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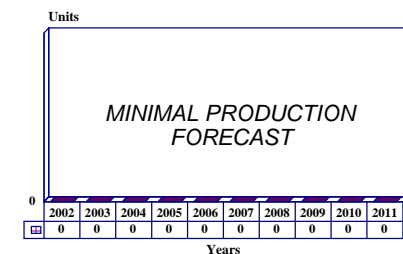
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Mk 38 25 mm Naval Gun – Archive 04/2003

Outlook

- Extensively used by US Navy and US Coastguard
- Existing weapons inventory adequate
- Being replaced on LPD-17 and DDG-51 classes by 30 mm Mk 46
- Export possibilities very limited
- This report will be archived next year

10 Year Unit Production Forecast
2002 - 2011



Orientation

Description. One-inch (25 mm) semi- and fully automatic machine gun with manual training and elevation.

Tel: +1 413 586 2330
Fax: +1 413 586 1324
(developer, producer of STARC; integrator)

Sponsor

United States Navy
Naval Sea Systems Command (NAVSEA)
2531 Jefferson Davis Highway
Arlington, Virginia (VA) 22242-5160
USA
Tel: +1 703 602 6920
Public Affairs: +1 301 743 6006
+1 703 602 1556

United States Navy
Crane Division
Naval Surface Warfare Center
Washington, DC
USA
(original design, assembly of the gun)

Licensees. No production licenses have been granted.

Contractors

Alliant Techsystems (ATK)
Minneapolis, Minnesota (MN)
USA
(ammunition)

Boeing Company
5000 East McDowell Road
Mesa, Arizona (AZ) 85205
USA
Tel: +1 602 391 7007
(producer of gun components)

Kollmorgen Corp
Electro-Optical Division
347 King Street
Northampton, Massachusetts (MA) 01060
USA

Status. In service. Upgrading of existing units continues.

Total Produced. A little over 500 guns of this type have been supplied to the US Navy, US Coast Guard, and a small number of export clients. The weapons are maintained in a rotating pool, available for temporary installation on various deploying ships and permanent installation on certain amphibious and auxiliary ships, patrol craft and Coast Guard cutters.

Application. The 25 mm Bushmaster is effective for close-in surface-to-surface and surface-to-air engagements against small watercraft and aircraft at distances of up to 2,700 yards (about 2.5 km). It is also suited for other short-distance self-protection such as mine detonation and swimmer/Zodiac neutralization.

Platform. The Mk 38 gun is used as a close-in “junk-busting” weapon against small craft on major warships and as the primary gun armament on small patrol craft.

Price Range. The Bushmaster 25 mm L87 Mk 38 Chain Gun® has been quoted at a unit price of US\$53,232.

The STARC-25/Mk 38 Mod stabilizer and controller system offered by Kollmorgen has a unit price of roughly US\$250,000 (for upgrades on existing mounts) and US\$500,000 (for new-build installations).

Technical Data

	<u>Metric</u>	<u>US</u>
Specifications		
Bore	25.4 mm	1 in
Caliber	25.4 mm (NATO Standard 87)	87
Length (overall)	2.74 m	9.0 ft
Width	320 mm	12.6 in
Height	373 mm	14.7 in
Length Behind Front of Feed	577 mm	22.7 in
Weapon Weight	110.7 kg	243.5 lb
Mount (Mk 88) Weight	459.1 kg	1,010 lb
Rate of Fire	single shots and up to 200 rpm	
Effective Range	up to 2,450 m, from close-in	up to 2,700 yd
Muzzle Velocity (HEI-T)	1,100 m/sec	3,600 ft/sec
Muzzle Velocity (APDS)	1,360 m/sec	4,460 ft/sec
Peak Recoil	4,540 kg	10,000 lb

Design Features. The Mk 38 Bushmaster is the naval version of the Chain Gun®, an externally powered weapon developed by Hughes for the US Army. The Mk 38 fires the 25 x 137 mm Oerlikon pattern cartridges (standard NATO 25 mm ammunition). Procured by the Army as the M-242, the gun is designated Mk 38 in naval service; the pedestal mount, Mk 88 Mod 0.

