of the gun, and there is a hatch directly above their position.

Power is provided by a Mitsubishi 6 ZF turbocharged diesel, developing 450 horsepower, and coupled to a manual transmission. The Type 75 SPH uses much of the chassis components of the Type 74 tank, though internally it has a totally different arrangement. The Type 75 is not amphibious, but has excellent fording, able to ford 1.3 meters. Armor is on the thin side, though not as bad as the Type 74. Armor is of aluminum, and capable of stopping 20mm rounds from the front, and 7.62mm rounds from the side and rear. The crew is protected by an NBC Overpressure system, as well as an automatic fire suppression system. The drive consists of a rear sprocket and a front-mounted idler; it has no return rollers. Suspension is by pure torsion bar; this can lead to a rough ride across country.

The turret of the Type 75 is on the rear of the vehicle, facilitating ammo replenishment, particularly through the turret's rear doors. Below the turret in the hull is a mediumish door, which can be used for crew ingress and egress, but is primarily used to replenish fuzes, charges, and special rounds. The gun on the Type 75 is of a size that it can fire most Western 155mm ammunition, though certain specialist rounds such as the Copperhead cannot be used because the breech on the gun and the cradle do not open far enough to allow for these lengthy rounds. The short L/30 barrel of the gun, however, severely limits range. Despite the abbreviated barrel, the barrel does have a fume extractor and a beefy muzzle brake as well as recuperators and shock absorbers, leading to soft recoil. Maximum elevation is 65 degrees, and depression -5 degrees; this, along with the short barrel, has led to a secondary tasking as a tank destroyer. The turret can rotate 360 degrees, though there is a known instability when the Type 75 fires shots to the side.

Despite the two loaders in the vehicle, the Type 75 is equipped with a semiautomatic autoloader, leaving the loaders to install fuzes and charges and help in the firing of rounds that do not fit into the autoloader. Though normally requiring an FDC for accurate fire, data can be transmitted through the Type 75's data-capable radios and a small computer (more a data box) can then figure out and supply firing solutions with the information inputted by the gunner. The directional gear consists of a simple gyrocompass along with some minor computer equipment to allow minor final positional changes to put the Type 75 in the final position.

It is obvious that the Type 75 cannot conduct a lengthy bombardment with the ammunition it carries in its racks. Thus, the Type 75 is usually trailed by several ammo-carrying vehicles, usually converted APCs.

Type 75 1990's Upgrade

An upgrade in the early 1990s was done to some Type 75s starting in the 1990s; at the time, production of the new Type 99 SPH was lagging and the JGSDF needed more up-to-date howitzers for some of its units. This was done as a stop-gap measure pending full production of the Type 99 and only about one-quarter of Type 75s were so upgraded.

The upgrade primarily brought significant computerization and automation to the Type 75's bag of tricks. This includes an indirect fire computer able to generate (with the upgrade's other electronic upgrades) its own fire solutions if the target coordinates are known, self-surveying capability, the ability to work directly with FIST teams equipped with the proper radios and equipment (and its own data-capable radios), and an inertial navigation device with a mapping module. The Upgraded Type 75 adds a direct fire control computer for those emergency direct-fire shots, and a laser rangefinder which doubles as a laser designator. From the outside, perhaps the most obvious upgrade is its L/39 gun, though an 8kW APU can also be seen in a basket on right side of the turret near the rear. A nice touch is the ration/water heater, big enough for four men's rations, inside the vehicle at the commander's position. The Upgraded Type 75 has a little more ammunition carried internally, but this is primarily to make the magazines work better with the new autoloader.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
Type 75	\$431,512	D, A	500 kg	25.3 tons	6	21	Passive IR (D, G, C), Image Intensification (G)	Shielded
Type 75 (Upgraded)	\$743,488	D, A	468 kg	25.82 tons	6	22	Passive IR (D, G, C), Image Intensification (G), Back-Up LLTV (D)	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
Type 75	130/91	36/25	650	167	Trtd	T4	TF4 TS4 TR4 HF11 HS4 HR3
Type 75 (Upgraded)	127/89	35/25	650	170	Trtd	T4	TF4 TS4 TR4 HF11 HS4 HR3

Vehicle	Fire Control	Stabilization	Armament	Ammunition
Type 75	+1	Basic	155mm L/30 Howitzer, M-2HB (C)	28x155mm, 1000x.50
Type 75 (Upgraded)	+2	Fair	155mm L/39 Howitzer, M-2HB (C)	30x155mm, 1000x.50

Mitsubishi Type 99

Notes: The Japanese have long known that the Type 75 was an inadequate self-propelled howitzer, even in its upgraded form. To this end, they, starting in 1985, decided to take a quantum leap over the Type 75, designing a fully modern SP howitzer. And it brings together as many modern ideas on self-propelled howitzer design as possible, within budget constraints. And the budget has been the biggest problem with the Type 99; meant to have replaced the Type 75 by now, but only 111 have been put into service as of 2015.

The Type 99 was originally designed to use an L/52 gun, and may still be retrofitted with one in the future; however, initial production versions used an L/39 barrel and a different gun, though all these initial production gun barrels were upgraded to L/52 barrels and new gun mechanisms to match by 2012. The howitzer on the Type 99 can use any sort of Western or Chinese 155mm rounds. The gun is based on the FH-70 towed howitzer design. The gun has a substantial muzzle brake, but not a fume extractor. The gun is equipped with a full autoloader, with little intervention required by the loader, except when rounds that are unusually short or long or require special fuzing or charging must be loaded. The gun is equipped with full computerized fire control gear, both for indirect and direct fire. The gun also has a laser rangefinder for use in direct fire, and it can also double as a laser designator. The Type 99 is equipped with GPS, along with a computerized mapping module, and secure data-capable radios; FC equipment is, reportedly, on par with other vehicles of its generation like the PzH2000, and M109A6 Paladin. It is, however, able to act as its own FDC. The Type 99 is capable of bursts of 6 rounds per minute for 10 minutes, or three rounds in 10 seconds for two bursts, but normal fire rate is three rounds per minute. It is also capable of MRSI bursts. The Type 99 is capable of direct fire missions, including antivehicle shots, though the ammunition for vehicle engagements is not normally carried on the Type 99 SP howitzer itself. The

ordnance is capable of 65 degrees of elevation and depression, with +65 and -5 degrees. The Type 99 is primarily fed by six 6-round magazines, but nine rounds (normally special, long, or short) are carried in a bin on the floor of the vehicle.

Layout is basically the same as other Japanese SP howitzers. The driver is on the front right, with three vision blocks to his front; the center one has a night vision channel. The driver uses conventional controls and has automatic transmission. At the rear of the chassis is a door for egress and ingress of the crew. At the rear door of the turret are large doors for ammunition resupply. The turret is to the rear of the vehicle. The commander is on the right of the turret, with a manually-operated cupola, which has all-around vision blocks including a night vision channel. He has a heavy weapons mount with an AV2 gun shield to the front. On the other side of the turret is a hatch for the loader, which is often equipped with own machinegun on a pintle, and has a forward AV2 gun shield. On each side of the turret is a hatch, normally used for equipment loading or single-round loading.

A battery of Type 99s normally has three guns, three Type 99 ammo resupply vehicles, a counterbattery radar vehicle, and an FDC based on the Type 89 IFV's hull.

The Type 99 is based on the Type 89 IFV, though lengthened with an additional roadwheel. The turret is also specifically-designed for the Type 99, and is capable of 360 degrees of rotation. A combination of recuperators, shock absorbers, the huge muzzle brake, and the weight of the vehicle mean that the gun can fire in any direction without the need to deploy spades or stabilizers. Armor is heavier than on earlier Japanese howitzers, though made from aluminum. The Mitsubishi 6SY31WA engine is a 600-horsepower turbocharged diesel, and is mounted to the left of the driver. The engine is coupled to an automatic transmission, and the two are in a unified powerpack which may be installed and uninstalled in one piece in 30 minutes with the proper equipment. The vehicle has both air conditioning and heating, as well as a ration heater. To protect the crew, an NBC overpressure system is installed; in addition, an air filtration system is in place to prevent fume buildup, as the gun has no fume extractor.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
Type 99 (Early)	\$1,732,625	D, A	685 kg	39.86 tons	4	24	Passive IR (D, G, C), Image Intensification (C), 2 nd Gen Image Intensification (G), Back-Up LLTV (D)	Shielded
Type 99 (Production)	\$1,768,678	D, A	650 kg	40 tons	4	25	Passive IR (D, G, C), Image Intensification (C), 2 nd Gen Image Intensification (G), Back-Up LLTV (D)	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
Type 99 (Early)	114/80	32/22	419	221	Trtd	T4	TF16Sp TS6Sp TR5 HF20Sp HS7Sp HR5
Type 99 (Production)	114/80	32/22	419	221	Trtd	T4	TF16Sp TS6Sp TR5 HF20Sp HS7Sp HR5

Vehicle	Fire Control	Stabilization	Armament	Ammunition
Type 99 (Early)	+2	Fair	155mm Japan Steel Works L/39 Howitzer, M-2HB (C), Type 62 (L)	45x155mm, 650x.50, 1000x7.62mm
Type 99 (Production)	+2	Fair	155mm Japan Steel Works L/52 Howitzer, M-2HB (C), Type 62 (L)	45x155mm, 650x.50, 1000x7.62mm

ROMARM Model 89

Notes: This Romanian self-propelled howitzer is basically the turret of the 2S1 fitted onto the chassis of a modified MLI-84 IFV. The resulting vehicle is lighter than the 2S1, somewhat cheaper, and better able to travel on the flimsy roads and bridges often found in Romania, as well as better handling on the mountain paths in southern Romania. It has not been exported as of yet, nor has it been offered for export. The Romanians are in the process of replacing the Model 89 with true 2S1s, and only 18 Model 89 of the original 42 remain in service today.

The 2S1 turret fits perfectly into the MLI-84's turret ring, though the 2S1 turret itself is a bit larger than that of the MLI-84. The 2A31 122mm gun itself is not the same as on the 2S1, but is a Romanian ground-mounted gun that has several common components with the 2S1's 2A31 gun. The gun itself is actually a gun/howitzer, meaning that the gun has deliberately low depression and can function as a tank destroyer as well as a howitzer. The gun on the Model 89 has a semiautomatic autoloader, meaning that the loader must affix the fuzes and place the round in the autoloading train for loading into the breech; the breech block is also semiautomatic, and the loader must close the breech. The Model 89 seems almost to be optimized for the tank destroyer role, as the fire control suite is marginally more advanced than the indirect fire computer. Max Depression is -3 degrees with elevation +70 degrees. A Model 45 normally carries a few antitank rounds (about 10% of its total), but mostly carries howitzer-type rounds. The gun turret has 360 degree rotation and can also fire from any angle. The Model 45 does not normally have a commander's machinegun, though an optional one it figured into the entry. The commander has a manually-rotating cupola, with all-around vision blocks and a night channel is borrows from the gunner.

Following the BMP-1 design, the MLI-84 has a driver's hatch on the front right hull, and commander's and gunner's positions in the turret; the turret has one hatch for the commander. All three have night vision equipment. The Model 89 has a new engine, the Perkins CV-8V-1240 DTS supercharged diesel developing 360 horsepower; this is larger and heavier, but is more powerful than standard BMP-1 engine, and is also uprated slightly from the MLI-84's engine. The fitting of its engine and the associated automatic transmission required rebuilding and enlarging of the engine compartment. The increase in the length of the hull also allowed small fuel tanks to be incorporated into the walls, increasing the fuel capacity. The gaps between the roadwheels are also wider. Unfortunately, the suspension is still of the conventional torsion bar type with shock absorbers only on the first and last roadwheels on each side, so the ride can be even rougher than that of the BMP-1. The heavier weight of the Model 89 also reduced its amphibious capability; it is slow in the water, and freeboard is greatly reduced. The crew and passenger are protected by a fire detection and extinguishing system, and the commander also has access to a Geiger counter and chemical agent detector, which can be operated with hatches closed.

The Model 89 retains the MLI-84's doors in the rear, but has no firing ports. From the 2S1 turret, the Model 89 inherits the long equipment box on the left side of the turret. This is large enough to carry ancillary equipment for the Model 89, and little more. At the rear of the turret are slotted covers used to retract a portion of the suspension during swimming and fording operations. This of course requires that the turret be squared up with the front when swimming and fording deeply. The Model 89 has an NBC overpressure with a collective NBC backup. As intimated above, the Model 89 is amphibious, and has waterjets and bilge pumps. The Model 89 does require an FDC, though it does have one short-range and one long-range secure radio, both with data capability.

Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
\$288,780	D, A	500 kg	17.5 tons	5	14	Passive IR (D, G), Image Intensification (G)	Shielded

Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor*
157/110	40/28/11	600	134	Trtd	T4	TF10 TS6 TR6 HF8 HS4 HR4

Fire Control	Stabilization	Armament	Ammunition
+2	Fair	122mm L/40 D-30 Howitzer, NSVT (C)	40x122mm, 500x12.7mm

*Chassis deck armor is 3; Turret deck armor is 5.

Kharkov 2S1 (SO-122) Gvozdika

Notes: This Russian 122mm self-propelled howitzer was first seen in a parade in Poland in 1974, and for that reason, is often called the M1974 in the West. The Russian designation is SO-122 or SAU-122, but it more commonly known to its crews as the Gvozdika (Carnation). It was sold far and wide, and current and former users number nearly 40, from Russia herself to Vietnam (though some users have as little as one example). The 2S1 has seen combat in Chechnya, by Iraqi forces in the Gulf War and the 2003 invasion as well as new-purchase examples for the New Iraqi Army, by the Serbians in the Yugoslavian Civil War and the Kosovo intervention, in the 2008 South Ossetia War, by the Libyans (on both sides) in the Libyan Revolution, and currently in the Syrian Civil War (or free-for-all, as it seems to be).

The 2S1 is the modified hull of an MT-LB (the ACRV), lengthened by one roadwheel, topped with a large, low turret armed with a modification of the 122mm D-30 howitzer. In this role, the gun is useful for direct as well as indirect fire, though lack of armor in the chassis limits it's survivability as a direct-fire vehicle. An autoloader is installed, and this limits the necessary crew to four, though two other troops can fit inside if they stay out of the way. 8 rounds are carried on the left and right of the sidewalls; these are normally unusual rounds (such as HEAT) or rounds longer than normal length. The remaining 24 are carried in the ready position; the loader must still load the rounds manually into the breech, but there is a breech elevator and a power rammer and flicker. For longer bombardments or ammo replenishment, the 2S1 is fed through a rear hull door and put into their places by the gunner and loader. Computers and radios are limited and an FDC is required for proper operation of the 2S1, though the 2S1 does have an indirect fire computer and a very basic mapping module with equally basic inertial navigation. The driver and the gunner have night vision equipment, and the commander has a primitive CITS, enabling the 2S1 to be used as a tank destroyer (though it does not normally carry the ammunition mix to function as a tank destroyer for long; normally, only two special rounds were carried, and these were normally CLGPs). As issued, there is no commander's machinegun, though examples in South Ossetia often have one mounted on a pintle. The D-30, as mounted on the 2S1, has a large double baffle muzzle brake and a fume extractor. The gun has a depression limit of -3 degrees and an elevation limit of +70 degrees.

As a member of the ACRV family, it is mechanically almost identical to the ACRV and has the same engine and manual transmission. The engine is the YaMZ-238N turbocharged diesel with an output of 240 horsepower. (This was replaced in the early 1990s with an upgraded version of the same engine, but developing 300 horsepower.) The suspension can be raised and lowered, to hide in hull-down positions, clear intervening terrain, or lock the suspension down to allow it to be air-delivered. The 2S1 can be made amphibious with very little preparation (less than 2 minutes). It travel over deep snow, mud, beach sand, swamps, etc, using wide 670mm tracks which can be fitted; the normal ones are 400mm wide. During these forays into rough terrain, only 30 rounds for the main gun are normally carried. 24 rounds are in ready racks; 16 more are carried on the sides of the turret basket. Empty cartridge cases are ejected outside of the turret. An unusual feature of the 2S1 is it's suspension height; designed for airdropping, it's suspension can be lowered to the point that all roadwheels, return bogie, and sprocket are all on the ground.

There is a driver's hatch on the front deck, and commander and loader's hatches on the turret deck. There is a large door in the rear of the hull to resupply the vehicle with ammunition; this has a single firing port at the center, carried over from the ACRV. The crew has an NBC Overpressure system to protect them. A long stowage box is mounted on the left side of the turret.

The Polish use an updated version of the 2S1 designated the 2S1T Gozdzik; this has a TOPAZ digital fire control system, including a GPS receiver with inertial navigation backup, full mapping computer, an indirect fire computer, and a small laptop to allow the Gozdzik to essentially act as its own FDC, taking instructions directly from FIST teams and even units in the field (if the person calling for fire has the necessary skill). The Gozdzik has the newest digital military radios, including two long range radios that are data-capable. It also has the upgraded engine.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
2S1 Gvozdika	\$434,162	D, A	600 kg	15.7 tons	4+2	13	Passive IR (D, G, C), Image Intensification (G)	Shielded
2S1 Gvozdika (Engine Upgrade)	\$459,396	D, A	700 kg	15.7 tons	4+2	13	Passive IR (D, G, C), Image Intensification (G)	Shielded
2S1T Gozdzik	\$917,953	D, A	540 kg	16.35 tons	4+2	15	Passive IR (D, G, C), Image Intensification (G), Thermal Imaging (C)	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
2S1 Gvozdika	115/81	32/22/3	550	83	Trtd	T4	TF6 TS4 TR3 HF8 HS3 HR2
2S1 Gvozdika (Engine Upgrade)	137/96	38/27/4	550	111	Trtd	T4	TF6 TS4 TR3 HF8 HS3 HR2

Upgrade) 2S1T Gozdik	133/93	37/26/4	550	111	Trtd	T4	TF8 TS6 TR4 HF10 HS5 HR2
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Vehicle	Fire Control	Stabilization	Armament	Ammunition
2S1 Gvozdika	+1	Basic	122mm L/40 2A31 Howitzer	40x122mm
2S1T Gozdik	+2	Fair	122mm L/40 2A31 Howitzer	40x122mm

Uraltransmash 2S3 (SO-152) Akatsiya

Notes: The 2S3, also known as the SO-122 and CO-122, was introduced at about the same time as the 2S1, first appearing to the West in 1973, and thus often known to NATO as the M1973. However, it had been in development since 1967 and 1971 in service. The 2S3 can be mistaken at first glance for the American M-109, though the gun is longer than a stock M-109; according to some sources, the 2S3 was developed in response to the M-109. Some 33 countries use the 2S3 – including seven at the OPFOR at the US National Training Center. They have taken part in combat in Afghanistan, the Tajikistani Civil War, both Chechen Wars, the South Ossetia intervention, the Libyan Civil War, and the Syrian Civil War. The 2S3 was produced until 1993. The 2S3 is in use by some 20 countries; the Russians still use the latest versions, but still have about 1600 earlier versions in storage. The Russian Naval Infantry is the single largest user of the 2S3 series. The variants in use by Russia include the 2S3M, 2S3M1 and 2S3M2, depending upon the level of the unit in question. Though the 2S3 is being replaced by the 2S19, it does not appear that the Russians intend to replace all of them, especially in the face of continual upgrades. The Chinese also use a modified form of the 2S3, the Type 83, but this is handled on the Chinese SP Artillery web page, as it is sufficiently different.

2S3

The 2S3 is based on the heavier chassis of the same type as used on the SA-4 Ganef SAM system, but has six rather than seven roadwheels. The engine is a V-59 turbocharged diesel developing 520 horsepower, coupled to a semi-automatic transmission. The chassis have wide tracks for optimum performance in rough terrain, though not as wide as true rough-terrain tracks. The vehicle has six roadwheels, with different spacing between the roadwheels than on the SA-4 Ganef chassis.

The driver's compartment is at the front right, with the engine and radio equipment to his left. To the right side of the rear is a large hatch for crew entry and exit and ammunition resupply; this has a small vision block in it. On the left turret deck is a manually-rotating cupola for the commander, with all-around vision blocks and one block with a night channel; this hatch also has equipment to allow its pintle-mounted machinegun to be aimed and fired with the hatch closed. On the turret deck on the opposite side of the turret is a loader's hatch with vision blocks to the right side and forward.

The main gun is a short-barreled howitzer with a maximum elevation +63 degrees and depression of -4 degrees. The gun was developed from the D-22 and is differs primarily in having a large muzzle brake, two recuperators above the main gun, and a fume extractor. The 2S3 has a manually-operated brace on the glacis to support the gun during travel. The commander's weapon is almost always a PKM which, as stated above, can be aimed and fired (but not reloaded) with the hatch closed. Computers and radios are limited and an FDC is required for proper operation of the 2S3, though the 2S3 does have an indirect fire computer and a very basic mapping module with equally basic inertial navigation. ROF is 2.6-3.5 rounds per minute maximum depending on the rounds fired; though for a sustained bombardment 4 rounds per minute is the normal ROF. The gun is capable of firing small-yield nuclear shells, but it is well known, even amongst the crews, that the crew firing the round will receive radiation and overpressure effects from the round, as well as a small amount of thermal pulse. (The vehicle is protected from EMP.) The gunsight is a combination of a periscopic indirect fire sight and a telescopic direct fire sight.

The 2S3 has self-entrenching equipment which allows the 2S3 to dig itself a hull-down fighting position in soil in 20-40 minutes, depending on how hard-packed the soil is. There are large hatches on the rear of the hull and on the right side of the turret; the door on the side of the turret is primarily for ammo case ejection and replenishment, while the door on the hull is both used for replenishment and for crew ingress and egress.

The crew has hatches for the commander and loader on the turret roof and for the driver on the front left deck in addition to the hatches already stated. The commander's machinegun may be aimed and fired (but not loaded) from under armor, and the commander may tap into the vehicle's fire control and has the same stabilization as the vehicle itself.

Early in development, the 2S1 was found to have an unacceptable level of gas contamination from the gun, and the Army did not accept the new vehicle for a year. This delayed the initial operational deployment from 1969 to 1973.

2S3M

The 2S3M differs primarily in the main gun, which is three calibers longer; ammunition stowage, which is increased to 46; a new autoloader, which feeds the gun from a 12-round autoloading drum; and the ability to use the Krasnopol CLGP.

2S3M1

The 2S3M1 is a 2S3M with full datalink capabilities and computer capabilities which allow it to function as its own FDC. This includes inertial navigation and a mapping computer. They can also take directly from FIST instruction or function as a coordinated whole through an FDC. The 2S3M1 has radar and IR absorbent/reflective paint; this is little actual protection, though it gives enemy gunners targeting the 2S3M1 with IR, Thermal, FLIR, or radar-based weapon a -1 to hit.

2S3M2

This is a 2S3M1 with a modernized automatic digital fire control system, including more compact computers and a laser rangefinder with ballistic computer for use by the main gun and commander's machinegun in direct fire. The 2S3M2 can use GLONASS satellites, and feed the results to the navigational and mapping computer. The 2S3M2 has a new gun barrel which is L/39. The 2S3M2 has a system similar to the US Blue Force/Red Force tracker, along with a vehicle state computer.

2S3M2-155

Built primarily for export, this is a 2S3M2 equipped with M-385 155mm L/39 howitzer. It can fire all but the latest Western and Chinese 155mm rounds. It is otherwise for game purposes like the 2S3M2. This has been shown at some international arms shows on and off since 2000.

2S3M3

This version of the 2S3M2 was still experimental as of 2018; the primary difference is the installation of a version of the 2A33M which can fire most of the more powerful rounds that the 2S19 is capable of firing. Tests among possible customers have generally been good, but some shots with more powerful rounds have given the breech block and barrel root cracks. The 2S3M3 was designed primarily to keep the 2S3 relevant, particularly among export customers.

Vehicles	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
2S3	\$538,603	D, A	800 kg	27.5 tons	6	25	Passive IR (D, G, C), WL/IR Searchlight (C), Image Intensification (G, C)	Shielded
2S3M	\$674,498	D, A	713 kg	28.78 tons	6	25	Passive IR (D, G, C), WL/IR Searchlight (C), Image Intensification (G, C)	Shielded
2S3M1	\$1,280,548	D, A	628 kg	28.88 tons	6	28	Passive IR (D, G, C), WL/IR Searchlight (C), Image Intensification (G, C)	Shielded
2S3M2	\$1,439,840	D, A	538 kg	29.24 tons	6	21	Passive IR (D, G, C), FLIR (G, C), Image Intensification (G, C)	Shielded
2S3M2-155	\$1,463,067	D, A	508 kg	29.27 tons	6	21	Passive IR (D, G, C), FLIR (G, C), Image Intensification (G, C)	Shielded
2S3M3	\$1,583,824	D, A	538 kg	29.24 tons	6	21	Passive IR (D, G, C), FLIR (G, C), Image Intensification (G, C)	Shielded

Vehicles	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
2S3	136/95	38/26	830	193	Trtd	T4	TF5 TS4 TR3 HF8 HS3 HR2
2S3M	133/93	37/25	830	197	Trtd	T4	TF5 TS4 TR3 HF8 HS3 HR2
2S3M1	133/93	37/25	830	198	Trtd	T4	TF5 TS4 TR3 HF8 HS3 HR2
2S3M2	132/92	37/25	830	199	Trtd	T4	TF6Sp TS5Sp TR3 HF9Sp HS4Sp HR2*
2S3M2-155	132/92	37/25	830	199	Trtd	T4	TF6Sp TS5Sp TR3 HF9Sp HS4Sp HR2*
2S3M3	132/92	37/25	830	199	Trtd	T4	TF6Sp TS5Sp TR3 HF9Sp HS4Sp HR2*

Vehicles	Fire Control	Stabilization	Armament	Ammunition
2S3	+1	Basic	152mm L/27 2A33 Howitzer, PKT (C)	35x152mm, 1500x7.62mm
2S3M	+1	Basic	152mm L/30 2A33M Howitzer, PKT (C)	46x152mm, 1500x7.62mm
2S3M1	+2	Fair	152mm L/30 2A33M Howitzer, PKT (C)	46x152mm, 1500x7.62mm
2S3M2	+3	Fair	152mm L/39 2A33M2 Howitzer, PKT (C)	46x152mm, 1500x7.62mm
2S3M2-155	+3	Fair	155mm L/39 M-385 Howitzer, PKT (C)	46x155mm, 1500x7.62mm
2S3M3	+3	Fair	152mm L/39 2A33M3 Howitzer, PKT (C)	46x155mm, 1500x7.62mm

Uraltransmash 2S5 Giatsint-S

Notes: This 152mm self-propelled howitzer has been in Russian service since 1972. It looks very much like a smaller version of the SO-203, or for that matter, the US M-110. It was developed at the same time as the 2A36 Giatsint-B towed 152mm gun/howitzer. Currently, it is used by Russia, Ethiopia, Belarus, and Ukraine (who inherited theirs from the Soviet Army) and by Finland, the Soviet Union's only customer of the 2S5. This vehicle is known as the Telak 91 in Finnish service. The 2S5 is notable in that it can fire 0.1-2 KT nuclear rounds. Russian forces used the 2S5 in the First and Second Chechen Wars, and the Ukrainian forces are currently using it in their war with the Russians.

The 152mm 2A37 howitzer (a variant of the ground-mounted 2A36 field gun) is one of the first long-barreled 152mm howitzers employed by the Russian Army. It is capable of firing virtually any 152mm round in the Russian inventory, except for some of the most up-to-date CLGPs. The maximum depression is -2.5 degrees; maximum elevation is +58 degrees. It is actually capable of direct fire and has a limited traverse of 15 degrees to each side; HEAT rounds were designed for the 2S5 and 2A36. Elevation is relatively low at +58 degrees; depression is -2.5 degrees. The gun does not have a full autoloader, but it does have a loading assist device, including a lifting device to the breech and a power rammer. The howitzer is mounted in an open position on the rear deck of the vehicle; when firing, a spade is lowered in the rear and front to brace the vehicle. The 2S5 can actually carry the respectable amount of 30 rounds onboard for the howitzer, including fuzes and charges. Secondary armament consists a light machinegun in an OHWS-type mount; the commander can aim and fire (but not load) the machinegun with the hatches closed. The aiming device is actually the same as used on the BM-21 MLRS, the D726-45 Mechanical Sight consisting of a PG-1M panorama and OPChM-91A Optical Sight.

Nominally, the 2S5 has a crew of seven; however, only five ride in the 2S5 when traveling; the other two ride in the ammunition supply truck and get on the gun when pulled into a combat position. When traveling, the vehicle commander is seated in a raised superstructure behind the driver, and has a cupola with a machinegun and a white light/IR spotlight. The driver is on the front right of the vehicle, in front of the commander's position. The other crewmembers are seated in the rear of the vehicle when traveling and have a ramp in the rear face. When the weapon is in action, the gunner sits to the left of the gun, with a shield to his front only. The driver and commander have IR vision blocks for their positions; the commander's position also has a searchlight, which can be operated with hatches closed. Three minutes are required to bring the gun into action, and three more to take the gun out of action. The gun has a nominal fire rate of 5-6 rounds per minute.

Of course, crew protection, especially when in firing position, is the 2S5's weak point. When in action, there is no protection for any of the crewmembers, with the exception of the AV2 gun shield to the front of the gunner. When traveling, the four crewmembers inside have a maximum of 15mm of steel armor; from some angles, small arms can penetrate the 2S5. (Of course, this is better than the supply trucks...) The crew has an NBC overpressure system, but a vehicular collective NBC system is essentially impossible to implement on such a vehicle. There is a machinegun at the commander's hatch, and there are racks for an SA-14 SAM and an RPG-7 Rocket Launcher.

The engine of the 2S5 is the same V-59 turbocharged diesel as on the 2S3, developing 520 horsepower, coupled to a semi-automatic transmission. There are shock absorbers on the first two and last two roadwheels, leading to a reasonably comfortable ride. The chassis is the Krug chassis, used for many medium and some heavy antiaircraft missile systems. The 2S5 has a manual transmission, though it has conventional controls. The 2S5 is air-transportable, can be transported as a sling load under a heavy-lift helicopter, and is air-droppable.

The 2S5M

The Russians have recently been updating their 2S5s, replacing the analog and manual electronics with a digital fire control suite, GLONASS land navigation system, the Russian version of a Blue Force/Red Force tracker, and a vehicle state computer. This results in a complete electronics suite similar to that of the 2S3M2. The electrical system has also been upgraded to handle the extra load, new radios have been installed, and a 5-compartment fire detection and suppression has been installed. These upgraded vehicles are for the small amount of 2S5s still in the Russian military as well as the export market.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
2S5	\$492,078	D, A	500 kg	28.2 tons	5	23	Passive IR (D, C), WL/IR Searchlight (C)	Shielded**
2S5M	\$1,098.594	D, A	430 kg	28.48 tons	5	26	Passive IR (D, C), WL/IR Searchlight (C)	Shielded**

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor*
2S5	134/94	37/26	400	193	Trtd	T8	TF1 TS1 TR1 HF8 HS3 HR2
2S5M	133/93	37/26	400	195	Trtd	T8	TF1 TS1 TR1 HF8 HS3 HR2

Vehicle	Fire Control	Stabilization	Armament	Ammunition
2S5	None	None	152mm 2A37 L/54 gun/howitzer, PKT (C)	30x152mm, 1500x7.62mm
2S5M	+2	None	152mm 2A37 L/54 gun/howitzer, PKT (C)	30x152mm, 1500x7.62mm

*The Turret AVs are for the gun itself. The crew has no actual protection when on the gun, other than the gunner's gun shield.

**This protection, as well as the NBC Overpressure system, apply only when the crew is inside the vehicle, if the crew is working the gun, they are not so protected.

Uraltransmash 2S7 (SO-203) Pion

Notes: This is the heaviest self-propelled howitzer employed by the Russian Army. It is normally a front-level asset, used for heavy bombardment of high-priority enemy fortified positions and heavy enemy troop concentrations, and to support large attacks. Since it was first identified by the West in 1975, it is also known as the M1975. It is estimated that over 1000 have been built; most have been retained by the Russian Army, but five former Soviet Republics and Slovakia inherited the gun from the Russians or the former Czechoslovakian Army. Slovakia is known to have only two, neither of which are in active service, but kept in operational shape. Poland formerly used the 2S7, but in 2006 they sold them back to the Russians. The rest of the countries that have them do not keep them in operational status, using them as museum pieces or having scrapped them. The Russians used some in the invasion of Afghanistan and is still using them in their war in Ukraine; the Georgians used six of them against the Russians during the war of 2008. (Interesting note – these 2S7s were originally meant for the Russians to use against the Georgians, but the Georgians captured them and their ammunition when they entered the country on the railroad. They never gave them back after the war.) Other countries which have them in active inventory include Angola, Azerbaijan, North Korea, Ukraine, and Uzbekistan. None have used them in actual warfare. Belarus has 36 kept in working condition, but in reserve. It is notable that, while marketed for a few years, it has not been seen on the international marketplace in about a decade.

The 2S7 uses a lengthened T-80 chassis as a base, with some components of the T-72 and some components of the Krug chassis system. An almost unarmored chassis; the purpose is to move the massive gun around, and they were never expected to be anywhere the front lines. Huge spades are lowered at the rear before the gun is raised into firing position. The 2A44 203mm gun is mounted on a turntable at the rear of the 2S7; the gun has a limited traverse of 15 degrees to each side. Maximum elevation is 60 degrees, while maximum depression is 0 degrees. (Despite the minimum elevation, no provision has been made to give the 2S7 direct-fire capability.) The rounds are specialist rounds designed for the 2S7, and they include nuclear rounds with yields of 0.1-2 kilotons. Only four rounds are carried on the 2S7; the rest are carried on at least two heavy trucks for ammunition supply. The four carried are for immediate-response fire missions. The crew is nominally 14, including ammunition bearers, but seven are carried on those trucks, with the other seven carried in the ammo vehicles. (Often, only one ammo truck is used, as the 2S7's firepower is not often called upon.) A trackway can be extended to the loader from the supply vehicles. The gun has an elevating mechanism to the breech, a power rammer, and a mechanism to insert the round into the breechway, ready for the rammer. Normal rate of fire is 1.5 per minute, though this can be doubled, considering this hard work for that period. 5-6 minutes are required to make the 2S7 ready for action (assuming all seven vehicle crewmembers work to do so), and 3-5 minutes are required for the 2S7 to come out of action and be ready to travel. An interesting feature of the 2S7's gun is a firing alarm – the blast and noise of the gun actually produced a large amount of overpressure in the general area, and troops in the area must take cover when each shot is fired. (The alarm sounds five seconds before the shot until the shot is actually fired.) The gun is equipped with a loading assistance basket, but not a full autoloader, though it does have a power rammer. The sights are essentially the same set as those of the 2S5.

Other weapons normally carried by the 2S7 is a light machinegun, which can be placed on a pintle at the commander's position, but is not normally mounted. An SA-16s are also carried in case of air attack, along with three reloads; an RPG-7 is also normally carried in case of armor attack, along with six reloads.

When the crew is operating the howitzer, it does not have any protection from attack, and there is no Kevlar shield set as there is on the similar US M-107 and M-110 self-propelled howitzers. The 2S7 is normally followed around by a variety of command and resupply vehicles; most of these are heavy trucks or vehicles based on the MT-LB, PTS-M or PTS-2, or AT-T, and these normally include one or two FDC vehicles and command vehicles. It does have an NBC Overpressure system when the hatches are closed, but they rely on individual masks when on the crew and firing the 2S7. Electronics-wise, the 2S7 has two long-range, one medium-range, and one short-range radio. A basic fire control gun-laying computer and a basic inertial navigation with a mapping module.

Using a T-80 as a base, the 2S7 used a gas turbine V-46-1 engine, developing 780 horsepower (many of the improvements later carried out consisted solely of a change of the engine with a turbocharged diesel developing the same horsepower, but taking up less space. The 2S7 also carries an 18.6-kilowatt APU to power the systems when the engine power is off. Fuel consumption of the engine is huge, making the APU mandatory.

The 2S7M Mialka

Like most other Russian self-propelled artillery vehicles, the Russians have in recent years updated their 2S7s to the 2S7M standard. The 2S7M has a new fire control suite, land navigation suite with GLONASS receiver and an inertial navigation backup, fire control computers allowing it to act as its own FDC (though there is still usually an actual PDC vehicle to coordinate fires from a wide area and a variety of support sources), a BMS with vehicle state computer, and a general laptop containing primarily firing tips and procedures and technical information on the 2S7M and its associated vehicles. However, the 2S7M also has a full autoloader fed by an eight-round magazine, which increases the ROF to 2.5 rounds per minute. The 2S7M has also been given an updated version of the 2S7's engine, the V-46-I, which develops 840 horsepower and is turbocharged. The new autoloader also means that the vehicle crew is reduced by one, with the space occupied by former crewmember now occupied by the four more rounds that the 2S7M carries onboard. When firing, the assistant gunner usually stays in the vehicle, managing the fire control computers and associated radios; in addition, the commander usually stays inside the vehicle managing the radios and fire orders and assisting with the computers.

Twilight 2000 Notes: Though the 2S7 is capable of firing nuclear weapons, and there were a few recorded incidents of this being done during the Twilight War, Russian commanders were either loathe doing that (as some of the thermal, radiation, and fallout effects could engulf the gun position) or did not have many of them.

Merc 2000 Notes: The size and expense of operating the Pion meant that it was rarely used.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological**
2S7 Pion	\$593,596	D, A	500 kg	46.5 tons	7	37	Passive IR (D, C), WL Spotlight (C)	Shielded
2S7M Mialka	\$1,569,845	D, A	469 kg	46.63 tons	6	26	Passive IR (D, C), WL Spotlight (C)	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
2S7 Pion	124/87	34/24	500	231	Trtd	T6	TF2 TS1 TR1 HF4 HS3 HR2
2S7M Mialka	131/92	36/25	500	311	Trtd	T6	TF2 TS1 TR1 HF4 HS3 HR2

Vehicle	Fire Control	Stabilization	Armament	Ammunition
2S7 Pion	None	None	203mm L/56.2 2A44 Howitzer, PK, SA-16, RPG-7	4x203mm, 1500x7.62mm, 3xSA-16 SAMs, 6xRPG-7 Rockets
2S7M Mialka	+2	None	203mm L/56.2 2A44 Howitzer, PK, SA-16, RPG-7	8x203mm, 1500x7.62mm, 3xSA-16 SAMs, 6xRPG-7 Rockets

*The Turret AVs are for the gun itself. The crew has no actual protection when on the gun, other than the gunner's gun shield.

**The crew has complete NBC protection when in the vehicle, including NBC Overpressure. When they are manning the gun, they have none of the protection the vehicle affords.

Uraltransmash 2S19 Msta-S

Notes: This replacement for the SO-152 was first seen in 1989 in Russia, and is perhaps the first Russian SP artillery piece that is not named after a flower (Msta is the name of a river in Western Russia, popular with fishers and vacationers). Operators consist primarily of Russia and former Russian Republics, along with Ethiopia, Venezuela, and Morocco. (Morocco attempted to buy these vehicles "on the sly;" though the sale was found out, how many Morocco bought is unknown.) Though development of the 2S19 began in 1980 under the project name Ferma (as Ob'yekt 316), new developments in military vehicle design and ordnance led to continual upgrades, and production did not begin until 1989. The 2S19 was used in combat in the Second Chechen War, and continues to be used by both sides in Russia's incursion into Ukraine.

The 2S19 is based on the combined chassis of the T-80 and T-72; it has a version of the T-80's hull, but the latest T-72's engine. Armor is considerably lessened, but as SP artillery units generally stay out of combat, this is accessible. The armor of the 2S19 is, however, much better than most SP artillery of its generation. The howitzer's nomenclature is the 2A64, and is essentially an SP version of the Msta-B ground-mounted howitzer. Before firing, a dozer blade may be lowered to stabilize the vehicle; this blade can also dig emplacements. The gun can be fired without this stabilization, but the rocking of the 2S19 can become quite severe, possibly causing crew injury. The gun is capable of firing all known 152mm ordnance, including specialist rounds like the Krasnopol CLGP (and the Krasnopol-M, which fits in the autoloader), as well as tactical nuclear rounds. Elevation maximum is +68, with a depression maximum of -4 degrees. In a nod to this, a minimum of two HEAT rounds for the main gun are carried. The howitzer has a fume extractor.

The 2S19 has a semi-automatic gun laying system; once the crew knows the target's position and its own position, it can fire further fire missions on the same target or targets within 2 kilometers without further input from an FDC. The gun has an autoloader which feeds from six five-round magazines in the rear of the turret. A further 20 rounds are carried in various areas around the turret and towards the back of the vehicle; these normally carry unusual or little-used types of ammunition or rounds that are not the right size to fit into one of the autoloader magazines. Nominal rate of sustained fire is 6-8 rounds per minute; this rate can be doubled for up to 10 minutes, with each member of the crew tiring as if heavy work was performed. The 2S19 has an inertial navigation system, but not with a fully-computerized navigation/mapping module, It does carry several long-range and medium-range data-capable radios.

The engine used, as stated above, is a version of one used on a variant of the T-72. The engine is a V46-6 turbocharged diesel, developing 780 horsepower; it has an automatic transmission and conventional driving controls. The 2S19 can lay a smoke screen by injecting diesel fuel into its exhaust. The engine is a multifuel engine, capable of running on diesel, gasoline, alcohol, AvGas, JP4, JP5, and JP8. The 2S19 is not amphibious, but is capable of deep-fording (basically up to the just below the hatchway of the driver). A 16 kW APU is installed for operation with the engine switched off; this runs off of vehicle fuel tanks and can use the same fuels as the 2S19 (assuming the proper modifications have been made).

Appearance is basically similar to other SP artillery vehicles of its generation, with a very large turret and relatively small hull. When in an emplaced position, the resupply vehicles will generally bring out extra personnel for loading and handling ammunition, and trackways and conveyor belts are also normally carried by resupply vehicles. Resupply can be done through the rear of the turret or the back door in the hull (also for crew ingress and egress).

The driver sits in the front left, with the large turret in the center of the vehicle. The gunner is on the left side of the turret and the commander on the right. The commander has a heavy machinegun mount by his hatch that may be aimed and fired from within the vehicle. Ammunition for this gun is extremely limited, and it is primarily a defensive weapon. The crew has an NBC Overpressure

system with a vehicular NBC backup. The 2S19 also has a 16kW auxiliary power unit that allows the vehicle's radios and gun mechanisms to be powered without running the engine.

The 2S19M1

Introduced in the early 1990s, the 2S19M1 had an upgraded electrical system as well as a GLONASS system (with the inertial navigation kept as a backup) and a full land navigation and mapping computer. It also has fully-automatic gun laying, and no longer requires the use of an FDC (though one is often used for full coordination with other units and support vehicles and aircraft). The gun was also rebarreled to L/54. The 2S19M1 has been re-engined with a V-84A turbocharged diesel developing 840 horsepower (though the same APU was kept).