The weapon is a single-barrel, air-cooled, semi- and full-automatic machine gun system that is, in its standard configuration, manually trained and elevated. The guidance system is unstabilized in its base form, although an automatic guidance system has been developed and is being offered by the US company, Kollmorgen, for retrofit and new-build installations.

The name Chain Gun® comes from the use of a loop of standard industrial double-row roller chain, carried horizontally, to drive the bolt back and forth. The length and width of the chain are determined by the length of the round and by the desired rate of fire. The chain runs at constant speed, carrying a shoe that drives the bolt. When in line with the bolt, the shoe pulls back and forth, locking and opening the bolt. When the shoe travels to one side (along the belt, perpendicular to the gun’s axis), the gun has time to fire or to eject a fired cartridge (depending on where in the cycle this travel occurs). The feed to the gun is powered by the same motor that drives the chain.

During firing, the gun’s barrel, bolt, and breech mechanism recoil together as one unit independent of the weapon’s receiver, which bears no direct firing stresses and can thus be produced from lightweight aluminum. Despite this construction, McDonnell Douglas Helicopter Co (MDHC) claims some in-service M-242 receivers have withstood the firing of over 10,000 rounds without adverse effects.

Unlike its land-based counterparts, which offer a dual-feed capability that allows two different ammunition natures to be alternately fed at will from opposite sides of the weapon according to target type, Mk 38 systems are configured for single-direction feed only, since there is no requirement for armor-defeating ammunition.

Since the Mk 38 Bushmaster is crew-served, a safety interlock system is provided. If the barrel fails to recoil due to a long-duration hangfire or other ammunition fault, the gun will stop with the breech still locked. After the defective round has been cleared, firing will resume when the gunner releases and presses the trigger again.

Operational Characteristics. The fire can be launched in single shots or in automatic mode at a rate of 175 rounds per minute. The gun is credited with a barrel life of 25,000 rounds; dispersion is 0.5 mil. The system, which is crewed by a single gunner (typically

assisted by a spotter), is manually controlled and self-contained. The Mk 88 mount gives 360 degrees traverse (but has safety stops), and permits elevation of +55 degrees down to -20 degrees. The gun's chain mechanism is driven from a 24 V DC battery charged from the ship's electrical power supply via a Mk 218 power unit. The Mk 88 mount is not stabilized and is hand-aimed; therefore, it cannot make very many hits when mounted on a lively small combatant.

Though shields were seen on some early Mk 38 systems, current guns offer no crew protection. A pair of ballistic panels, one on either flank of the gun, have also been used, but this measure is now understood to have been dropped. Fire control is provided by a relatively simple Aimpoint red-dot optical sight. US Coast Guard trials are reportedly under way with the Loral/Solartron OBVACT firing simulator for Mk 38 system training.

The Mk 38 gun uses standard linked ammunition. It also fires from an open bolt, which protects it against cook-off hazards, and empty cases are ejected forward

of the weapon (overboard). Reliability is assessed as 23,700 mean rounds between stoppages, based on demonstrated performance, and claimed dispersion is 0.5 mils.

Interestingly, although electrochemical rifling (ECR) is attracting a lot of interest elsewhere today, MDHC (then Hughes) developed its own ECR process for the Bushmaster barrels some time ago. Since these have a progressive gain twist to minimize in-bore drag, ECR, which removes metal by electrolysis to form the rifling grooves, is an easier approach than cut rifling.

In naval configuration, the Mk 38 gun delivers single shots plus automatic fire at up to 200 rpm. Operational ammunition is 25 mm M-792 HEI-T and for training M-793 TP-T. With the M-792 round, the maximum effective range is 2,470 meters, and 150 linked rounds are carried on the gun. According to Kollmorgen, however, the effective range is extended beyond the specified 2,500 meters when using the stabilizer/weapon control system Mk 38 Mod 0.