The 2S19M1-155

As might be surmised from the designation, this export model, introduced to the international marketplace in 2006, is equipped with a modified M-835 155mm gun with a barrel length of L/52. The Russians will fit Western fire control, computers, and GPS to the vehicle as desired. Otherwise, only the changes necessary to use the 155mm gun and ammunition have been made to the vehicle and its electronics. Thusfar, no sales have been made.

The 2S19M2

Introduced in 2013, the 2S19M2 is a marked improvement to the 2S19M1, having a new digital fire control system which increases ROF to 8-9 rounds per minute, or double that for short bursts. The land navigation system has been improved with a more agile computer, allowing navigation to be computed on the fly at top cross-country speed. This improvement also speeds up coordinate input time, reducing the preparation to fire time by 30 seconds. There is the equivalent of a laptop computer, containing manuals, technical orders on the 2S19M2 and associated vehicles, as well as the rounds the gun uses, and is linked to the radios so that it can receive maps, plans, OPORDs, etc. – Essentially the equivalent of a BMS with vehicle state computers.

The 2S33 Msta-SM2

This version is just getting into Russian service, entering LRIP in 2017, and with an uncertain future due to budgetary concerns; in 2016, the Russian Army ordered an initial batch of 30, but they have received only half of these as of late 2018. The main gun has been replaced by a version called the 2A79, which can fire ammunition with more propellant charges and with a higher breech pressure, allowing for markedly-increased maximum ranges, such as the base rounds having a range of 40 kilometers versus the 25-kilometer range of the earlier 2S19 versions. Assisting in this is a longer main gun, which also uses a heavier barrel with a more-efficient fume extractor. The turret also has more efficient ventilators as well as an air conditioning system. Additional attention is given to top-attack and mine/IED attacks.

The 2S30 Iset

I have not been able to find out enough about this version to develop stats for it; as of late 2018 it is still in the preliminary stages of development. Improvements are said to center around more efficient computers and a higher level of automation. Some sources state that both domestic and export versions are being designed, the latter with 155mm guns. There are no stats below, and the entry is only here for completeness.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
2S19 Msta-S	\$874,752	D, G, AvGas, A, Jet Fuel	500 kg	42 tons	5	25	Passive IR (D, G, C), Image Intensification (G, C), Thermal Imaging (C)	Shielded
2S19M1 Msta-S	\$1,098,807	D, A	540 kg	42.24 tons	5	26	Passive IR (D, G, C), Image Intensification (G, C), Thermal Imaging (C)	Shielded
2S19M1-155 Msta-S	\$1,119,247	D, A	502 kg	42.39 tons	5	27	Passive IR (D, G, C), Image Intensification (G, C), Thermal Imaging (C)	Shielded
2S19M2 Msta-S	\$1,489,024	D, A	539 kg	42.25 tons	5	23	Passive IR (G, C), Image Intensification (D, G, C), Thermal Imaging (G),	Shielded

2S33 Msta-SM2	\$1,595,788	D, A	422 kg	42.72 tons	5	25	FLIR (C) Passive IR (G, C), Image Intensification (D, G, C), Thermal Imaging (G), FLIR (C)	Shielded
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Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
2S19 Msta-S	134/94	37/26	1000	289	Trtd	T6	TF19Sp TS10 TR8 HF24Sp HS8Sp HR6
2S19M1 Msta-S	142/99	39/28	1000	312	Trtd	T6	TF19Sp TS10 TR8 HF24Sp HS8Sp HR6
2S19M1-155 Msta-S	141/99	39/28	1000	313	Trtd	T6	TF19Sp TS10 TR8 HF24Sp HS8Sp HR6
2S19M2 Msta-S	142/99	39/28	1000	312	Trtd	T6	TF19Sp TS10 TR8 HF24Sp HS8Sp HR6
2S33 Msta-SM2	140/98	39/28	1000	315	Trtd	T6	TF19Sp TS10 TR8 HF24Sp HS8Sp HR6*

Vehicle	Fire Control	Stabilization	Armament	Ammunition
2S19 Msta-S	+2	Basic	152mm L/47 2A64 gun/howitzer, NSVT (C)	50x152mm, 300x12.7mm
2S19M1/M2 Msta-S	+2	Basic	152mm L/54 2A64M gun/howitzer, NSVT (C)	50x152mm, 300x12.7mm
2S19M1-155 Msta-S	+2	Basic	155mm M-835M howitzer, NSVT (C)	50x155mm, 300x12.7mm
2S33 Msta-SM2	+2	Fair	152mm L/60 2A79 gun/howitzer, NSVT (C)	50x152mm, 300x12.7mm

*Turret Roof AV is 5Sp. Hull Roof AV is 5. Hull Floor AV is 6Sp.

Uraltransmash 2S35 Koalitsiya-SV

Notes: The 2S35 was first seen in rehearsals for the 2015 Moscow Victory Day Parade. Despite this, the 2S35 is still in the preliminary stages of development, and specifications seem to change every few months. Meant to be a partial replacement for the 2S19 and earlier vehicles, the 2S35 is not hitting the chronic Russian budgetary problems, and in any event is not expected to be in even LRIP until 2020. Thus, only 12 have been delivered to Russian forces as of 2018. For the most part, the design is said to be revolutionary, using a modification of the 2S19's turret on the chassis of a T-90 or T-14. (And crazier ideas were also tried out...) Current design work appears to center around the T-90 chassis topped with a greatly-enlarged 2S19 turret, possibly with a T-14 engine and transmission. In addition, a special resupply vehicle is also believed to be in design.

The 2S35 is probably equivalent to the 2S30 Iset in conception – a highly-automated, digitized, and computerized self-propelled artillery gun. It appears to have taken several design cues from the defunct US Crusader SPH program, as the crew are seated on the front deck ahead of the turret in self-contained armored capsules, each with NBC Overpressure systems, space for rations and a ration heater, a small refrigerated water tun, and an amount of personal gear. Other spaces in the hull contain bulkier personal gear for the crew, and there is a tunnel to allow crewmembers to go to the turret and service the gun, though fire missions themselves are done from within the crew capsules. Each crew capsule has its own fire detection and suppression system, as well as NBC Overpressure system. Both the gunner and commander have full gun firing controls, though in practice this job is normally split between the two or done solely by the gunner. There is an RWS atop the turret mounting a Kord heavy machinegun; this is fed by a single long belt, has automatic jam clearing (under most circumstances) and is otherwise aimed and fired from the commander's, gunner's, or driver's positions, though normally the commander controls this RWS. The crew can also enter the turret, and there is space and positions for them to fight from the turret if necessary. Armor is somewhat heavier than on a 2S19, the in addition to the crew fire detection and suppression systems, there are such systems for the engine, transmission, engine, fuel cells, and two in the turret (concentrating on the gun and ammunition magazines). Just to be sure, the 2S35 has five smoke grenade launchers on each side of the turret, and it can lay a thick, oily smoke screen by injecting diesel into its exhaust.

The 2S35 essentially has a version of the 2S33's electronics, fire control, BMS, and vehicle state suites, but on steroids. They are designed to operate completely remotely, though they have backups in the turret. The commander and the gunner have full fire control systems as well as the BMS, vehicle state, and gun state computers. All three crewmembers have full access to the radios, as well as the navigation computers. The commander also has access to a small computer with everything from technical manuals on the 2S35 to specifications on the ammunition and computer systems. The driver actually has enhanced access to the navigation suite, giving information on the navigation parts of the BMS, full navigation with waypoints, friendly fuel and replenishment positions,

and projected range with available vehicle fuel onboard. The crew does not have to leave the vehicle if outside troops are available to replenish supplies and ammunition, as they are brought in through hatches in the rear of the hull and turret. The crew has a full night vision and long-range day vision suite, including access to sensors in the turret and a backup camera for the driver.

The gun, the 2A88, is fed by several autoloaders, and they are able to feed both normal and special rounds. A new GPS-guided round is said to have been developed for the 2A88, which has a range of 70 kilometers. The gun has a fire rate of 8 rounds per minute; increasing the rate of fire by doughty work of the crew is not possible, though MRSI fire is possible and an initial barrage of five rounds in ten seconds is also possible if the target coordinates are known when the 2S35 has come to a stop. In a normal barrage, two bracing struts are lowered at the rear of the vehicle, though again those first five rounds may be fired without the struts. The 2A88 is fed from fourteen 5-round magazines, with the autoloader also loading the charges. The fuzes are affixed when the round is loaded, but electronically programmed by the fire control computers before firing. The charges are ignited by an electrical system instead of a conventional primer system.

The chassis is a modified form of that of the parent vehicle; Current 2S35s use the chassis of a T-90, with the primary modifications being to the electrical system and to the front of the hull to accommodate and protect the crew. Currently, the 2S35 gets ammunition replenishment from an 8x8 military truck chassis, modified for the purpose. A special reload vehicle is said to be in development, which will be used for the 2S35 and 2S19. The 2S35 has a self-entrenching blade at the front, which can also be used as a secondary stabilizing device during long bombardments. The entrenching blade can dig a hull-down position in 12-40 minutes, depending upon the terrain surface.

The T-90 chassis is powered by a 1000-horsepower turbocharged diesel engine, an upgraded version of the V-84MS engine used in the T-90. It is equipped with more shock absorbers than the standard T-90, to better allow the 2S35 to compute fire solutions on the move. The vehicle is equipped with a conventional driver control setup, with "T-Bar" directional control column instead of a steering wheel. The transmission is automatic with a manual backup, and the 2S35 has power steering and power brakes, as well as a power-assisted gear shifter (all of which have manual backups). The driver is in the middle of the front hull in front of the turret, with the commander to the right and gunner to the left. Only the commander and gunner have hatches; the driver works his way out of the driver's or gunner's hatch. In addition, there are two hatches in the turret roof (if occupied, normally by the commander and gunner), and the hatches in the hull and chassis rear, many for replenishment. Up to four conveyor belts may be fitted to the 2S35 (two to the turret and two to the hull; in the case of external replenishment of ammunition, two loaders work to place the special fuzes on the rounds, put the rounds into the correct magazines, and put the charges in the right place for the autoloader to use them. For operation without the engine on, a 20kW APU is fitted in the lower right rear of the turret. This runs off the vehicular supply of diesel.

The hull and turret can mount Kontakt-5 ERA, on the hull front, hull sides, and all sides of the turret as well as the front half of the turret roof. The turret roof also mounts the Arena Active Protection System, which defends against incoming rounds. As stated above, the crew capsules and turret have an NBC Overpressure system, as well as vehicular NBC backup to plug into. The crew capsules and turret also have air conditioning and heating.

The 2S35-155 Koalitsiya-SV

This is an export model armed with a 155mm L/52 howitzer, said to be derived from the design of one or more NATO countries, but domestically-produced without license. Other than the changes required to convert the 2S35 to fire 155mm rounds (primarily in the fire control software, magazines, and autoloader), it is identical to the standard 2S35.

The 2S35M – A Koalitsiya on a T-14 Armata chassis

"2S35M" is not an official designation for this possible version of the 2S35; it is my own estimate as to what the vehicle would be called, and the game references to it. Whether this version will ever be built is in question; the Russians have enough of a budgetary problem introducing the T-14 Armata tank and to a greater extent, its subtypes, and whether a 2S35 on a T-14 chassis is a serious question. So far, as of late 2018, only one prototype has been built, and the Russian Military budget even limits the amount of testing that may be conducted with this prototype, as all new artillery efforts are based in the standard 2S35 and the T-14 tank, respectively. The main difference between the T-90-based 2S35 and the T-14-based 2S35M would be the better armor protection in the hull and a slightly greater weight, as the T-14's hull is slightly heavier than the T-90's hull. The front of the hull of the 2S35M mimics the crew capsules of the T-14. The vehicle would also be faster and more agile, as the standard T-14 engine is much more powerful.

The Original Prototypical 2S35

Russia displayed a totally different vehicle prototype in 2006, also called the 2S35 at the time. This vehicle is sort of an upgraded 2S19 with some components of the 2S19 and the then-later 2S35; much of the fire control, navigation, BMS, vehicle state computers, and OWS are the same as on the 2S35. However, this original 2S35 was fitted with a pair of 152mm 2A64M howitzers, which could be singly or two at a time. The modified 2S19 was equipped with nine 5-round magazines and bins holding 15 more special-use rounds to be loaded manually. The buffering of the guns when fired takes up much of the recoil, yet recoil was still considered excessive. The crew is housed in the turret and hull; it does not have the crew capsules of the later "real" 2S35s. Fire control software is updated to allow for the firing of two howitzers. If one gun fails, the autoloader can use the ammunition magazines allotted to the other howitzer. The guns did not fire at once; the firing is staggered by a few seconds to reduce system heat and turret fumes. The guns can be depressed enough to allow direct fire; in such a case, one round hits (if a hit is rolled), and the other shot will hit within a circle 1d6 meters wide. In the end, it was decided that the kinks could not be worked out of the system in any reasonable period of time. Another problem is tactical – if this kind of 2S35 is destroyed, two howitzers have been taken out, while with a single-

howitzer system, only one gun is destroyed. Again, in the case of malfunctions, they will affect only one gun on a single-gunned SP howitzer instead of two. Finally, it was not believed that a double-gun system would sell well on the international arms market.

The 2S35-1 Koalitsiya-KSh – 2S35 on a budget

The 2S35-1 truck-mounted Koalitsiya system was designed not only for lighter Russian independent brigades and divisions, but for export customers who want a world-leading artillery system, but can't afford the full 2S35. The 2S35-1 uses the same 2A88 howitzer of the 2S35, along with most of the electronics, fire control, and navigation package, inside a reduced-size and reduced-armor turret and on an armored version of an 8x8 military truck. (The Russians will be flexible for export customers about the truck on which it will mount the turret, but the current version is based on the KamAZ-6560). The turret keeps the basic form and internal configuration of the 2S35's turret, including the autoloading system and replenishment system, But the size of the turret has been made smaller, primarily by reducing the amount of ammunition carried to 12 magazines of five rounds and to a smaller extent, rearrangement of internal equipment. The gun system is, however, able to conduct all fire missions that can be done with the 2S35, and has all the internal equipment of the 2A88 system.

The cab of the KamAZ truck has an enlarged cab containing the crew and the fire control system. The cab is also equipped with several data-capable radios. The cab is equipped with a vehicle state computer and a land navigation system, though not the BMS system of the 2S35. Maximum rate of fire remains about 8 rounds per minute. The 2S35-1 can be ready to fire within 90 seconds of a halt (if the target position is known before the halt and the gun may begin to slew into place before the truck is halted); in that time, the gun is laid on target, the autoloaders have indexed a magazine and loaded the first round, and struts have been lowered at each corner of the truck. The gun can similarly be out of action and ready to travel in the same 90 seconds. The crew does not have to leave the cab to conduct a fire mission, though if necessary, a fire mission can be conducted from within the turret. Normally, the driver and commander sit in the front of the vehicle, while the gunner is in the rear of the cab.

The cab is armored against even medium-caliber rifle bullets (such as those fired by most snipers) as well as shell splinters. The cab (and the turret) are equipped with an NBC Overpressure system as well as a vehicular NBC backup. The cab and the turret are also radiologically-protected. The cab doors are heavy enough that they require a hydraulic assist to allow the crew to open them. The windows are some 12 centimeters thick, and have the same armor value as the face they are in. The side windows cannot be rolled down.

The KamAZ-6560 is a long-bed truck with four wheels on the front and four wheels on the rear. The engine used on the 2S35-1 is a KamAZ-740 35-400, a turbocharged diesel capable of 400 horsepower. The front bumper has a self-recovery winch with 200 meters of cable and a pull strength of 40 tons. The tires are run-flats and are puncture-resistant, and have central tire inflation.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
2S35 Koalitsiya-SV	\$1,854,267	D, A	500 kg	55 tons	3	31	Passive IR (G, C), 2 nd Gen Image Intensification (D, G, C), FLIR (G, C), Backup CCD Day/Night Camera (D)	Shielded
2S35-155 Koalitsiya-SV	\$1,882,083	D, A	455 kg	55.19 tons	3	29	Passive IR (G, C), 2 nd Gen Image Intensification (D, G, C), FLIR (G, C), Backup CCD Day/Night Camera (D)	Shielded
2S35M Koalitsiya-SV	\$1,870,617	D, A	600 kg	58 tons	3	41	Passive IR (G, C), 2 nd Gen Image Intensification (D, G, C), FLIR (G, C), Backup CCD Day/Night Camera (D)	Shielded
2S35 (Original Prototype)	\$1,517,038	D, A	349 kg	43.01 tons	4	26	Passive IR (G, C), Image Intensification (D, G, C), Thermal Imaging (G), FLIR (C)	Shielded

2S35-1 Koalitsiya- KSh	\$1,450,907	D, A	422 kg	35 tons	3	19	Passive IR (G, C), 2 nd Gen Image Intensification (D, G), Thermal Imaging (G, C), Backup CCD Day/Night Camera (D)	Shielded
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Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor		
2S35 Koalitsiya-SV	132/93	37/26	1200	373	Trtd	T6	TF35Sp	TS15Sp	TR10 HF45Cp HS15Sp HR12*
2S35-155 Koalitsiya-SV	132/93	37/26	1200	374	Trtd	T6	TF35Sp	TS15Sp	TR10 HF45Cp HS15Sp HR12*
2S35M Koalitsiya-SV	146/103	41/28	1200	446	Trtd	T6	TF35Sp	TS15Sp	TR10 HF55Cp HS20Sp HR14**
2S35 (Original Prototype)	140/98	39/27	1000	312	Trtd	T6	TF19Sp	TS10	TR8 HF24Sp HS8Sp HR6***
2S35-1 Koalitsiya-KSh	94/66	26/18	550	147	Trtd	W(5)	TF20Sp	TS10Sp	TR6 HF5Sp HS4Sp HR4****

Vehicle	Fire Control	Stabilization	Armament	Ammunition
2S35 Koalitsiya-SV	+2	Fair	152mm L/54 2A88 gun/howitzer, Kord (RWS)	70x152mm, 1500x12.7mm
2S35-155 Koalitsiya-SV	+2	Basic	155mm L/52 M-835M howitzer, Kord (RWS)	70x152mm, 1500x12.7mm
2S35M Koalitsiya-SV	+2	Basic	152mm L/54 2A88 gun/howitzer, Kord (RWS)	70x152mm, 1500x12.7mm
2S35 (Original Prototype)	+2	Fair	2x152mm L/60 2A79 gun/howitzer, NSVT (C)	50x152mm, 300x12.7mm
2S35-1 Koalitsiya-KSh	+2	None	152mm L/54 2A88 gun/howitzer, Kord (RWS)	60x152mm, 1500x12.7mm

*Hull and turret Roof AV is 7. Floor AV is 7Sp.

**Hull Roof AV is 8Sp. Turret Roof AV is 7. Floor AV is 8Sp.

***Turret Roof AV is 5Sp. Hull Roof AV is 5. Hull Floor AV is 6Sp.

****Cab Roof AV is 4. Turret Roof AV is 7. Floor AV is 4Sp, except under the cab, where it is 5Sp.

Denel/GDLS Canada LAV III/T7 (LAV III Light SP Howitzer)

Notes: Though using the LAV III as a base, this version with a compact turreted 105mm howitzer was developed primarily by Denel. (Users of the LAV III and Stryker are reportedly already interested in the design, and the South Africans are already advertising it as the LAV III Stryker T7.) It is also known as the LSPH (Light Self-Propelled Howitzer). Denel approached GDLS Canada after the cancellation of the US NLOS-C, which South Africa was to be a major player in. GDLS is also a major player, and Rheinmetall is developing a new range of ammunition for the gun. The Stryker Brigades are already putting the LAV III Stryker through heavy field testing, and the US Marines are reportedly also interested. Other possible future users include South Africa, Canada, Britain, and Australia.

The T7 turret makes the LAV III a useful fire support platform, while keeping the advantages of the LAV III. Key to the development of the T7 turret was the development of a new lightweight howitzer cannon, including the incorporation of new materials such as composite laminates in gun and mechanism as well as technology borrowed from the G6 1A3 Rhino heavy artillery vehicle, particularly the electronics.

The LAV III/T7 relies greatly on automation; the crew is only three and one is the driver. The commander also serves as the gunner and there is an assistant gunner. The resulting vehicle is small, and can be airdropped from a C-130 aircraft. Virtually all rounds are autoloading and autorammed. The autoloading elements and fire control elements have a high degree of redundancy. All functions are controlled from flat panels displayed around the turret; even the driver has a screen displaying vehicle state, fuel, and mapping information. The 105mm howitzer does not require any sort of jacks or outriggers to be lowered. The rear door doubles as an ammunition replenishment door. The gun is much longer than most 105mm howitzers at L/52. It is tipped with a multibaffle muzzle brake and a fume extractor, and in a pinch, may be used as a direct-fire vehicle. The gun is fed by two magazines in the hull below the turret – one 56-round projectile magazine, and one 42-charge magazine to the left. The gun has a fully functional autoloader, but if necessary, the commander and assistant gunner may crawl through a tunnel to operate the turret manually. The T7 Gun has even demonstrated the extreme-precision shooting of firing three rounds into the same hole in the target.

As with the LAV III the LAV III/T7 has a Caterpillar 31236 turbocharged diesel developing 350 horsepower and coupled to an automatic transmission. The driver is in the front left with conventional controls, and a night vision block. The drive is 8x8 and has a central tire inflation system, traction control, and antilock braking. The commander/gunner is on the right side of the turret, with the AG on the left; the commander/gunner has a manually-operated cupola with a weapon mount. The AG can also operate as a gunner if needed. However, in most cases, the turret is unmanned, with the commander, gunner, and driver in the front hull, operating the howitzer by remote control. The vehicle has a 10kW APU to run the systems while the vehicle's engine is off.

Add-on appliqué armor as well as MEXAS ceramic appliqué armor is available. (In both cases, this includes an antimine panel on the floor.) The gun itself is actually a gun/howitzer, designed for both direct fire and indirect fire with equal aplomb. It is meant to reduce fortifications as well as fire support missions, as well as the occasional engagement of enemy vehicles and personnel by direct fire. A new line of ammunition was developed to take advantage of this fact. In recognition of the reduced crew, the ammunition is unitary, with combustible shell casings.

Also in recognition of the reduced crew, computers reduce the workload as much as possible, though they allow the LAV III/T7 to act as its own FDC, it can also rapidly and digitally take data from FISTs and FDCs and send them directly to the gun, which at the push of a button will slew and elevate/depress itself to the correct coarse position, requiring only fine adjustments. A GPS and backup intentional navigation system is supplied, along with a mapping computer module.

The LAV III Stryker is airportable via sling load from a heavy-lift helicopter, and internally in an aircraft at least the size of a C-130. Though airdropping and LAPES delivery has not yet been tested, Denel asserts that these methods of delivery will be feasible for the LAV III Stryker.

The T7 turret is also compatible with the Patria AMV and Rooikat, though these configurations have not yet been built.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
LAV III Stryker	\$1,095,671	D, A	680 kg	18.3 tons	3	20	Passive IR (D, C, AG), 2 nd Gen Image Intensification (C, AG), FLIR (C)	Enclosed
With Appliqué Armor	\$1,097,549	D, A	581 kg	18.98 tons	3	22	Passive IR (D, C, AG), 2 nd Gen Image Intensification (C, AG), FLIR (C)	Enclosed
With MEXAS	\$1,129,830	D, A	431 kg	19.48 tons	3	22	Passive IR (D, C, AG), 2 nd Gen Image Intensification (C, AG), FLIR (C)	Enclosed

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
LAV III/T7	165/83	46/23	400	129	Trtd	W(6)	TF7Sp TS6Sp TR4 HF9Sp HS6Sp HR5*
With Appliqué Armor	162/82	45/23	400	131	Trtd	W(6)	TF7Sp TS10 TR7 HF12Sp HS8Sp HR6**
With	160/81	44/23	400	133	Trtd	W(6)	TF10Cp TS8Sp TR4 HF12Cp

Vehicle	Fire Control	Stabilization	Armament	Ammunition
LAV III Stryker	+3	Fair	105mm L/52 T7 Howitzer, MG4 (C)	56x105mm, 2000x7.62mm

*Floor AV is 5; Roof AV is 3.

**Floor AV is 5Sp, Roof AV is 4.

***Floor AV is 5Cp, Turret Roof AV is 4Cp, Hull Roof AV is 4.

Denel T5-52 Condor

Notes: The T5-52 is sort of a counterpart to the French Caesar, but the similarities quickly end as the T5-52 is based on a larger, heavier truck, about a heavy truck. During development, the T5-52 was called the Condor and it still retains that name amongst many of its users and even the chain of command. The T5-52 is offered for export, and has taken part in many Arms Expositions, but so far only India had bought more than evaluation versions. However, SANDF is very interested in the design, and Pakistan has the Condor under consideration. SANDF does appear to be more interested in the L/45 version.

The Condor is based on the Tatra WN 8x8 truck chassis, but the South Africans actually get the trucks from India, where they are manufactured under license. This chassis has a turbocharged diesel engine, developing 355 horsepower. The truck chassis has automatic transmission, power steering and brakes, antilock brakes, traction control, and run-flat tires which are also puncture resistant and have central tire inflation regulation. The cab is enlarged to fit the four crewmembers that normally ride in the cab, as well as their personal gear and a 30-liter chilled drinking water tank. The cab has air conditioning and heating, as well as a Vehicular NBC system. The truck can ford 1.4 meters and cross a 2-meter trench. Suspension is 8x8. The Condor is fitted with a 30kW APU to provide complete power for the complete gun mechanisms and electronics of the host vehicle and up to two more Condors or 2-5 other types of vehicles such as FDC or command sections.

Before firing, three stabilizers are lowered; two of these have steps in them to enter the fighting compartment, while the rear jack has a ladder. In testing, the Condor was to have an L/45 gun, but production versions have an L/52 gun. The gun has a compact muzzle brake and a fume extractor. The gun is fed by a magazine; the autoloader takes the projectile from the magazine and a power rammer pushes the projectile into the breech, where manually-loaded charges are added. Fuze affixing is semiautomatic. The gun has the G5-2000 top carriage of the ground-mounted G5. The gun turntable may rotate 360 degrees for travel, but may normally be fired in a 40-degree deflection from the centerline to the rear (Emergency shots may be taken outside of that 80-degree arc, but it is possible that the vehicle will become overbalanced if the gun is fired very far outside that arc.) The gun also has a direct fire capability, with a maximum depression of -3 degrees and a maximum elevation of 75 degrees. The T4-52 has considerable computer power to calculate position of the gun given fire control coordinates; among these is an enhanced artillery ballistic computer allowing the gun to execute MRSI fire and may use any sort of Western or Chinese 155mm ammunition. The gun includes a second autoloader which lifts rounds from the ground and lifts them as a three-round autoloader cassette, from which the round can be loaded into the breech and rammed into position.

The normal crew for the Condor is eight, but only four travel with the Condor, and are in the cab when traveling. Four others are transported on ammunition or supply trucks. No commander's weapon is normally fitted, though the armored versions sometimes mount a light machinegun.

Fire Control and truck electronics include an inertial navigation system with mapping module, generation of fire coordinates, and automatic gun elevation and turning to get the proper shot. Though the onboard system can normally generate accurate fire coordinates, targeting will be more accurate if an FDC is used. The systems may be run off vehicle power or be provided by another vehicle or an external generator. The vehicle's engine has a Power Take-Off for this purpose.

The truck chassis has a 355 horsepower turbocharged diesel engine. Normally, the truck has no armor protection; however, a kit of light armor able to stop assault rifle rounds and shell splinters may be added. Despite this, the crew, when working on the gun, has no armor protection.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
T5-52	\$923,189	D, A	750 kg	28 tons	4(+4)	27	Passive IR (G, C)	Enclosed
With Armor Kit	\$924,974	D, A	574 kg	28.71 tons	4(+4)	27	Passive IR (G, C)	Enclosed
T5-45	\$908,762	D, A	783 kg	27.87 tons	4(+4)	25	Passive IR (G, C)	Enclosed
With Armor Kit	\$910,547	D, A	607 kg	28.58 tons	4(+4)	25	Passive IR (G, C)	Enclosed

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
T5-52	125/63	34/18	700	131	Trtd	W(4)	TF1 TS1 TR1 HF1 HS1 HR1
With Armor Kit	124/62	34/18	700	133	Trtd	W(4)	TF1 TS1 TR1 HF2 HS2 HR2*
T5-45	125/63	34/18	700	131	Trtd	W(4)	TF1 TS1 TR1 HF1 HS1 HR1
With Armor Kit	124/62	34/18	700	133	Trtd	W(4)	TF1 TS1 TR1 HF2 HS2 HR2*

Vehicle	Fire Control	Stabilization	Armament	Ammunition
T5-52	+2	Basic	155mm G5-2000 L/52 Howitzer	27x155mm
T5-45	+2	Basic	155mm G5-DLS L/45 Howitzer	27x155mm

*The AV value listed is primarily for the cab; however, the underside of the vehicle also benefits from the armor kit.

LIW G6 Rhino

Notes: This is the standard South African self-propelled howitzer, and is also in service with Oman and the United Arab Emirates. It is essentially a mobile version of the G5 howitzer. Chile briefly produced the G6 under license as the CC-SP-45, though the vehicle had a short service life in Chile and production was very limited. The New Iraqi Army also uses a version of the G6. The Iraqis called their version of the G6 the Al-Manjoon, The Al-Fao version of the Al-Manjoon's main modification allows for the storage and use of chemical-warhead munitions, something the Al-Manjoon lacks.

The electronics are just short of being able to act as it's own FDC – The G6 still requires an FDC for proper firing information, but once the coordinates are transmitted, the G6's own electronics calculate the fire solution. These are collected into the indirect fire computer, and the gunner must then only push one button for the gun and turret to automatically lay itself. The gun also has a telescopic sight for direct fire out to 3 kilometers, plus the gunner's night vision gear. Both L/45 and L/52 systems are in service with South Africa, who is in the process changing to L/52; most other countries that use the G6 use the L/52 barrel. In addition there is the G6/52, which has more advanced systems. The commander has a heavy machinegun on his manually-operated cupola. Eight smoke grenades launchers round out the armament; these are four per side. The ammunition bins have blow-off panels. The gun is capable of firing any Western or Chinese 155mm ammunition. The gun has a large muzzle brake and a fume extractor made of glass fiber; this is the subject of some controversy, as a few fume extractors have been discovered with cracks in them. The turret has a rear door on the right for ammunition replenishment. The gun has a maximum elevation of +75 and a maximum depression of -5 degrees.

Armor is fairly decent for its type of vehicle, able to usually stop 20mm hits from the front, and 7.62mm and grenade and artillery shell splinters all around the vehicle. The G6 has an MRAP hull, and is capable of surviving a blast from a TM-46 antitank mine (though it may roll the vehicle over). Power is provided by a 525-horsepower turbocharged diesel, with an automatic transmission and conventional controls. The engine is located behind the driver. Originally, the G6 had 4x6 suspension, with the front axle not being powered; however, this was quickly upgraded to a 6x6 configuration. The crew is protected by an NBC overpressure system and an automatic fire detection and suppression system. Navigation is by GPS. One striking feature of the G6 is a powerful 22kW APU, and the G6 is capable of conducting a fire mission on only the APU as power or of powering several vehicles and command-post-type shelters at once..

The G6 has an interesting driver's position: it is at the front center, self-contained, with unusually large (for an armored vehicle) armored windows, giving the driver excellent visibility. He has a swing-down night vision scope. The driver benefits from an automatic transmission; the driver may also select manual or semiautomatic modes as desired. He has conventional driving controls. The large ballistic glass windows can be protected by swing-down armored panels with vision slits in them. In front of the driver is a wedge-shaped bin that normally stows extra ammunition and doubles as a brush cutter. The driver has no direct access to the fighting compartment; should he wish to go back there, he has to climb out of his compartment, climb up on the turret, and enter through one of the hatches there. The commander is on the top of the right side of the turret, with a manually-operating cupola and all-around vision blocks. One of these blocks has a night channel. The second hatch is essentially for everyone else in the crew. The crew has an air conditioning and heating system, as well as three chilled drinking water tanks, a 10-liter one in the driver's compartment, a 60-liter one in the turret, and a 60-liter one near the rear door. The vehicle commander has a limited ability to drive the G6 from his position should the driver become a casualty.

The G6 is powered by a German-manufactured Magirus Deutz BF12L513 FC V12 turbocharged diesel engine developing 525 horsepower. Instead of being up front like most armored vehicles, the engine is in between the driver and the crew compartments. The G6 has large 21x25 run-flat puncture resistant tires.

G6/52

In addition to having a longer barrel, the G6/52 has additional electronics, self-surveying capability, and the ability to generate its own fire coordinates, thus being able to act as its own FDC. The G6/52 has been successfully tested with the US M982 Excalibur round. The G6/52 mounts a more powerful 34 kW APU mounted outside the turret.

Al-Manjoon and Al-Fao

The Al-Manjoon version of the G6/52 has a crew reduced to five (one less loader), can support sustained fire rates of 8 rounds per minute, has a more powerful version of the standard G6/52 engine which develops 575 horsepower, and is capable of MRSI fire and burst rates of six rounds per minute for 3 minutes. The Al-Manjoon has additional computer power and software, primarily in the area of processing fire requests and passing them on to the fire control computer more efficiently. The Al-Fao version of the Al-Manjoon is capable of firing and storing properly up to six chemical-warhead rounds, but fire rate is reduced to 6 rounds per minute in a sustained bombardment, or a burst rate of 3 rounds per minute when firing chemical rounds. Armor protection is slightly increased. The Al-Fao also has a special FC computer mode for the firing of chemical projectiles. (The Al-Manjoon does not have the storage racks, gun breech, charges, or special FC settings necessary to fire chemical rounds.)

Iraq is considering replacing the commander's M2HB with a CROWS-type station, but details on this have not yet been released, and this version has not been included below.

G6 1A3

In addition to the improvements of the G6/52, the G6 1A3 features a steel fume extractor instead of the glass fiber fume extractor. Additional safety interlocks are installed; for example, it is no longer possible to double-load the gun. The power rammer has been improved, allowing sustained fire rates of six per minute, or a burst rate of about 3 minutes firing at the rate every phase. This pace puts an additional level of fatigue on the crew (except for the driver). The vehicle state is monitored; the driver has a Windows-based touch screen which allows him to monitor all aspects of the vehicle's operation. The commander's touch screen functions integrally with the GPS and mapping module. The gunner has a digital rangefinder and display, meaning he can aim without having to look into eyepieces. The G6 1A3 is capable of MRSI firing. The driver has a simple screen which allows him to drive in the correct route and range, and monitor systems such as the fuel, engine, and transmission. The only user of the G6 1A3 is the UAE; it was specifically designed for their use, but is also available on the export market.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
G6	\$886,610	D, A	750 kg	36.5 tons	6	22	Image Intensification (D, C, G), Passive IR (G, C)	Enclosed
G6/52	\$906,457	D, A	715 kg	36.64 tons	6	24	Image Intensification (D, C, G), Passive IR (G, C)	Enclosed
Al- Manjoon	\$1,071,442	D, A	676 kg	36.8 tons	5	25	Passive IR (C), Image Intensification (D), 2 nd Gen Image Intensification (G, C), Thermal Imaging (G)	Shielded
Al-Fao	\$1,108,342	D, A	676 kg	36.8 tons	5	26	Passive IR (C), Image Intensification (D), 2 nd Gen Image Intensification (G, C), Thermal Imaging (G)	Shielded
G6 1A3	\$1,166,413	D, A	629 kg	36.98 tons	6	25	Image Intensification (D, C, G), Passive IR (G, C), Thermal Imaging (G)	Enclosed

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
G6	122/62	34/17	700	193	Trtd	W(4)	TF14 TS7 TR7 HF18 HS6 HR5
G6/52	122/62	34/17	700	193	Trtd	W(4)	TF14 TS7 TR7 HF18 HS6 HR5
Al-Manjoon	131/66	37/18	700	213	Trtd	W(4)	TF15Sp TS8Sp TR7 HF19Sp HS7Sp HR5*
Al-Fao	131/66	37/18	700	213	Trtd	W(4)	TF15Sp TS8Sp TR7 HF19Sp HS7Sp HR5*
G6 1A3	121/62	34/14	700	194	Trtd	W(4)	TF14 TS7 TR7 HF18 HS6 HR5*

Vehicle	Fire Control	Stabilization	Armament	Ammunition
G6	+1	Basic	155mm L/45 Howitzer, M-2HB (C)	47x155mm, 2000x.50
G6/52	+2	Basic	155mm L/52 Howitzer, M-2HB (C)	47x155mm, 2000x.50
Al- Manjoon/Al- Fao	+2	Good	155mm L/52 Howitzer, M-2HB (C)	47x155mm, 2000x.50
G6 1A3	+2	Fair	155mm L/52 Howitzer, M-2HB (C)	47x155mm, 2000x.50

*The Al-Manjoon, Al-Fao, and G6 1A3 have a Hull Floor of 5Sp in addition to their normal MRAP hull.

Samsung Techwin K9 Thunder

Notes: K9 development began as an upgrade program for their K-55s (versions of the US M-109A2) to bring them up to the M-109A6's level, in the early 1990s. The K9 program outgrew this effort quickly, becoming its own weapons system in earnest. The K9 became operational in 1999, and remains the South Koreans' top mobile artillery solution. The South Koreans have since been working on an ammunition supply vehicle, the K10, and the K9 is also produced in an export version for Turkey, the T-155. The K9 is also a contender in the final phases of the search for a replacement for Australia's SP artillery system. The K9 was involved in the Bombardment of Yeonpyeong during the 2010 border incident. Some 300 are in service with the ROK Army. Design work began as far back as 1989, but field testing did not begin until 1998, and service use did not begin until 1999. In addition, a 10 test versions, known as the K9 Vajra-T, have been sold to India for field testing, and the Finnish use a version called the K9FIN Moukari (Sledgehammer). The Indians have indicated that the Vajra-T exceeds their requirements and may, after decades of design and trial or foreign designs, may be the final winner of the Indian SP artillery competition. Estonia has ordered 12 K9s, with deliveries to commence in 2020. The Norwegians are buying 34 K9s, with an option for 24 more, with deliveries to start in 2019. The Egyptians have been testing the K9 since 2018, though no firm sales offers have yet been tendered. The Australians are seriously considering the K9, as it meets all the requirements for their Land I7 Artillery Replacement Program. Azerbaijan has expressed interest in the K9. Finally, the Polish Krab uses the chassis of the K9.

The K9 is an advanced self-propelled howitzer, similar in concept and performance to SP howitzers such as the US M-109A6 Paladin, German PZH-2000, and Israeli Slammer. The K9 features a 52-caliber length gun with a large multibaffle muzzle brake and a fume extractor and heavy hydropneumatic recoil recuperators. The K9 has GPS, fire control computers, a land navigation system, inertial navigation and GPS, and automatic fire solution input from FIST vehicles. If necessary, the K9's computers are sufficient to figure their own fire solutions given data from a FIST. The K9 can begin to fire within 3 phases of a halt and begin to lay fire without the aid of an FDC if the target's location is known. With the help of fire input from a FIST vehicle or FDC, the K9 may fire immediately after a halt. By use of an automatic rammer, the K9 may decrease reload time to 1 for one minute every ten minutes. Like most advanced artillery pieces, it is capable of MRSI fire missions and of limited direct-fire combat. The gun is capable for firing for an hour solid before gun deformation occurs and the gun must be cleaned out, The gun is a beefy multibaffle muzzle brake and a fume extractor. The K9's gun is able to launch all Western and Chinese 155mm rounds, including exotic rounds like Copperhead and other CLGP rounds. (It could probably fire newer rounds, but hasn't tested with such.) Burst fire of 5 rounds in one minute are capable, though the sustained rate of fire is 2 rounds per minute. Sustained rates of fire of six rounds per minute are possible for 20 minutes, after which the gun crew (except the commander), will have sustained one level of fatigue. The gun's travel lock is electrically-actuated from the gunner's position. Under normal circumstances, the K9 is ready to fire 30 seconds after a halt and can secure from firing position and move out within 60 seconds. The K9 carries a conveyor belt externally allowing the transfer of 12 rounds, fuzes, or charges at the rate of 12 rounds per minute from ammunition supply trucks or a ground pile.

The K9 has a marked resemblance to the M-109A6, though the bustle racks on the rear of the turret are armored and have an AV of 3. The K9 has decent armor protection for its type of vehicle, and has automatic targeting laser detection, which automatically launches smoke grenades in the direction of the targeting radar; these smoke grenades also burn in IR and UV bands. There are medium-sized doors on the right side of the turret to load equipment and ammunition if necessary; however, primarily reloading is supposed to be done using the K10 Ammunition Resupply Vehicle., which mates directly with the open rear turret doors of the K9's turret. The K9 has its own 10kW APU.

The K9 is powered by a German MTU MT 881 Ka-500 diesel engine, produced under license from Germany, and developing 800 horsepower. The transmission is an adaptation of that found on the US M-1A1 tank. The suspension is hydropneumatic. The commander and primary loader have hatches on the roof; the commander has a manually-rotating cupola with a weapons mount, while the loader does not have a cupola, though he has vision blocks facing forward and to the right side. Though it is not standard, his position is often seen with lock-down points for a medium machinegun on a tripod. The driver is in the front left, opposite the engine/power pack. The driver has three wide-angle vision blocks to the front and angles to the sides, and he has an interface and map LCD screen at his position, which also allow him to navigate via waypoints. The commander uses the gunner's sights via an elbow telescope, while the gunner has a full complement of sights, including three telescopic sights that may work with the night sights. The commander does have his own image intensifier, on a channel to one of his vision blocks, as well as a panoramic sight, and he can aim and fire his gun from under cover. He also has the MAPS system, similar to the US Blue Force/Red Force Tracker system. The crew is protected by an NBC Overpressure system, with a vehicular NBC backup. The K9 has an air conditioner and heater. Powerful hydropneumatic shock absorbers are present on the two rear roadwheels, Ammunition resupply is done through a hole in the rear face, or via a hatch on either side of the turret.

K9A1

Also known as the K9 PIP, the K-9A1 has a new gunner's sight with improved night vision and day vision suite. The vehicle also has a rear surveillance camera similar to that of the K1E1 tanks, and a backup camera for the driver. Finally, fire control computers and software have been improved. It has a fully-automatic autoloader, with associated magazines. A 16kW APU has been added for operations when the engine is off; in a pinch, this APU is powerful enough to power another vehicle or command post whose power-generation mechanisms have been damaged.

XK9A2

The XK9A2 (designation assigned by myself, and is provisional) is a version of the K9A1 with an unmanned turret with a fully

automatic autoloader which loads projectiles and charges (the fuzes are already affixed at the time the magazines are loaded). The fuzes get their settings via a radio link with the gunner's fire control computer. The commander, gunner, and driver sit in the front of the vehicle, with the driver on the right and commander on the left, with the gunner between them. They have all access to the same equipment on the K9 and K9A1, via a hard-wired link to the fire control system. The commander controls a CROWS-type system atop the turret, which may be aimed and fired from the commander's position, though he must reload it by climbing through a short tunnel to the turret. For that matter, the gunner also has a tunnel to access the turret if necessary, and the commander and gunner may also fight from the turret. Behind the crewmembers in a space for personal gear and other essential gear. The Xk9A2 is powered by the same engine as the Turkish T-155 is powered, and has the same driver's controls.

T-155 Firtina

The T-155 Firtina (Storm) is a variant of the K9A1 produced for Turkey. The first few were imported whole and in knock-down kits from South Korea, while the rest will be license-produced in Turkey. The Turks expect to have 255 in force by 2020, when production will cease. The T-155 Firtina has several differences from the K9; perhaps the greatest is the lack of the commander's panoramic sight. The T-155 is powered by a German MTU 881 Ka-500 engine, a derivative of the K9's engine, which develops 1000 horsepower. The turret design is modified to fit Turkish fire control equipment, their autoloader, and computers and radios, as well as to suit Turkish manufacturing methods. The T-155 also has slightly-increased armor.

Twilight 2000 Notes: These vehicles do not exist in the Twilight 2000 timeline.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
K9 Thunder	\$1,333,465	D, A	505 kg	46.3 tons	5	24	Passive IR (D, G), Image Intensification (G, C)	Shielded
K9A1 Thunder	\$1,518,235	D, A	497 kg	47 tons	5	25	Passive IR (D, G), 2 nd Gen Image Intensification (G, C), Backup Camera (D), Rear CCD Day/Night Camera (D, G, C)	Shielded
XK9A2 Thunder	\$1,662,881	D, A	526 kg	44.65 tons	3	25	Passive IR (D, G), 2 nd Gen Image Intensification (G, C), FLIR (G, C), Backup Camera (D), Rear CCD Day/Night Camera (D, G, C)	Shielded
T-155 Firtina	\$1,660,656	D, A	505 kg	46.5 tons	5	24	Passive IR (D, G), Image Intensification (G)	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
K9 Thunder	127/89	35/25	850	296	Trtd	T4	TF11Sp TS8Sp TR8 HF14Sp HS6Sp HR4
K9A1 Thunder	126/88	35/25	850	298	Trtd	T4	TF11Sp TS8Sp TR8 HF14Sp HS6Sp HR4
XK9A2 Thunder	181/127	36/25	850	327	Trtd	T4	TF13Sp TS10Sp TR9 HF15Sp HS7Sp HR4
T-155 Firtina	174/122	35/24	850	340	Trtd	T4	TF12Sp TS9Sp TR8 HF15Sp HS7Sp HR4

Vehicle	Fire Control	Stabilization	Armament	Ammunition
K9 Thunder/T-155	+2	Fair	155mm L/52 Howitzer, K6 (C), M60 (L)	48x155mm, 1000x.50, 1000x7.62mm
XK9A2 Thunder	+3	Fair	155mm L/52 Howitzer, K6 (CROWS), Mk19 (CROWS)	48x155mm, 2000x.50, 200x40mm

Bofors Bandkanon 1

Notes: The Bandkanon (Swedish Army designation Bkan 1) was a Swedish self-propelled artillery piece originally designed in the mid-1960s and placed in service in the late 1960s. Originally, 70 Bandkanons were to be built, but the budget prohibited this at the time, with only 26 Bandkanonen 1As being produced, with a few later under the 1C variant. Due to budget cuts at the time of introduction, only 26 Bkan 1As were produced – and most Bkan 1Cs were upgraded 1As. (The RL cost of the Bkan was almost outrageous at the time.) The Bandkanon is noted for its L/52 gun, an exceptionally-long and far-ranging gun for the time, and the fact that the gun was fed from a magazine with a full autoloader, giving it one of the highest rates of fire that any SP artillery piece has ever had. Due to the low numbers of the Bkan present, they were assigned primarily at division level. The Swedish Army phased out the Bandkanon 1A and 1C in 2003. The Bkan was to have the firepower of an MRL (for whatever reason, the Swedes at the time did not actually produce or put into service any large-caliber MRLs). The Bkan program resulted from the abortive KRV Tank Project, which was supposed to result in a family of vehicles on the same chassis. In the end, only the Bkan 1 and S103 resulted from this initiative.

The Bkan 1A was the first version. Until the advent of the Bkan 1C, the original version was simply designated Bkan 1. Though the Bkan 1A had a large chassis, it was given the engine of the S-Tank, which, on the Bkan, made the vehicle woefully underpowered, especially considering that the Baskanon was one of the heaviest military vehicles of its time.

The 155mm m/60 gun of the Bkan 1 was fed from a 14-round magazine, with one available in the vehicle. They could be reloaded as a single magazine full of rounds by a special support vehicle. Special rounds could be loaded into the breech with some help from the autoloader, but this was a difficult and awkward procedure and not used very often. When fed from the magazine, the gun could fire 14 rounds in under 48 seconds (in game terms, an entire magazine in nine 5-second phases, or a bit over 1.5 rounds per second), though reloading is a lengthy process taking nearly 10 minutes. The magazine can also be hand-loaded with help from the autoloader, taking three phases to load one round into the magazine; there is, however, no mechanism for hand-loading the actual gun. The Bkan1A had its own crane, allowing it to take a magazine off of itself and take a fresh one from the back of a support vehicle and load itself. The travel lock for the main gun is at the very front of the glacis plate, and is also power-operated. On each side of the glacis at the front are clusters of four smoke grenade launchers. The commander's machinegun is the Swedish Army near-standard Ksp m/58. The Bkan 1A had a surprisingly advanced electronic fire control suite for the time, necessitated by the lack of crewmembers involved in the actual firing of the howitzer, and the possibility of only remote firing of the howitzer. (The gunner has only to press three buttons to load from the autoloader, aim the gun using a partially-automatic aiming system, and fire it.)

The engines were the same as on the S103A version of the S-Tank; these included the Boeing GT-502 gas turbine developing 300 horsepower, and a Rolls Royce K-60 diesel with 240 horsepower. The transmission and drive train were also taken from the S103A, appropriately modified for the larger chassis and greater number of roadwheels, as well as greater weight. The use of the S103A's drive components and engine led to criticism that the Bkan 1 was underpowered; however, unless an emergency move was being done, high speed was not normally required from the Bkan 1. In an emergency move or dash move, with both engines operating, the Bkan 1 does have a great deal of power and quick power response. A by-product of the use of the S103's drive train and suspension components is its ability to rock the chassis back and forth, useful for quick azimuth changes and fine tuning. Due to limits in the size of the autoloader and breech, the Bkan 1 was only able to fire 155mm shells in existence available in the late 1960s. (This includes the 155mm tactical nuclear shell; though they were not ubiquitous enough for the Bkan to carry a full magazine of tac nukes, imagine a 48-second salvo of 14 20-kiloton nuclear weapons being fired!) The Bkan used special unitary ammunition that included the projectile and combustible case charge module, with the fuzes being set remotely by programming from the assistant gunner. (Though its rounds are based on the 155mm rounds available at the time, they were modified for use on the Bkan.)- The crew normally rides in the front hull, and the gunner, assistant gunner, commander, and driver normally do their jobs from the front hull, and they are in the forward-most portion of the front hull.

The turret of the Bkan 1 is in the rear of the vehicle, though it has limited traverse. There is a driver's compartment on the front left behind a highly-sloped glacis plate; the turret is divided into three compartments, with the gunner and one loader being on the left, with a hatch above them. The commander is on the right, and he has a power-operated cupola with a weapon mount on it. The center compartment houses the autoloader and the interface for the magazine. The Bandkanon has an inertial land navigation system that allows it to take somewhat inaccurate shots (-1 to skill rolls) without input from an FDC.

The Bkan 1C produced primarily automotive improvements, including the use of a unified power pack which can be changed using the appropriate equipment in half an hour. The engines were upgraded to a Boeing 502-10MA (same power, but less fuel consumption and less maintenance required). The Bkan 1C had a Detroit Diesel 290-horsepower turbocharged diesel for its main power; however, the Bkan 1C was still considered underpowered. The drive train was modified to being it more in line with the S103C. The crane was removed, as the support vehicles meant for the Bkan 1C already were standardized with such a crane. The Bkan 1C used the POS 2 land navigation system, which was essentially an improved inertial navigation system with a mapping module. Unfortunately, the retrofits had a high RL cost, and the production line was only reopened for a very short time, so only about 30 Bkan 1C's ever existed at any one time.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
Bandkanon 1A	\$530,272	D, G, AvG, A,+ JP5	563 kg	52 tons	6	26	Passive IR (D, G, C)	Shielded
Bandkanon 1C	\$487.360	D, G, AvG, A, + JP5	500 kg	53 tons	6	27	Passive IR (D, G, C)	Shielded

Vehicle	Tr Mov*	Com Mov*	Fuel Cap	Fuel Cons*	Config	Susp	Armor
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Bandkanon 1A	88/62	24/17	1445	233	Trtd	T5	TF19 TS10 TR7 HF24 HS8 HR5
Bandkanon 1C	92/65	26/18	1445	322	Trtd	T5	TF19 TS10 TR7 HF24 HS8 HR5

Vehicle	Fire Control	Stabilization	Armament	Ammunition
Bandkanon 1A/1C	None	None	155mm L/52 m/60 Howitzer, Ksp m/58 (C)	14x155mm, 1000x7.62mm

*If using only the diesel engine, reduce speed by 55%, and reduce fuel consumption by 55%.

Bofors FH77AD Archer

Notes: This self-propelled gun is part efficiency, part quickness to get into production, and part expediency. The main purpose was to quickly mechanize the Swedish field howitzers. It is essentially an FH77 field howitzer mounted on the chassis of a 6x6 all-terrain Volvo truck. In addition to Sweden, the Iranians use the Archer, though how they acquired them is currently a mystery; what is known is that Sweden did not sell them to the Iranians. The deal with the Indians (for both the FH77BD and FH77B) was subject to accusations of a kickback and bribery scheme, which is still being resolved. Certain defense officials on both sides and in a cutout company in Argentina are said to be subject to arrest at any time. Norway was going to acquire 24 BW systems, but then abruptly cancelled their order, for reasons I have not been able to find out as of yet. Croatia was originally interested in the FH77BW, but before any contracts could be signed, the Germans offered them used and surplus PzH2000s, which they elected to acquire instead of the FH77BW. Sweden appears to be the major user of the Archer, with a complement of 24, which unfortunately were delivered late by two years in 2013, and in 2016, they were still being delivered to the Swedish Army. The loss of user orders has greatly increased the RL per cost, as has the upgrades requested by the Swedish Army.

The Archer is mounted at the rear of the truck chassis. The gun is an L/38 155mm howitzer. The remainder of the truck bed is used for ammunition, fuzes, charges, and personal gear and truck pioneer tools. It is able to fire all types of Western and Chinese 155mm ammunition, including some rather exotic special rounds. A small amount of space is provided for this purpose. The gun can be brought into action within 50 seconds of a stop, and brought back to traveling order in 3 minutes. The Archer has its own land navigation (GPS with inertial navigation backup), along with a mapping computer and module, and an artillery ballistic computer and a GP ruggedized laptop. It can generate its own firing solutions with coordinates from a FIST team, or without one if the map location of the target is known. Before firing, two beefy spades are lowered at the rear for stabilization. Note that the howitzer has a limited traverse of 15 degrees in either direction. An option (reflected in the stats below) is a non-rotating cupola with a medium machinegun mounted on a swivel mount. The gun is capable of firing all makes of 155mm ammunition in the world, including the new US M982 Excalibur round. The projectiles may be propelled by standard NATO charges, NATO modular charges, or Bofors Uniflex 2 combustible-case modular charges. The gun is capable of MRSI fire (six rounds in 7 seconds) as well as burst fire of up to six rounds in 30 seconds for 1 minute. Normal fire rate is two rounds in three seconds, provided the gun is feeding from magazines. MRSI salvos may be up to six rounds (one magazine) in size, instead of the five rounds normally used by other MRSI-capable gun systems. The vehicle can be ready to fire an initial burst of six in 30 seconds after a halt, and the jacks are not generally lowered for this initial burst. The gun may be fully loaded by a support vehicle carrying magazines of ammunition in 10 minutes for all seven magazines. The gun module is normally operated unmanned, from controls in the cab, including the loading of fresh magazines. The gun itself is a modification of the FH77 towed artillery piece.

The FH77AD is mounted on a Volvo FM-12 series articulated truck, with 6x6 suspension and the suspension raised and strengthened for its off-road and artillery-hauling role. The bed is highly abbreviated, just enough to carry ammunition and personal/truck gear. It is powered by a D12C340 Euro 2 engine and an automatic transmission, developing 340 horsepower. A 15kW APU is provided, which supplies the necessary operating power. The vehicle is capable of driving in up to 1 meter of snow, water, or mud, and can be air-transported in aircraft about the size of the Airbus A400M's size. The tires are run flats and have central tire pressure regulation. The tires are also puncture resistant. The cab and gun module has a modicum of armor, mostly protective from shell splinters or small arms armor-piercing rounds up to 7.62mm Nagant. The underside is the most heavily protected part of the vehicle; it is reportedly been tested with charges of up to 6 kilograms with the vehicle capable of keeping going and with only minimal disruption to the crew. (The mine protection system is itself a modified version of that on the Finnish Pasi APC.) The cab is also protected by NBC Overpressure and antiradiological liners for both the cab and gun module. (The gun module is open-topped and not protected by NBC Overpressure; when the crews must work there, they use a Vehicular NBC system.) The vehicle is also protected by a four-module fire detection and suppression system²

The FH77BD is the version sold for export; it has an L/45 barrel instead of the FH77AD's shorter barrel. The BW replaces that gun barrel with an L/52 barrel, and replaces the simple machinegun mount with a Protector RWS mounting a Ksp m/58 and an HK GMG. The engine has been updated to a version of the standard engine with a horsepower rating of 460 horsepower. It is otherwise identical to the AD, and has virtually replaced the original ADs and BDs in the Swedish Army, with the new BWs being upgraded from the earlier vehicles.

The cab of the FH77AD is armored, and the HF armor figure is applied to all angles of fire against the cab, instead of just fire originating from the front of the vehicle.

Twilight 2000 Notes: This work had just begun as the Twilight War commenced, and only about 30 ADs and six BDs had been manufactured at the outset of the war. Though production continued at a slow rate during the war, not many more FH77AD's were

made until well after the Twilight War. The BW was not produced until many years after the Twilight War. Production of the BD was not continued after the Twilight War, with only BWs being made when production picked up again after the Twilight War.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological**
FH77AD	\$1,096,551	D, A	650 kg	30 tons	4	18	Headlights	Shielded
FH77BD	\$1,115,218	D, A	627 kg	30.09 tons	4	18	Headlights	Shielded
FH77BW	\$1,197,680	D, A	582 kg	30.27 tons	4	21	Headlights	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor*					
FH77AD	103/52	29/14	500	125	Std	W(4)	TF3	TS2	TR2	HF4	HS3	HR3
FH77BD	103/52	29/14	500	125	Std	W(4)	TF3	TS2	TR2	HF4	HS3	HR3
FH77BW	128/64	36/18	500	169	Std	W(4)	TF3	TS2	TR2	HF4	HS3	HR3

Vehicle	Fire Control	Stabilization	Armament	Ammunition
FH77AD	None	None	155mm L/38 Howitzer, Ksp m/58 (C)	42x155mm, 1000x7.62mm
FH77BD	None	None	155mm L/45 Howitzer, Ksp m/58 (C)	42x155mm, 1000x7.62mm
FH77BW	None	None	155mm L/52 Howitzer, Ksp m/58 (RWS), HK GMG (RWS)	42x155mm, 2000x7.62mm, 400x40mm

T-34/122

Notes: In the late 1960s, Syria was unable to receive regular shipments of 2S1 self-propelled howitzers from Russia. Needing more mobile artillery, it used obsolete T-34 tank chassis and D-30 field guns and created a self-propelled howitzer. The first such modification was done in the late 1960s and they were out of service by 1974, rapidly replaced by more advanced Soviet-supplied vehicles and field guns. The design work and gun-vehicle matings were actually done by the Czechs at the behest of the Russians, rather than being a Syrian idea. However, Syrian ordnance was used; the Syrians at the time had plenty of D-30 field gun/howitzers and T-34/85s in reserve at the time. Though not the best vehicles in the world, the T-34/122 was one of the first mobile artillery designs for the Syrians, and they took great pride in them. They were generally known as the "T-122" in Syrian service.

The entire turret is removed from the T-34/85 base, leaving only the chassis. Also removed was the ammunition racks for the 85mm tank gun ammunition, the bow machinegun, and essentially all the turret-related equipment. While they were at it, the engine and transmission were overhauled and essentially brought to "zero miles" standards. New welds and the additions made to the vehicle were professional-looking; they did not look ad-hoc in nature. When the engines came out of overhaul, they were somewhat upgraded, developing 493 horsepower.

The hull exterior was modified with the addition of a large steel plate that ran from the glacis to just behind where the back of the turret was (just in front of the engine grills are). Five steel ammunition boxes were added to each side of this plate; each box held four 122mm rounds. Another steel plate and mounting equipment were added on top of the main plate, to mount the D-30. The gun trails were removed, and the wheels and carriage were locked down, allowing for a small amount of deflection. The gun shield remained attached to the mounted D-30. The gun can be rotated through 360 degrees, but due to the light weight of the chassis, firing could be done only facing the rear in a 60-degree arc to the right or left. Around the gun platform, with the ammo bins inside of it, was a raised section of thick steel plate about 35 centimeters high. The front section could be swung down to allow the engagement of direct-fire targets. Armored louvers were mounted over the air intake and radiator openings. Often, the gun crew would mount poles with a tarp or camouflage net over the position to obtain some measure of camouflage, but more to get some protection from the sun and the heat coming off the engine. Gun controls are manual, including the use of elevation and deflection manually-cranked wheels.

Personal equipment was normally carried at the rear of the gun platform, where there was less gun equipment, as were generally 3-5 jerry cans of water. One T-34/122 in each battery was equipped with a Passive IR sight. The rear fenders were equipped with clusters of four smoke grenade launchers.

T-34/122s were encountered by Israeli forces as late as 1983 in the hands of pro-Syrian militias in Lebanon. The T-34/122 was generally easy to operate and maintain, which was a good fit in the Syrian Army of the 1970s, which had a low-level of technical expertise.

Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision**	Radiological
\$229,511	D, A	768 kg	29 tons	6	12	Headlights	Enclosed

Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor*
127/89	35/25	560	179	Trtd	T4	TF1 TS1 TR1 HF16 HS6 HR4

Fire Control	Stabilization	Armament	Ammunition
None	None	122mm D-30 Howitzer L/38, PKT (C)	40x122mm, 1000x7.62mm

*For turret armor, the "turret" has a low parapet of armor plate, which can be hid behind and otherwise protects the legs of the gunners. This has an AV of 3. In "front" of the gun (which faces to the rear), the gun also has a gun shield, which protects two gunners (one on each side of the breech), completely if crouching and all except the upper chest and head is standing, with an AV of 2. If the "turret" armor in front of the gun is raised, the AV3 level of protection is also gained, with both the gun shield and "turret" armor both applying, depending on the attitude of those behind the armor and gun shield.

**If this is a vehicle with an IR scope, the gun commander generally uses it at night when aiming. This device is Passive IR, with a small IR searchlight. Such a vehicle costs \$14,000 more, and has an increase of 140 kilograms in weight.

M44T

Notes: This is an upgrade of the old M44 155mm self-propelled howitzer, which Turkey bought from the United States in the 1950s. The upgrade work was done by a German consortium of MTU, GLS and Rheinmetall, and was comprehensive almost to the point of trashing the entire vehicle and starting from scratch. Design Work began in 1987, with upgrades being done as quickly as possible. Some 222 of these upgrades were done. Turkey has expressed a willingness to do the upgrades for other countries, but there are no takers as of yet. The upgrades are modular, so an end user may pick and choose about what upgrades to make. However, the M44Ts have long been sent to reserve sites, for use of recently-Called-up reserves (and it would have to be a national emergency for that to happen). The M44Ts are kept in running order; the engines, gun barrel, transmission, and electrical systems await use with those components in essentially a “zero-miles” state, and are kept in repair by a special mechanic company assigned to them. That is most of them; the last such conversion was done in 1992, and in 2015 news footage an M44T was seen firing at Syrian positions. It is believed that no more than 39 M44Ts are actually in active status.

The original gasoline engine was replaced with a more fuel-efficient 450-horsepower MB-833 Aa-501 diesel engine, and the transmission was replaced in accordance with this new power pack and automatic instead of manual. An engine preheater has been fitted for starts in cold weather. The fuel tank size was increased, the electrical system was upgraded, and the gun was replaced with a NATO 155mm L/36 howitzer. (This barrel length was basically a compromise between hitting power, range, and the balance of the vehicle. The gun is seated in the chassis to allow for the increased recoil of the new gun and to lower the silhouette; the gunner is seated in the chassis to put him in line with the gun. The commander is in a manually-rotating cupola with all-around vision blocks, and there is one loader's hatch on the opposite side from the commander, with no vision blocks. As the loader's hatch is much further forward than the commander's hatch, the loader's hatch has a Plexiglas windshield in front of it to keep splashing down when fording or in muddy environments. The driver's seat has been reconfigured into a padded bucket seat which also energy-absorbent. This new seat and driver's position in in the hull instead of the turret.

The electrical system has been almost totally replaced, and the driver's instrument panel has been replaced. The suspension has new high-strength shock absorbers and torsion bars, and the track replaced by improved ones, and dust skirts installed. The new gun has new ammunition racks installed. In the M44Ts still in active service, they have been fitted with a GPS system with a mapping module, and several small mission-use computers.

Twilight 2000 Notes: 186 of these vehicles were converted beginning in 1986, and saw extensive service in Northern Iraq and Eastern Europe during the Twilight War.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
Original M44T	\$527,038	D, A	750 kg	29.03 tons	5	22	Headlights	Enclosed
Current-Use M55T	\$681,121	D, A	750 kg	29..13 tons	5	24	Headlights	Shielded

	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
Original M44T	129/91	36/25	780	167	Std	T4	HF6 HS3 HR2
Current-Use M55T	129/91	36/25	780	167	Std	T4	HF6 HS3 HR2

	Fire Control	Stabilization	Armament	Ammunition
Original M44T	+1	Basic	155mm L/36 Howitzer, M-2HB (C)	24x155mm, 900x.50
Current-Use M55T	+3	Fair	155mm L/36 Howitzer, M-2HB (C)	24x155mm, 900x.50

M52T K/M Obus

Notes: This is an upgraded version of the old M52 105mm self-propelled howitzer, which Turkey bought from the US in the 1950s. 365 upgraded were completed, starting in 1995. As with the M44T, the M52T is a cooperative German/Turkish upgrade.

Improvements include the replacement of the howitzer with a 155mm L/39 NATO howitzer, based on the gun of the M109G SPA. In place of the former 105mm L/33 gun, replacement of the original gasoline engine with a 450-horsepower MB-833 Aa-501 diesel engine; the transmission was replaced in accordance with this new power pack and automatic instead of manual. An engine preheater has been fitted for starts in cold weather. The fuel tank size was increased and the gun mounted in a larger turret. Computer fire control is also added, allowing the crew to accurately fire if the target location is known; though this generates faster coordinates, the assistance of an FDC is still needed, or inaccurate fire will result (x4 scatter distance). As the electrical system was not up to par with the new systems, this has been upgraded as well; the suspension has also been upgraded to allow the increased weight. The higher power gun also required the addition of a larger recoil spade at the rear of the chassis, which must be lowered before firing of the gun. Modified storage racks allow the M52T to fire more modern ammunition. A Turkish-developed fire control system has been installed in the M52T. Armor has been somewhat improved, specially on the floor. 4kW APU has been added for power-off operation. A GPS system and various small computers have been installed, as well as a small GP computer.

On the right side of the turret roof is a manually-operated cupola for the commander. On the left is a hatch on a non-rotating cupola for the driver; this hatch has a wide-angle vision block on the left, and three normal ones to the front. On each side of the turret is a large door, primarily for ammunition resupply, but also for crew and equipment entry. Unusually, the driver is seated in the turret basket; this allows the vehicle to have a smaller nose and allows for the new power pack, but takes some practice on the part of the driver. (A vision block that always depicts a frontal sight picture helps.) The turret has a limited traverse of 60 degrees left or right.

Twilight 2000 Notes: 365 of these conversions were available at the beginning of the Twilight War.

Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
\$1,610,397	D, A	633 kg	29.5 tons	5	23	Passive IR (D, G, C), Image Intensification (G)	Shielded

Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
128/90	26/25	780	167	Trtd	T4	TF5 TS4 TR3 HF8 HS3 HR3*

Fire Control	Stabilization	Armament	Ammunition
+3	Fair	155mm L/39 Howitzer, M-2HB (C)	48x155mm, 500x.50

*Hull floor and hull and Turret Roof are AV3.

MKE Yavuz

In 2015, the Turkish and Germans got together and developed a large 52-caliber 155mm Howitzer, the Panther. Though the Panther was used only in a limited role for Turkish service as, while it has an 18-horsepower engine to slowly move the Panther into and out of position, this was far from a self-propelled system in the traditional sense; while it helped bring the gun into and out of action more quickly, it did not have the flexibility of a full self-propelled system. On the other hand, the upcoming T-155 Firtina is a behemoth that is based on the South Korean K9A1, can take considerable punishment, has more advanced firing systems, it too lacks the flexibility of the Yavuz. The Turkish Army, however, wanted to make a large number of their Panthers mobile, so the heavy truck-mounted Yavuz was designed.

The Yavuz is based on a German MAN 6x6 chassis; the Panther's entire undercarriage is largely removed except for the part of the operating gear necessary to move the gun. The gun is at the rear of the chassis, and fires to the rear, to a 60-degree arc in either direction. The cab design, however, is by MKE, and includes room for all crewmembers, remote firing equipment, some personal gear, and a small space for a cot. (Essentially, the cab is a "double-double": cab, both much longer than the MAN's cab and wider. The cab is also protected by a modicum of armor, as well as NBC Overpressure and an RWS above the commander's seat.

The Yavuz is equipped with a fully-automated gun and magazine control system, along with modern fire control equipment. The Yavuz's gun is equipped with a semiautomatic loading system. On each side of the gun is a magazine containing nine rounds; additional magazines are carried on with side of the truck, and can be exchanged for a fresh magazine in about 5 minutes. The entire Yavuz can be ready to fire within 60 seconds of pulling into a position (most of this time is spent verifying position before zeroing in on a target). The Yavuz's crew need not exit the cab to operate the gun, unless something untoward happens during operation or external reloading, in which case the two loaders would exit the cab. The ordnance is 52-calibers long and tipped with a large muzzle brake, and has the shock absorbers and reuptake mechanism of the Panther. Before firing, a large baseplate/spade is lowered at the rear. The Yavuz is capable of operating without an FDC or with one gun operating as the FDC with the rest of available guns conducting the fire mission, but current doctrine calls for the use of an FDC, which can provide more precise fire information. (In addition, several trucks also make up the unit, which tote ammunition.) The Yavuz does have a full GPS suite with a mapping module and a BMS, but the Turks do prefer to use dedicated FDCs (and it is not just the Yavuz, it is with most artillery that the Turkish Army uses), to ensure the most precise accuracy.

Many experts have criticized for Yavuz as being underpowered, having no armor around its gun, and for the vehicle being too light for the power of its gun. Note that due to its design, the Yavuz is not capable in any way of fire on the move.

Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological*
\$981,491	D, A	550 kg	40 tons	5	29	Headlights	Shielded

Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
113/55	31/16	330	157	Stnd	W(3)	HF3 HS3 HR3**

Fire Control	Stabilization	Armament	Ammunition
+3	None	155mm Panther L/52 Howitzer, M-2HB (C)	36x155mm, 1500x.50

*This NBC protection is only for the cab; the rest of the Yavuz is considered Open.

**The AV3 protection is only for the cab; the rest of the Yavuz has an AVof 1, except for the floor, which has an AV3 through the entire floor.

ALC M7 Priest

Notes: Though this vehicle was officially named the Sherman Fire Support Vehicle, the name "Priest" was given to it by British crews who looked at its pulpit-like commander's station, and after similar commander's stations on their Bishop and Deacon SP Artillery. Based on the chassis of the M4 Sherman series, the M7 has no turret, an open top, and mounts a 105mm howitzer instead of more normal Sherman armament. It is, however, a sort of a kludge, mounted on a chassis not meant to be carrying such a weapon to give it a measure of mobility in a war that was becoming more and more mobile. It was sort of a "Let's start with a Sherman, than add a howitzer, lop off the top, leave it open..." and such. Such a design genesis had worked with British guns and some Canadian gun, based on M3 Lee and Grant chassis. And the Americans needed that more mobile was discovered to be needed yesterday, in the Sicilian campaign, and they didn't need SPHs armed with and firing British ordnance, i.e., not in the US supply chain. With no dedicated SPH design available that could be put into action almost immediately, the Priest was settled upon for US units. While the first Priests were sent to US Army units in North Africa, they were based on M3 Lee main battle tanks, supply was soon diverted to the Lend-Lease program and to Britain. They had their own teething problems with them, and ended up replacing their guns with British-made ordnance. Two iterations of these early Priests went through in less than three months, and then the base hull was changed to the M4 Sherman tank. Though it may seem that there was a lot of internal space (if open-topped); however, most of this space was reserved for the backstroke of the gun, which was not well-buffered.

The Priest was, like the Sherman, widely exported, but by 2000, remained in service only by Yugoslavia, Israel (in a reserve role), and some South American and Southeast Asian countries.

The M7 Priest proved to be so ubiquitous that most US Army posts have one parked in front of their museums, or at their parks of main gates. There is a similar mounting in front of most Israeli armor and former West German armor museums.

The M7 – the Original Priest

The US Army needed mobile heavy artillery and it needed it yesterday, As the M3 Lee was being quickly supplanted with the M4 Sherman, this was seen as a vehicle which could be modified and altered (in and off the production line) to produce a semi-ad hoc self-propelled howitzer. In order to maintain a low silhouette, the gun's elevation was limited to 35 degrees, which effectively gave the gun less than 75% of the range that the howitzer was actually capable of delivering. Some 800 of these versions were produced, though many were built for the British under the Lend-Lease program. As construction and modification work went on, the M7 acquired more and more M4 components, starting with the suspension, to the primary fighting compartment incorporating more and more cast steel. The British made an ad hoc FDC version of the M7, in which 24 rounds for the main gun were replaced with radio equipment and a radio operator. An early modification to the M7 allowed the M7 to greatly-modify it's ammunition storage, increasing main gun round carriage dramatically. The engine is the Wright R975 EC2 developing 340 horsepower and with manual transmission. The driver was on a front right sponson, looking through the face of the sponson with one vision block to his front and one to his left side.

Other Sherman-Based Priests

The introduction of the M7B1 completed the move to the Sherman chassis, specifically the M4A3. The engine was replaced with a higher-producing one of the same type, developing 400 horsepower. The turret was removed and the gun installed into this space, with the pulpit-like commander's station next to the gun installation on the right. Continual unsolved problems with the limited elevation (and lack of depression) of the main gun reared its head. These Priests began delivery in Sep 1943.

In the Korean War, the lack of elevation and deflection flexibility finally became a serious issue in North Korea's rough terrain and deep valleys. The poor depression (roughly +5 degrees) could not be fixed, but the maximum elevation was increased dramatically to +65 degrees. In addition, the commander's station was increased in height to the point that it has a 360-degree field of fire, and could fire almost straight up. This was the M7B2.

The M7 was also used as the basis for an FDC vehicle, which was meant to be used with units equipped with the M7. These essentially the same as the later Defrocked Priests, and like them, received no official designation. Instead of a large number of troops, they were equipped with two long-range, two medium-range, and two short-range vehicular radios. (And that was in the days when most vehicular radios were huge.) The FDC also carried 10 field telephones, enough to be connected to each gun in the battery plus a couple of spares. Though it had no howitzer, it did carry more ammunition for its machinegun. A large number of equipment to plot and aim fire and produce fire missions was also carried. The FDC variant was equipped with bows and a tarp to cover the FDC section in the rear; this tended to make the FDC a target and was often not used.

The "Defrocked Priest"

During the Allied effort to capture Caen and during the breakout from the Normandy beaches, moving troops under protection became for a short time more important than moving howitzers. To this end, the howitzer, ammo racks, fuze storage...essentially everything that made the Priest an SPH, was removed and troops piled into the rear. The fronts were fitted with Cullen devices and they were used as assault personnel carriers. No additional vision blocks, firing ports, or doors were installed, just climb on the thing and go. They were later converted back to their SP howitzer configurations. They never received an official US Army designation, but were usually called "Defrocked Priests," "Unfrocked Priests" or "Holy Rollers" Most of the modifications were actually produced by Canadian engineers, and most of them were in fact used by the 2nd Canadian Division and the British 51st Highland Division, as they were meant to take the brunt of the German resistance on Sword and Gold Beaches, and later in the push inland after the landings.

The Canadians saw this modification and ran with it, producing the Kangaroo APC. (This will be found in Canadian APCs.)

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
M7 (Early)	\$201,324	G, A	500 kg	22.67 tons	5	17	Headlights	Open
M7 (Late)	\$237,845	G, A	425 kg	22.97 tons	6	19	Headlights	Open
M7 FDC	\$61,760	G, A	468 kg	22.8 tons	7	21	Headlights	Open
M7B1	\$231,832	G, A	425 kg	22.97 tons	6	19	Headlights	Open
M7B2	\$240,376	G, A	425 kg	22.98 tons	6	16	Headlights	Open
"Defrocked Priest"	\$38,793	G, A	1.76 tons	21.64 tons	2+12	14	Headlights	Open

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
M7 (Early)	125/88	35/24	662	149	Stnd	T4	HF8 HS5 HR4
M7 (Late)	125/88	35/24	662	152	Stnd	T4	HF8 HS5 HR4
M7 FDC	126/88	35/25	662	189	Stnd	T4	HF8 HS5 HR4
M7B1/M7B2	140/98	39/27	677	178	Stnd	T4	HF8 HS5 HR4
"Defrocked Priest"	131/91	36/25	662	152	Stnd	T4	HF8 HS5 HR4

Vehicle	Fire Control	Stabilization	Armament	Ammunition
M7 (Early)	Nil	None	105mm M1A2 L/22 Howitzer, M2HB (C)	57x105mm, 1000x .50
M7 (Late)/M7B1	Nil	None	105mm M1A2 L/22 Howitzer, M2HB (C)	69x105mm, 1000x .50
M7 FDC	Nil	None	M2HB (C)	1000x.50
M7B2	Nil	None	105mm M1A2 L/22 Howitzer, M2HB (C)	45x105mm, 1000x .50
"Defrocked Priest"	Nil	None	M2HB (C)	2000x.50

Cadillac M44

Notes: This elderly self-propelled howitzer dates from US use in the early 1950s. It went out of US service in 1962, but as of 2000 was still being used by Greece, Jordan, Spain, and Taiwan. Turkey also used them, but these were upgraded in the 1980s to the M44T standard (see Turkish Self-Propelled Artillery). Many were also used by Italy, but most of these ended up as range targets after their service was complete. They were widely disseminated, and can be found in a number of museum and private collections. The chassis is that of the M41 Walker Bulldog light tank; instead of a turret, the M44 was fitted with a large open-topped superstructure which allowed the designers to simplify the design as well as lower the silhouette and reduce the costs of the vehicle. The M44 replaced the World War Two M41 155mm Howitzer Motor Carriage.

The US Army looked at the prototypes and blueprints, and were enthusiastic about the new vehicle, and 250 were built even before type-standardization was applied; these 250 vehicles were provisionally called T99E1s. In field-testing, however, a plethora of problems rapidly became apparent. The T99E1 attempted to use as much of the M41's chassis as possible, to simplify production and logistics. However, the engine, originally under the crew compartment, proved to make the vehicle too high in silhouette. The five roadwheels of the M41 chassis became six, with the track idler being deleted and the front roadwheel doing double duty as a roadwheel/track idler. The engine was therefore relocated to the front, which incidentally allowed for a smaller profile while still having a fully-enclosed superstructure. This led to a new problem – exhaust fumes from the engine made it into the crew compartment, along with the more substantial fumes from firing the gun. The problem with these fumes was essentially never solved; instead, the roof was removed from the superstructure became open-topped. This resulted in the T149, which, after all T99E1s were rebuilt, became the M44.

The M45 L/23 gun has much shorter range than normal NATO standard 155mm howitzers but can fire most 155mm rounds. Again, the short gun was used to lighten the vehicle and simplify the design. The driver was in the front of the superstructure; indeed, all crewmembers were in the superstructure. The M45 was a variant of the M114 used on the M41 HMC, modified to dramatically reduce recoil forces of the gun. To aid in reloading, the rear had a round lifter, which took the round from the ground to the reloading door in the rear. The commander's position was on the front right superstructure corner, and he has a pintle-mounted weapon mounted on a manually-rotating cupola. The rest of the crew was deeper in the superstructure with vision blocks and sights for both direct and indirect fire; the gunner is on the front right, while the loaders are in the left rear. Traverse within the superstructure was very narrow; and 30 degrees to the left or right. Elevation, on the other hand, was from -5 to +65 degrees.

The M44's binary powerpack was in the front of the vehicle. The engine was a gasoline-fueled AOSI-895-3 engine, developing 450 horsepower, and hooked to a manual transmission. The engine and transmission were also capable of exceptional torque, improving

off-road performance. Steering is by a simple T-bar, with a gas, brake, and clutch pedal. The M44A1 used a variant of this engine, the AOSI-895-5, which used fuel injection and increased fuel efficiency, and developed 500 horsepower.

The British Army called the M44 the Cardinal.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
T99E1	\$272,791		710 kg	29 tons	5	23	Headlights	Enclosed
M44	\$267,591	G, A	750 kg	28.35 tons	5	23	Headlights	Open
M44A1	\$262,722	G, A	780 kg	28.05 tons	5	23	Headlights	Open

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
T99E1	129/91	36/25	568	202	Std	T4	HF9 HS4 HR2*
M44	131/92	36/26	568	200	Std	T4	HF9 HS4 HR2*
M44A1	142/100	40/28	568	222	Std	T4	HF9 HS4 HR2*

Vehicle	Fire Control	Stabilization	Armament	Ammunition
M44 (Both)/T99E1	None	Basic	155mm M45 L/23 Howitzer, M2HB (C)	24x155mm, 900x.50

Cadillac M52

Notes: These ancient self-propelled howitzers were still being used by Greece, South Korea, and Spain at the turn of the century. Turkey upgraded their M52s to the M52T standard in the late 1980s and early 1990s (see Turkish Self-Propelled Artillery). Their original purpose in the US Army was to replace the M7 Priest and M37 105mm HMC. The M52 saw extensive use by the US and ARVN during the American involvement in the Vietnam War. Though development began in 1951, there were repeated developmental problems and delays and first issue did not take place until 1955. The vehicle is in a large part similar to the M44, but it has a partially-rotating turret instead of a fixed, open superstructure. The M52 was a contemporary of the M44; in fact, though design work began on the M52 almost a year earlier than the M44. However, the turret was difficult to get right and field testing did not take place until 1955, two years later than the M44.

The M52 was based on components of the M41 Walker Bulldog light tank, though it does not use the full chassis. The M52 has a large turret at the rear of the chassis, with a non-rotating cupola at the front left of the turret for the driver. He has all-around vision blocks and a hatch with an adjustable-height seat. He also has a two-piece hatch to his left. The gunner is on the right side of the turret and has a hatch to his right with a vision block in it. The hatchway is small and the hatch is more to receive instructions than for anything else. The gunner's primary sights are indirect fire sights and a x4 telescopic sight with a 10-degree field of view. At the rear of the turret to the right is the commander's cupola. The cupola has all-around vision blocks and a sight allowing him to look for air threats while the vehicle is buttoned up. He has a pintle-mounted machinegun. The cupola is found at the right rear of the turret, unlike most turreted armored vehicles. In Vietnam, a machinegun mount was often mounted by the loader's hatch, and machinegun ammunition load increased to whatever could be shoehorned in. At the rear of the turret are a two-piece circular hatchway and a rectangular two-piece hatch below it; these are for crew entry and ammunition resupply. The gun can be depressed to -10 degrees or elevated to +65 degrees. The turret faces forward and may be turned up to 60 degrees to the right or left. The ammo is positioned in the vehicle with a set of 21 ready-use rounds; the rest is usually kept in the packing crates on the floor of the turret and in the area behind the turret ring. Resupply is done via a large door on either side of the turret. The gun is a 105mm gun designated M49 and has slightly better optics for aiming. than the M44's gun.

The M52 was originally supposed to have an "ultimate" fire control, but funding was cut and this was replaced in development with a more basic fire control system. The fancy fire control system was also seen as contrary to the spirit of the program, which led to several vehicles being built on the same basic chassis. The hull is in fact quite similar to the M44's hull, though the M52 has a fully-enclosed turret instead of an open superstructure. The M52 uses the same supercharged gasoline engine that the M44 version uses; this was also updated to the fuel-injection system of the M44A1 during development, and the new engine develops 500 horsepower. The M52 also has a 1kW APU, powered by gasoline.

Twilight 2000 Notes: Greek M52s were given a unit award in 2001 during the Twilight War for their dogged defense of the 2-9 Salient near Sparta.

The M52 was the first US SPH that was designated "Self-Propelled Howitzer" rather than "Gun, Howitzer Carriage."

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
M52	\$355,808	G, A	750 kg	24.5 tons	5	21	Headlights	Enclosed
M52A1	\$356,793	G, A	750 kg	25.2 tons	5	21	Headlights	Enclosed

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
M52	145/102	40/28	659	251	Std	T4	TF5 TS3 TR3 HF6 HS3 HR2
M52A1	154/108	43/30	659	278	Std	T4	TF5 TS3 TR3 HF6 HS3 HR2

Vehicle	Fire Control	Stabilization	Armament	Ammunition
M52	None	Basic	105mm M49 L/30 Howitzer, M2HB (C)	102x105mm, 900x.50
M52A1	+1	Basic	105mm M49 L/30 Howitzer, M2HB (C)	102x105mm, 900x.50

FMC M107

Notes: This self-propelled howitzer was developed in the 1950s at the same time as the M110 203mm SP howitzer. The M110 was to be the lighter brother to the M110. It has been long phased out of service in most armies that once used them, including the US, but in 2000 was still being used by Greece (converted to M110A2), Iran, Israel, and South Korea. They were used by a dozen countries, including both the US Army and Marines. (Modern-day Vietnam does not actively use the M107, but keeps some captured during the Vietnam war in working order.) The vehicle is normally accompanied by a drove of M548 tracked load carriers or (later) M992 FAASVs, carrying the ammunition and 8 members of the gun crew. The M108 had one of the longest effective ranges of all Cold War howitzers. Combat use was limited to US forces in Vietnam and the IDF. (The IDF calls the M107 the Romach.) The M578 is also based on the M107 and M110 chassis. Most M110s were eventually modified into M110A2's, as the designs are modular; on a few occasions, M110s were re-modified back to M107A1s.

The chassis is the same as used on the M110, but like the rest of the vehicle, the gun hasn't been produced since 1980, and parts for it are getting hard to find except in countries actively using them. The gun is carried on top of the chassis of the vehicle; it's 175mm L/60 gun is hard-hitting and satisfyingly long-ranged. The mounting unfortunately gives no protection to the crew from small arms fire or artillery splinters; to remedy this, a tubular framework was issued with the vehicle that could be erected around the firing position; over which Kevlar shields are placed. Most of the time, these were considered too cumbersome and difficult to use, and they were typically left strapped to the side of the vehicle or abandoned in the rear areas. Without these shields, the turret armor value from all directions is 0 for the crew or 1 for the gun.

The M107 is powered by a 450-horsepower supercharged General Motors 8V71T diesel, with a semi-automatic transmission. The M107 was not heavy for SP artillery of the time, and it won speed records at the time of its introduction; in fact, with the barrel removed and packed beside the M107 on the same pallet, it could be airdropped. The engine is on the right front, and the driver is on the front right deck; he is the only crewmember under armor. The commander's position is opposite the driver on the front right deck. Behind them are seats for three members of the crew. At the rear is the gun and a large stabilizing spade which raises and lowers depending whether the gun is in or out of action. (Firing without the spade lowered is right out!) The M107 was fairly quick for its time, and was one of the first self-propelled howitzers to in and out of action fast enough to use the then-new shoot-and-scoot technique. (An M107 recorded a speed of 80 kph in Germany in the 1970s; however, this speed run did break a torsion bar.)

The gun and only armament is a 175mm M113 howitzer. The gun tube is so long that the gun is mounted at the very rear of the hull to counterbalance it. The early-model M107 had an L30 barrel, but this was found inadequate and the standard barrel length became L/60. At the rear are two elevators for the shells and charges; the same charges are used for the M107 as for the M110. The elevators include a device to insert the shell and charges in line with the breech, where a power rammer takes over. When US and some other countries' M107s reached their service lives, most were turned into M110A2s; this was an easy conversion. The M113 gun had a long range, but is notoriously inaccurate at ranges longer than Long range (to put it in game terms). If an M113 gun fires at longer ranges, triple scatter ranges. It is also notoriously difficult to load quickly, with 1 rpm being the maximum burst rate. The M113 gun has a minimum depression of -2 degrees, and a maximum elevation of +65 degrees. Deflection, however, is limited to 30 degrees in either direction, from the front. The crew includes three gunners, but the 8 loaders are carried in the accompanying vehicles. Special steel alloy is used to lighten the gun barrel without sacrificing strength. However, it was not as strong as advertised; in Vietnam, barrels with supposed design lifetimes of 1000 rounds tended to last a maximum of 428 rounds. The M107A1 was therefore designed, with a new M113A1 gun that corrected the early-wear problem; essentially, the M107 has what would be considered a bull barrel with a stainless steel bore.

The M107 was poorly-protected, and took heavy losses in Vietnam from suicide raids by infantry, Viet Cong, and combat engineers. The IDF has considerable success, however, at destroying SA-2 SAM sites from long range. IDF experience, and the effect of being outranged by artillery rockets, led to a new family of base-bleed and ERFB ammunition for the M107.

Note that while the M107 is capable of direct fire. Actual direct fire shots are quite difficult due to the cumbersomeness of the vehicle and gun. In addition, there are no dedicated antivehicle rounds available for the M107, nor are there defensive rounds like Beehive rounds are made for the M107.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
M107 (Early)	\$146,692	G, A	940 kg	27.61 tons	5 (+8)	23	Headlights	Enclosed
M107 (Standard)	\$213,217	G, A	800 kg	28.17 tons	5 (+8)	24	Headlights	Enclosed
M107A1	\$191,272	G, A	1.01 tons	24.74 tons	5 (+8)	21	Headlights	Enclosed

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor*
M107 (Early)	134/94	37/26	1137	251	Std	T4	TF1 TS1 TR1 HF4 HS2 HR2
M107 (Standard)	132/92	37/26	1137	251	Std	T4	TF1 TS1 TR1 HF4 HS2 HR2

M107A1	145/101	40/28	1137	251	Std	T4	TF1 TS1 TR1 HF4 HS2 HR2
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Vehicle	Fire Control	Stabilization	Armament	Ammunition
M107 (Early)	None	None	175mm M113 L/30 Howitzer	2x175mm
M107/M107A1	None	None	175mm M113 L/60 Howitzer	2x175mm

*Kevlar Sheets may be erected on a frame to protect the gunners and loaders, giving a turret AV of 2 on all sides.

Cadillac M108

Notes: This elderly self-propelled howitzer is still being used by Brazil, Spain, Taiwan, and Turkey. The only combat service seen by the M108 is in the Vietnam War, where it was used by the US. Though it had an excellent combat record, after the Vietnam War, NATO felt that the M109 was better for employment with NATO forces. The M108 was specifically designed to replace the M52 SPH above.

The M108 uses components also used by several armored vehicles, including the turret of the M109 and some of the suspension of the M113 APC. Components from the M107 comprise the primary chassis. It uses the M103 L/30 105mm howitzer; the M108 was meant to be the light component of the US's SP howitzer fleet, and at the time, bridged the gap between 120/4.2" mortars and the 155mm howitzer. Nonetheless, the warhead of a 120/4.2" mortar is comparable to a 105mm round, and they became superfluous with the introduction of the M109. The gun is capable of extreme elevation and depression, with a depression of -6 degrees and an elevation of an astounding +75 degrees. (HEAT rounds were devised to take advantage of the low depression, making direct fire effective.) The chemical rounds present a special problem; their range is short enough that firing into a headwind could contaminate friendly positions, and the M108 has no NBC protection. It's aluminum armor is decent for such a vehicle, but there are no anti-spall liners. On the whole, the M108 looks a bit lumpish, being flat on all sides of the chassis and a squat turret mounted at the rear of the chassis.

The driver has a hatch on the front left deck, the commander and gunner have hatches on the turret roof, and there are large doors on either side of the turret and in the rear of the turret for ammunition loading. It is amphibious with preparation (takes 9 minutes) through inflatable bags that attach to the hull above the tracks. Power is provided by a Detroit Diesel 8V71T supercharged diesel, derated to 426 horsepower due to the lighter weight than the M108 and to help conserve fuel. However, the M108 was one of the first US armored vehicles to be equipped with an automatic transmission. In Vietnam, crews were normally equipped with several M14s or M16s, a plethora of fragmentation grenades, and an M20A1B1 Super Bazooka rocket launcher. However, these were not standard issue and are included in the entry below.

Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
\$314,847	D, A	500 kg	21 tons	5	15	Passive IR (D, G)	Enclosed

Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
150/105	42/29/4	511	150	Trtd	T4	TF8 TS4 TR4 HF10 HS3 HR3

Fire Control	Stabilization	Armament	Ammunition
+1	Basic	105mm M103 L/30 Howitzer, M2HB (C)	87x105mm, 600x.50

BMY M109

Notes: The M109 is, essentially, a progressive upgrade of the M108; they use the same chassis and a modified version of the M108's turret.. The M109 was used, in its various iterations, by nearly 50 countries; most of these have been upgraded to various degrees, especially in the gun length. Most countries which originally used the M1209 are still using them, The M109A6 Paladin is a highly-modified version which will be covered in the next entry. With the cancellation of the XM2001 Crusader program, the M109A6 and other marks of the M109 remains the primary SP howitzer of some 25 of those 50 countries. Many have license agreements to allow them to produce M109s at home and modify them as needed; perhaps the greatest upgrades have been done by the South Koreans. Several European countries are either going their own way with a variety of SP howitzers, especially the AS-90.

M109: The Original

The original M109 was essentially a straightforward gun upgrade of the M108. It began deployment in 1963 and saw its first combat use by the US Army in Vietnam. It was, at the time of its development, essentially a heavy version of the M108 above. It has a short L/23 M284 155mm howitzer, tipped with a large double-baffle muzzle brake, It can fire basic NATO rounds (though not the more advanced rounds such as BB, RAP, Smart, and suchlike).The driver is, as on the M108, The turret has two large doors, one on each side; large ammunition loading doors in the rear (which allow replenishment from a ground pile via conveyor belts, from a resupply vehicle via conveyor belts, or by hand via conveyor belt. The M109, as all members of the series, can feed from the M992 FAASV resupply vehicle. M109 is able to fire while being resupplied, and also normally carries one conveyor belt, while the support vehicle carry one or two apiece. An additional, small ramp is found below the ammunition resupply doors, for crew ingress and egress; it is also used for resupply.

The gun of the M109 has two telescopic sights, an indirect fire telescope and gear, and night vision in case direct fire is necessary.

Like the M108, the M109 is capable of extreme elevation and deflection. The commander has a cupola with all-around vision blocks and is manually-rotating. The commander is equipped with a heavy machinegun on a pintle, but as this is considered defensive armament, little ammunition is provided for it. Power is produced by a derated 8V71T developing 406 horsepower, which makes the M109 slightly underpowered.

M109A1/M109A1B

The M109s were quickly upgraded to use an L/30 howitzer; these were designated M109A1. New production M109A1 were designated M109A1B. The M109A1B was intended as a kit for countries using the M109, and not for domestic use. The M109A1B also had several electrical and mechanical upgrades, and improved the night vision situation. Both vehicles included a computer, very primitive by today's standard, which was analog-based and helped compute fire solutions.

M109A2/M109A3/M109A3B

The primary modification in the M109A2 was the installation of an L/39 M186 cannon. The sights and night vision heads are now armor protected. Some 27 Reliability, and Maintainability (RAM) mid-life improvements were applied to the engine, transmission, suspension, and electrical system. The travel lock is counterbalanced to account for the weight of the longer gun. Stowage of rounds was increased. The M109A3 is an M109A1 upgraded to M109A2 standards; the M109A3B is an M109A1B upgraded to the same standard. A 10kW APU was added for power when the engine is switched off.

M109A4

The M109A2s and A3s were further upgraded in the early 1980s to give them NBC resistance, including anti-radiation cladding and an NBC overpressure system with a vehicular NBC backup. A heater was also added, as well as an engine preheater for starting in cold climate. The clutch for turret rotation was changed to hydraulic, though overall operation was still electrical. An additional hydraulic filter was added. The night vision suite was also strengthened. A mechanical loader was added, along with a manual rammer, easing somewhat reloading. A GPS system was installed, as well as a mapping module and a ruggedized, compact computer for use in computing fire solutions as well as having software to view and carry all applicable FMs, TOs, TBs, and other manuals. The computer also allows partial diagnosing of vehicle or ordnance problems, when used by a mechanic with the proper equipment. A second long-range radio was added, and all of these are secure radios.

M109A5/M109A5+

The main gun was replaced by an improved, longer-lasting M284 howitzer in an M182 mount. This new gun allowed the M109A5 to fire any sort of 155mm in the Western or Chinese arsenals. Some 30 kilometers can be achieved with RAP munitions. Another major modification was the upgrade of the engine to a 440-horsepower 8V71T supercharged diesel engine; this is an uprated version of the engines of previous M109s. M109A5s are often seen with appliqué of ERA on the front hull, glacis, vehicle sides, turret sides and front, and about the forward one third of the turret. They also often have a solid steel plate for mine protection. Eight smoke grenade launchers have been added, a cluster on each turret corner. One of the big improvements in the M109A5 is that most of the components have been made modular, making further upgrades easy. It has an embedded GPS system, limited self-surveying and a limited ability to function as its own FDC, though fire will be inaccurate (double scatter distances). The M109A5 has air conditioning and heating, including NBC filters. The fire control system includes onboard ballistic computing and automatic weapon pointing, which slews the turret and elevates or depresses the gun automatically to acquire the target (roughly; fine adjustments must be made by the gunner). The M109A5 also has a vehicle state system, though not a full BMS. Finally, there is a slave receptacle allowing the M109A5 to be powered by the generator aboard the M99A2 FAASV, and vice versa.

Various manufacturers, most notably IWI and BAe, have applied further upgrades to the M109A5; these are sometimes known as "M109A5.5s" or "M109A5+s." Upgrades include a power rammer, an autoloader, improved direct-fire sights, and computers that allow the M109A5+ to more fully integrate with the FDC. One computer is connected to the radio, allowing fire coordinates to be inputted directly into the gun, giving it a rough set of coordinates which are to be sharpened by the crew. The GPS has been backed up by an inertial navigation system, as many of the places in target countries do not have reliable connections with GPS satellites. Equipment includes appropriate earlier upgrades as well as a 30-liter tank of drinking water, an air conditioner, and a 13kW APU. Storage space for personal items is...well not ample, but more than the M109A5, with any sort of empty space being used for crew and personal gear. Thusfar, the M109A5+ has been exported only to Chile and Brazil, but IWI and BAe continue to market these upgrades, and claim that they can update an original M109 into an M109A5+.

Foreign Modifications to the M109

Various countries have made modifications to their M109. For the most part, this was limited to changes in label languages. Some, however, were much larger and comprehensive upgrades. These are listed below,

Ruag M109 KAWEST

This Swiss version of the M109 uses howitzers taken from a new design for a land-based gun, the Bison Fortress gun. The gun is L/47, and the KAWEST includes ECCM, vertically-firing flares and chaff in addition to normal smoke grenades. The KAWEST has more ammunition storage than most M109s. The KAWEST is equipped with ECCM and radio jamming capability, as well as integral navigation and an interface system for the commander and driver. Though it is not equipped with GPS, it is equipped with an inertial

navigation which is very accurate in interpreting the KAWEST's travels, and it can almost always find the way and its position. The KAWEST is therefore able to operate in a limited manner as its own FDC, though this is somewhat inaccurate and scatter distance is doubled at long range. The new autoloader includes a telescoping rammer, easing the loaders' work, and allowing a burst rate of 3 rounds in 15 seconds for one minute. The mechanical loader has been upgraded to a semiautomatic autoloader. The gun is positioned using gunner's input and an automatic ring laser gyroscope. The rounds and charges are contained in a magazine in the rear of the turret; this compartment is separated from the turret by a blastproof door and is equipped with blow-out panels. The gun has an automatic travel lock which engages at a command by the driver.

The KAWEST has an upgraded electrical system, including a new alternator which is 80% more effective than the unit it replaced. This replaces the existing M109 electrical system, and exceeds the NATO standard for the M109, and indeed, most NATO vehicles. The KAWEST can use the US STE-ICE diagnostic system. The KAWEST has a similar computer suite similar to the M109A5+. The batteries in the vehicle have been improved, and the amount of batteries has been doubled. It includes an updated 450-horsepower 8V71T supercharged diesel engine. The KAWEST Update includes a 12 kW APU for operation with the engine off; this APU can also provide power to up to two resupply conveyor belts. The KAWEST has a multichamber fire detection and fire/explosion system which operates in a separate system in the engine, ammunition supply. Fuel cells, turret, and driver's compartment. The driver has a fully automatic transmission with conventional driving controls; it also has a manual transmission backup. No applique armor packages have yet been developed for the KAWEST, but ERA can be applied to the turret side, front, front third of the turret roof, hull side, and glacis.

The proper Swiss Army designation is PzHb-79/95 and PzHb 88/95, depending what variant of the M109 they were upgraded from. Deliveries to the Swiss Army began in 2004, and are now complete. The Swiss are now offering the KAWEST as an upgrade package for earlier M109s, but there have been no takers so far. Upgrades of individual components of the KAWEST package are also available; the Dutch used the gun barrel and its associated fire control software to upgrade the UAE's M109A4s.

RDM/Rheinmetall M109L52

This is essentially an M109A4 fitted with the gun of the PzH-2000, along with mechanical and electrical components to mate the new gun with the M109 chassis. A few things, like GPS with mapping module, an artillery fire direction (AFD) computer, and a few gee-whizzes that allow the crew to keep track of the state of their vehicle, as was an autoloader. An armor upgrade was applied.

United Arab Emirates M109L47

This version is essentially an M109A4 with an L/47 gun.

Daewoo K-55

Notes: The first K-55s (also known as M109A2Ks) were virtually stock M109A2s supplied and later license-produced in South Korea. Thus, the K-55 was primarily an M109A1B with 27 improvements to Reliability, Availability, and Maintainability (RAM) mid-life improvements (MLUs). The gun is a 39-caliber 155mm howitzer, capable of firing all 155mm howitzer rounds available by the mid-1980s. The K-55 has traded shots across the DMZ on occasion. The K-55 is powered by a Detroit Diesel 8V71T 450 horsepower turbocharged diesel, with a semiautomatic transmission and mostly conventional driver's controls. The driver is on the front right side, while the rest of the crew is in the turret or directly behind it (one loader). The commander has a manually-operated cupola with all-around vision blocks and a weapons mount. The primary loader has a hatch on the left of the turret, but no vision blocks or weapon mount (though it was a common modification). The K-55 can produce a fire rate of 6 rounds per minute for 5 minutes, or a sustained fire rate of 3 rounds per minute; a raised fire rate is hard work, while a normal rate of bombardment is normal work. Like the M109A2, the K-55 has a 10kW APU, as well as a vehicle state system, map module, inertial navigation, NBC Overpressure, a laser rangefinder with ballistic computer for direct fire work, and a small computer for vehicles manuals and orders from other units and echelons. The K55 has an extra data-capable long-range radio which interfaces with that small computer.

The K-55A1 improvement installed a number of improvements, from the ability to fire all Western and Chinese 155mm rounds, further automotive improvements, installation of a fully automatic transmission, an automatic loader with power rammer, a 50-liter water tank, a crew ration heater/water heater, an integrated power pack, and improved gearing allowing for higher speeds despite the actual engine not having been changed. The K-55 typically carries ERA on its glacis, sides, turret sides, and the front one-third of the turret front. It can directly interface with the K-10 FAASV. GPS, a ballistic computer for both indirect and direct fire (though HEAT rounds are rarely carried, and then only two or three), and a ruggedized laptop with a mapping module linked to the GPS and secondary inertial navigation. The commander has an LCD telling him the vehicle and ammunition state. The commander has a full panoramic sight, with another vision block having a mil-ring for the artillery placement and pointing. The gunner has the same sort of ring. These were only partially effective and were not included on the K-9. The K-55A1 is fitted with NBC Overpressure with a vehicular NBC system backup. In extremis, the K-55A1 can come up with its own fire solutions, but accuracy will suffer; double scatter ranges.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
M109	\$388,359	D, A	500 kg	24.95 tons	6	19	Passive IR (D, C, G)	Enclosed
M109A1	\$411,760	D, A	474 kg	24.74 tons	6	19	Passive IR (D,	Enclosed

M109A1B	\$437,712	D, A	474 kg	24.74 tons	6	19	C, G) Passive IR (D, C, G), Image Intensification (G)	Enclosed
M109A2/A3	\$490,572	D, A	374 kg	25.54 tons	6	19	Passive IR (D, C, G)	Enclosed
M109A3B	\$341,529	D, A	374 kg	25.54 tons	6	19	Passive IR (D, C, G), Image Intensification (G)	Enclosed
M109A4	\$582,825	D, A	374 kg	25.54 tons	6	18	Passive IR (D, C, G), Image Intensification (G)	Shielded
M105A5	\$905,907	D, A	465 kg	25.76 tons	6	20	Passive IR (D, C, G), Image Intensification (G)	Shielded
M109A5+	\$1,075,081	D, A	438 kg	25.87 tons	6	21	Passive IR (D, C, G), Image Intensification (G)	Shielded
M109 KAWEST	\$3,484,388	D, A	428 kg	26.91 tons	6	19	Passive IR (D, C, G), Image Intensification (G), Thermal Imaging (G, C)	Shielded
M109L52	\$875,059	D, A	328 kg	26.51 tons	6	18	Passive IR (D, C, G), Image Intensification (G)	Shielded
K-55	\$964,418	D, A	500 kg	27.5 tons	6	21	Passive IR (D, G), Image Intensification (G)	Shielded
K-55A1	\$1,329,372	D, A	325 kg	28.5 tons	5	22	Passive IR (D, G), Image Intensification (G, C)	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
M109	133/93	37/26/4	511	151	Trtd	T4	TF8 TS4 TR4 HF10 HS3 HR3
M109A1/M109B1	134/94	37/26/4	511	150	Trtd	T4	TF8 TS4 TR4 HF10 HS3 HR3
M109A2/A3/A3B/A4	119/83	33/23/4	511	150	Trtd	T4	TF8 TS4 TR4 HF10 HS3 HR3
M109A5	126/88	35/22/3	511	163	Trtd	T4	TF10S6Sp TS4 TR4 HF12Sp HS5 HR3*
M109 KAWEST	128/89	36/25/4	511	167	Trtd	T4	TF11Sp TS5Sp TR4 HF13Sp HS5Sp HR3***
M109L52	116/81	32/22/3	511	151	Trtd	T4	TF10S6Sp TS4 TR4 HF12Sp HS5 HR3*
M109A5+	125/88	36/24/3	511	163	Trtd	T4	TF10S6Sp TS4 TR4 HF12Sp HS5 HR3**

K-55	121/85	34/24/3	511	166	Trtd	T4	TF8 TS4 TR4 HF10 HS3 HR3
K-55A1	118/83	33/23/3	511	166	Trtd	T4	TF8 TS4 TR4 HF10 HS3 HR3

Vehicle	Fire Control	Stabilization	Armament	Ammunition
M109	None	Basic	155mm M126 L/23 Howitzer, M2HB (C)	28x155mm, 600x50
M109A1/A1B	None	Basic	155mm M126A1 L/30 Howitzer, M2HB (C)	28x155mm, 600x50
M109A2/A3/A3B/A4	None	Basic	155mm M185 L/39 Howitzer, M2HB (C)	36x155mm, 600x.50
M109A4	+1	Basic	155mm M185 L/39 Howitzer, M2HB (C)	36x155mm, 600x.50
M109A5	+1	Basic	155mm M284 Howitzer, M2HB (C)	36x155mm, 600x.50
M109A5+	+2	Fair	155mm M284 Howitzer, M2HB (C)	36x155mm, 600x.50
M109 KAWEST	+2	Fair	155mm Bison Fortress L/47 Howitzer, M2HB (C)	40x155mm, 600x.50
M109L52	None	Basic	155mm L/52 Rheinmetall Howitzer, M2HB (C)	35x155mm, 600x.50
K-55 (Both)	+2	Fair	155mm L/39 Howitzer, M2HB (C), M60 (L)	48x155mm, 1000x.50, 1000x7.62mm

*Belly AV is 3.

**Belly AV is 3Sp.

***Bally AV is 5Sp. Roof AV is 5.

BAe M109A6/A7 Paladin

Notes: In the mid-to-late 1990s, development was begun on this radical upgrade of the M109 SP howitzer. The Army had been floundering out there, going through one abortive MRL, SP mortar, and SP Howitzer program, only to cancel them as soon as they could not meet the design roles, or killed in the budgetary arena. Two noted members of these casualties, the XM2002 Crusader and the NLOS Cannon, essentially led nowhere on the development track (though the NLOS Cannon is still officially in development). Basically, the designers of the Paladin put every equipment they could into the M109A6, along with improvements originally belonging to teat programs and vehicles. Delivery of these vehicles began by October 1998 and was largely completed by 2002. The Paladins have been about a 50/50 mix of upgraded vehicles and new-build M109A6s. Some 25 were built after the initial 960-vehicle block, and delivered by early 2002; these were largely test and experimentation vehicles for the upcoming M109A7 Paladin. The M109A6 is just now in 2014 being to be delivered to Active US Army units. The M109A7 is already in LRIP, but operational testing will not occur until September of 2014. Areas will be swathed in Kevlar antispall liners internally wherever possible.

M109A6 Paladin

The Paladin looks sort of like an M109 distorted by some sort of powerful steroids, as doorways small and large vision blocks, clamp-down points for cargo such as for servicing the Paladin, water cans, ration boxes, and some personal gear are basically everywhere. The turret has a huge bustle (used primarily for ammunition storage), and on the sides of the turret, bustle racks for crew equipment, ammunition, or suchlike. And there are literally tie-down points everywhere. The Paladin has two large ammunition-resupply doors at the rear of the bustle which open up directly into the Paladin's ammunition racks. The commander and gunner have similar hatches to those on other M109s, except the commander has a direct feed to night vision equipment, and also can mark targets for the gunner to deal with as the commander spots them. The gun can operate quickly from a stop, able to fire within 30 seconds of a stop is a round is already within the chamber. After firing a quick mission (1-3 rounds), the Paladin can be gone within 15 seconds of firing the howitzer, with the travel lock being engaged on the move. The gun autoloading system is advanced enough that one loader was removed from the required crew complement.

The M109A6's method of deployment is by small units; as few as four guns or less may be assigned to fire support for a mid-level attack, and times have occurred where only one or two Paladin's have been added as support. A Paladin is able to operate without data from an FDC, getting coordinates directly from requesting units or from FIST teams. The Paladin is the type of NATO vehicle where you might find "exotic" rounds; the Paladin Program is meant to operate with CLGPs, exotic smart rounds, and even newer BB, Excalibur, and RAP shells. The Paladin has a GPS system connected to LCD displays at the gunner's commander's, and driver's stations. The Paladin has the equivalent of a ruggedized laptop, which can reach throughout the vehicle revealing the vehicle state, as well as armament available, rations remaining, etc. The crew has a ration heater/water boiler available to the crew, as well as a 30-liter fresh water tank. The vehicle has air conditioning and heating with NBC Filters, as well as NBC Overpressure.

Perhaps the greatest deficiency in the M109, it's short gun, was not addressed by the Paladin upgrade, though a longer gun was experimented with. The Paladin has the M284 L/39 155mm cannon. The computer feeds coordinates to the fire control system, with the turret elevating, depressing, or slewing as necessary. (The Paladin's have what is called the PFDCS – Paladin Delivery Fire and Control System,) The Paladin essentially needs no FDC to produce accurate fire, though it does need information from a FIST team. The Paladin has a powerful ECCM unit to bore through EW interference if necessary, as well as high-power, long-range radios. One Paladin can feed coordinates and fire solutions to the others in a battery.

Power is provided by DDEC 8V71T supercharged diesel, the same as in the M109A5, but uprated to 450 horsepower. The engine is coupled to an automatic transmission, with a T-bar steering yoke. Some have said that the driver's compartment is rather roomy. Shock absorbers and tension bar systems are described as doing an excellent job. Three grenade launchers are being contemplated – standard smoke grenade generators, chaff grenades to fire straight up, and flares to fire straight up. (The vehicles below have those grenade launcher upgrades.) The armor protection has been increased; the problem that the engine power has been increased only a little, more armor is being carried – the result is a possible underpowered vehicle. The Paladin has a 13 kW APU; this can power both the gun and an FDC or another Paladin if necessary. In addition to standard armor, the turret and driver's position have Kevlar anti-spall liners.

The M109A7 Paladin

This upgraded paladin is very much the same as the M109A6; however, the M109A7 has a self-survey capability. Some of the M109A7's features are taken from the cancelled Crusader and NLOS-C SPHs. They are usually referred to as the PIM (Paladin Integrated Management). The chassis of the M109A7 is very different from that of its processor, having a large amount of components from the US Army's Bradley Fighting Vehicle, such as the engine, drive train, tracks, and suspension. The M109A7 also has six larger roadwheels instead of seven smaller ones. NLOS-C components include the autoloader, electrical rammer, and elevation and traverse drives. The Crusader's fire control system, BMS, vehicle state computer, GPS (with auxiliary inertial navigation), and radios are modified versions of those in the Crusader. The ammo racks and autoloader are finally compatible with even long and large rounds like the Excalibur. LRIP began in 2015, and eventually all M109A6s will be converted to M109A7s. Though initially, the M109A7 will have the same 450-horsepower engine as other Paladins, there is already rumors of the engine's being replaced by a Cummins turbocharged diesel developing 600 or 675 horsepower. The M109A7 has new technology autoloaders and some of the Fire Control and loading equipment of the Crusader. Guns and turrets are electrically controlled, to exacting tolerances. The gun is fed by a 22-round magazine in the rear of the turret, plus 17 rounds in racks partially surrounding the turret and in the rear.

The new cannon has an advanced bore evacuator, a new breech housing, and longer length that allows for longer range. The armor on the turret is improved and has Kevlar ballistic lining; a new fire control system is fitted, with GPS, onboard fire control computers, inertial navigation system, and automatic fire control input; frequency-hopping radios, night vision gear, a 15kW generator, a water heater (for heating rations), and a reduction in crew required to four. The Paladin is capable of laying and firing the howitzer without input from the FDC if the target's location is known, via the Automatic Fire-Control System (AFCS). The M109A7 Paladin may decrease reload time to 1 for one minute.

Early version used an M2HB at the commander's hatch, protected by AV2 gun shields. However, versions are now being retrofitted with CROWS RWSs which are equipped with an M2HB and a Mk19 grenade launchers. (This is what's illustrated in the stats below.) The A7 has lugs for ERA and attachment points for MEXAS applique armor. Currently, the M109A7 is armed with the M284 L/39 gun, though it is expected to be replaced with 52-caliber ordnance before it exits field testing.

The "M109A8" Paladin

This is a **fictional** (so far) variant of the Paladin, armed with the L/58 gun currently being tested on Paladins at Ft Sill, Texas. In addition, the vehicle is powered by the 675-horsepower listed above, and has a fire control system that is designed to work with the new gun, The M109A8 is equipped with a US copy of the Trophy hard-kill APS. Otherwise, it has the features of the M109A6 and M109A7, except that the 675-horsepower is standard.

All these vehicles are normally followed with an M992A3 ammunition carrier. This is simply an M992 modified to work with the Paladins.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
M109A6	\$1,431,463	D, A	561 kg	28.8 tons	5	26	Passive IR (D, G, C), Image Intensification (G, C), Backup Camera (D)	Shielded
M109A7 (L/39 Gun, 450 hp)	\$1,475,160	D, A	545 kg	34.78 tons	4	27	Passive IR (D, G), Image Intensification (G, C), Thermal Imager (C), Backup Camera (D)	Shielded
M109A7 (L/39 Gun, 600 hp)	\$1,475,713	D, A	542 kg	35.28 tons	4	30	Passive IR (D, G), Image Intensification (G, C), Thermal Imager (C), Backup Camera (D)	Shielded
M109A7 (L/39 Gun, 675 hp)	\$1,476,608	D, A	542 kg	35.56 tons	4	30	Passive IR (D, G), Image Intensification (G, C), Thermal Imager (C), Backup Camera (D)	Shielded
M109A7 (L/39 Gun, 450 hp)	\$1,509,821	D, A	537 kg	35.17 tons	4	30	Passive IR (D, G), Image Intensification (G, C), Thermal Imager (C), Backup Camera (D)	Shielded

hp, Applique) M109A7 (L/39 Gun, 600	\$1,510,296	D, A	542 kg	35.67 tons	4	30	Passive IR (D, G), Image Intensification (G, C), Thermal Imager (C), Backup Camera (D)	Shielded
hp, Applique) M109A7 (L/39 Gun, 675	\$1,511,889	D, A	542 kg	35.95 tons	4	30	Passive IR (D, G), Image Intensification (G, C), Thermal Imager (C), Backup Camera (D)	Shielded
hp, Applique) M109A7 (L/52 Gun, 450	\$1,509,388	D, A	511 kg	34.92 tons	4	30	Passive IR (D, G), Image Intensification (G, C), Thermal Imager (C), Backup Camera (D)	Shielded
hp) M109A7 (L/52 Gun, 600	\$1,509,829	D, A	538 kg	35.42 tons	4	30	Passive IR (D, G), Image Intensification (G, C), Thermal Imager (C), Backup Camera (D)	Shielded
hp) M109A7 (L/52 Gun, 675	\$1,510,503	D, A	538 kg	36.1 tons	4	32	Passive IR (D, G), Image Intensification (G, C), Thermal Imager (C), Backup Camera (D)	Shielded
hp) M109A7 (L/52 Gun, 450	\$1,544,126	D, A	506 kg	35.31 tons	4	30	Passive IR (D, G), Image Intensification (G, C), Thermal Imager (C), Backup Camera (D)	Shielded
hp, Applique) M109A7 (L/52 Gun, 600	\$1,544,706	D, A	528 kg	35.81 tons	4	30	Passive IR (D, G), Image Intensification (G, C), Thermal Imager (C), Backup Camera (D)	Shielded
hp, Applique) M109A7 (L/52 Gun, 675	\$1,545,205	D, A	528 kg	36.6 tons	4	32	Passive IR (D, G), Image Intensification (G, C), Thermal Imager (C), Backup Camera (D)	Shielded
hp, Applique) M109A8	\$1,812,260	D, A	520 kg	36.9 tons	4	32	Passive IR (D, G), 2 nd Gen Image Intensification (G, C), FLIR (C), Backup Camera (D)	Shielded
(Applique) M109A8	\$1,853,048	D, A	507 kg	37.4 tons	4	32	Passive IR (D, G), 2 nd Gen Image Intensification (G, C), FLIR (C), Backup Camera (D)	Shielded

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor
M109A6	129/90	26/25	511	167	Trtd	T4	TF11Sp TS7Sp TR7 HF14Sp HS5Sp HR5*
M109A7 (L/39 Gun, 450 hp)	103/72	29/20	511	167	Trtd	T4	TF11Sp TS7Sp TR7 HF14Sp HS5Sp HR5*
M109A7 (L/39 Gun, 600 hp)	125/88	35/24	511	222	Trtd	T4	TF11Sp TS7Sp TR7 HF14Sp HS5Sp HR5*
M109A7 (L/39 Gun, 675	137/96	38/27	511	250	Trtd	T4	TF11Sp TS7Sp TR7 HF14Sp HS5Sp HR5*

hp) M109A7 (L/39 Gun, 450	102/71	38/27	511	169	Trtd	T4	TF14Cp TS10Cp TR7 HF19Cp HS8Cp HR5**
hp, Applique) M109A7 (L/39 Gun, 600	124/87	35/24	511	224	Trtd	T4	TF14Cp TS10Cp TR7 HF19Cp HS8Cp HR5**
hp, Applique) M109A7 (L/39 Gun, 675	135/95	38/27	511	253	Trtd	T4	TF14Cp TS10Cp TR7 HF19Cp HS8Cp HR5**
hp, Applique) M109A7 (L/52 Gun, 450	103/72	29/20	511	168	Trtd	T4	TF11Sp TS7Sp TR7 HF14Sp HS5Sp HR5*
hp) M109A7 (L/52 Gun, 600	121/85	34/23	511	229	Trtd	T4	TF11Sp TS7Sp TR7 HF14Sp HS5Sp HR5*
hp) M109A7 (L/52 Gun, 675	135/95	38/27	511	254	Trtd	T4	TF11Sp TS7Sp TR7 HF14Sp HS5Sp HR5*
hp) M109A7 (L/52 Gun, 450	102/71	29/20	511	170	Trtd	T4	TF14Cp TS10Cp TR7 HF19Cp HS8Cp HR5**
hp, Applique) M109A7 (L/52 Gun, 600	120/84	33/23	511	231	Trtd	T4	TF14Cp TS10Cp TR7 HF19Cp HS8Cp HR5**
hp, Applique) M109A7 (L/52 Gun, 675	134/94	38/27	511	257	Trtd	T4	TF14Cp TS10Cp TR7 HF19Cp HS8Cp HR5**
hp, Applique) M109A8	133/93	38/27	511	259	Trtd	T4	TF12Sp TS8Sp TR7 HF14Sp HS6Sp HR5***
M109A8 (Applique)	131/92	38/27	511	262	Trtd	T4	TF15Cp TS11Cp TR7 HF20Cp TS9Cp HR5****

Vehicle	Fire Control	Stabilization	Armament	Ammunition
M109A6	+2	Fair	155mm L/39 Howitzer, M2HB (C), M60 (L)	39x155mm, 1000x.50, 1000x7.62mm
M109A7	+2	Fair	155mm L/39 or L/52 Howitzer, M2HB (CROWS), Mk 19 (CROWS)	39x155mm. 1000x.50, 400x40mm
M109A8	+2	Fair	155mm L/58 Howitzer, M2HB (CROWS), Mk 19 (CROWS)	39x155mm. 1000x.50, 400x40mm

*Floor AV is 4Sp.

**Roof Armor is AV 5, except for the front third of the turret roof, which is 6Cp. The Floor Armor for this variant is 6Sp.

***Roof Armor is AV 7; Floor Armor is AV 7Sp

****Roof Armor is AV 7, except for the front third of the turret roof, which is 8Cp. The Floor Armor is 8Sp.

BMY M110

Notes: Based upon the chassis of the M107 and developed in tandem, the M110 was meant to provide heavy-caliber support in situations when more mobility was required and where there was much uneven terrain, something the M107 was not good at dealing with. The gun also had a higher throw weight and this was appreciated, as the extra range of the M107 (in Vietnam, anyway) was not always necessary, while watching Viet Cong flop around full of shrapnel was always a treat. Some 25 countries use or used it; known current users include Greece, Turkey, Iran, Japan, Morocco, Pakistan, South Korea, and Taiwan. As the M110 lasted far longer than was expected, new ammunition types were being developed right up to the time of withdrawal. The new Vietnam Republic captured a good number of M110s and used them for about a decade in regional conflicts. The last US M110A2s in use by the US were in use in 1994 by the US Army Reserve.

The M2A2 L/23 203mm howitzer had decent enough range of its own to satisfy, and explosions were satisfyingly large. The M2A2 is itself a development of a British World War 1 8-inch howitzer. Recoil spades are lowered at the rear of the vehicle before firing and preferably sunk as deep as possible into hard-packed ground. The gun is carried on top of the chassis of the vehicle. This gives no protection to the crew from small arms fire or artillery splinters; to remedy this, a tubular framework was issued with the vehicle that could be erected around the firing position; over which Kevlar shields are placed. Most of the time, these were considered too cumbersome and difficult to use, and they were typically left strapped to the side of the vehicle or abandoned in the rear areas. The entire assembly looks like the canvas-over-bows cover on a 2.5-ton truck. Without these shields, the turret armor value from all directions is 0, while the gun's AV is 1. The gun is carried atop the chassis, with the gun mounted at the extreme rear of the M110. Practical range of fire on the turntable is left or right of 30 degrees of center of the front. As there is almost no room for ammunition on the vehicle, and also no room for 8 of the crew members, the M110A2 is normally followed by a large amount of support vehicles carrying these members and the ammunition, such as the M548, M648, or FAASV. Contrary to the M107, the M110 was known to be one of the more accurate SP guns around in the world at the time. The M110's barrel tube has no muzzle brake nor fume extractor. The round is absolutely massive; the shell itself is an average of 91 kilograms, not including fuze and charges; nonetheless, the gunners often found using a manual expedient – a hard rubber cylinder on a long stick – worked better than the power rammer. (This manual rammer was generally called a "lunger" by gun crews.) Using the power rammer required the barrel to be lowered to full depression, the round loaded, and the barrel raised again to firing position; using the manual rammer allowed the gun crew to skip the middle step, not requiring the crews to lower and raise the barrel. Even a high-speed, low drag crew could only get the M110 up to 4 rounds per minute fired, and then only for a short time (in game terms, firing at that rate for more than three minutes counts as heavy fatigue to the entire loading and ammo-bearing crew, and light fatigue to the gunners and commander).

Using a common chassis, the M110 uses a slightly-more derated version of the 8V71T supercharged diesel engine developing 405 horsepower. This was done to increase torque in both the engine and transmission. Transmission is manual. It was common practice in Vietnam to employ M107 and M110 barrels as needed, and a given carriage could literally be firing a different caliber every day of the week. The gun could be elevated to +65 degrees and depressed -2 degrees. The gun was fed from twin loading baskets; the charges and fuzes were affixed before the round was moved up to firing position.

Unusual rounds which could be fired from the M110 were the 0.5, 1, 5, and 10 kt nuclear warheads. They were never used in war, and not even test-fired very often, but formed a part of the nuclear triad.

Only the driver had a full-armored position, with vision blocks. He is the only one who had any sort of armored protection. The two gunners and two of the loaders formed the rest of the vehicle crew, but were essentially crouching on the deck, with poorly-formed seats. There is no Overpressure, no vehicular NBC system, only the crews' own protective masks,

The M110A1 and A2, other than cleaned-up electrical and hydraulic, had their barrels extended, with the M110A1 having an L/36 barrel and the M110A2 having an L/40 barrel. These were far less common than the original version, however. They also were given muzzle brakes and fume extractors. The M110A1s were almost all new-build (in 1977), the M110A2s were refitted M107s and M110s. The two barrel-length guns were designated M201 and M201A1.

In an unusual move, during Desert Storm, US F-111s were in need of casings for 5000-pound bunker busters. (This was a new idea and we didn't have any in stock at the time.) The casings were at first taken from retired M110s and their gun barrels, and had mixed results. Later, purpose-built 5000-pound bunker-buster casings were made. Before and after Desert Storm, new weapons were introduced that closed the "firepower gap" that the M110A2 once filled, such as the MLRS, improved M109s, the ATACMS, and a new series of bunker-buster bombs that were smart (at first LGBs, but later enhanced with GPS guidance.) These made the M110 (and M107) unnecessary to most countries, and their M110s were sold off, given away to improve relations, or scrapped. A good number have ended up in US military museums or on static display. (I saw an M110 on display at Ft Carson in Colorado in 1991; it was kept in shamefully poor condition...)

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
M110	\$218,153	D, A	500 kg	28.35 tons	5(+8)	23	Headlights	Enclosed
M110A1	\$251,316	D, A	490 kg	28.73 tons	5(+8)	23	Headlights	Enclosed
M110A2	\$277,560	D, A	381 kg	28.83 tons	5(+8)	20	Headlights	Enclosed

Vehicle	Tr Mov	Com Mov	Fuel Cap	Fuel Cons	Config	Susp	Armor*
M110	110/77	31/21	1137	150	Trtd	T4	HF4 HS2 HR2
M110A1	109/76	30/21	1137	149	Trtd	T4	HF4 HS2 HR2
M110A2	108/76	30/21	1137	149	Trtd	T4	HF4 HS2 HR2

Vehicle	Fire Control	Stabilization	Armament	Ammunition
M110	Nil	None	203mm L/23 Howitzer	2x203mm
M110A1	Nil	None	203mm L/36 Howitzer	2x203mm
M110A2	Nil	None	203mm L/40 Howitzer	2x203mm