Variants/Upgrades

In 1989, the Chain Gun® manufacturer McDonnell Douglas Helicopters announced a new series of weapons using the same principle. Those relevant to the naval market include the following Bushmaster models:

Bushmaster II. This 30 mm version had already fired 500 rounds as of late 1989 and was due for Austrian (AFV) and US Navy (2,000 round) tests. It fires Standard GAU-8 ammunition or modified Rarden or KCB ammunition. About 70 percent of the parts of this gun are the same as those used in the Bushmaster. Rates of fire are single-shot, 200 or 400 rounds per minute. Possible applications include the Minor Caliber Weapons Station, which is being developed by AAI.

Bushmaster III. The designation of a further enlarged version of the same basic gun that can fire 35 mm or 50 mm rounds with minor changes (including a barrel change). The first firings were carried out in July 1990 in 35 mm configuration.

Bushmaster IV. A derivative of Bushmaster III, chambered for Bofors 40 mm L70.

Mk 38 Mod/STARC-25. The stabilized and remote-controlled system offered by Kollmorgen. This adds a two-axis gyro stabilization for increased fire power, range, and hit probability by incorporating elevation motors and gyros, a new pedestal mounting and rotation motor, and a TV camera with the basic gun. The upgrade does not require deck penetration. Remote

control is available for improved operation and protection of the operator, as is interfacing with personal computer-based digital control of the target.

The system includes an automated video tracker and ballistic offset computations, including boresight adjust provisions, and can be integrated with off-mount sensors. The weapon and mount can be installed in less than four hours on the deck of the vessel, without the need for deck penetration, except for cables. The system's performance has been demonstrated at sea, at speeds of up to 50 knots, boosting the first-hit probability and operational flexibility. The low-cost, low-weight system can be retrofitted, and used either as a stand-alone system or integrated fully with the ship's combat system ammunition.

Mk 96. Also a stabilized version of the existing Mk 38 mount intended for deployment on the PC-1 Cyclone class. It combines a Bushmaster cannon and a Mk 19 grenade launcher.

Valkyrie. A number of stabilized gun mountings for the Bushmaster gun have been developed under the US Navy Stabilized Weapons Platform System (SWPS) program as the main armament for the PC-1 Cyclone class. These include the Valkyrie, a modular stabilized mounting that couples the cannon with an electro-optical fire-control system, a large, on-mount ammunition container, and a universal mounting for guided anti-surface (HELLFIRE) or anti-air (Stinger)

missiles or unguided rockets. Valkyrie is offered by the Electronics and Space Corporation, St. Louis, Missouri,

part of the Oerlikon-Contraves group.

Program Review

Background. Development and procurement of the Chain Gun® were originally approved in December 1971, and by mid-1988 over 5,000 had been delivered to the US Army. Today, the total deliveries have been pegged at more than 9,000 units, with a Bushmaster to be fitted on every Bradley Fighting Vehicle of the US Army.

Within months of its adoption by the Army, the Bushmaster also attracted the attention of the US Navy's Special Boat Squadron One. This interest had been prompted by a 1977 operational requirement for a more effective and reliable longer range naval weapon for Mk III and Mk IV patrol boats, one that was also to replace 20 mm Mk 16 guns in US amphibious craft, auxiliary ships, Coast Guard vessels, and landing craft. The new system was also envisioned as secondary armament for larger vessels.

The primary role for this new minor-caliber gun was to be close-range protection against surface threats, with secondary applications for air defense and engagement of shore-based targets. In August 1980, a month after the initial inquiry, US Navy staffs test-fired an M-242 from a Mk III Spectre class patrol boat. The weapon was installed on a Mk 68 naval mounting that had been modified by MDHC. Funds for purchase of the M-242 were subsequently allocated in the US Navy's 1982 budget.

At the end of 1982, the US Naval Sea Systems Command instructed the Naval Surface Warfare Center at Crane, Maryland, to design and manufacture a new deck mounting for the M-242. When installed on the resulting Mk 88 mount, the naval system was designated Mk 38 Mod 0, and is known informally as Sea Snake.

The first units to receive the Mk 38 (in August 1983) were US Navy Special Boat Units 12 and 20. Trials of the Mk 38 in three Panama-based Mk IV patrol boats subsequently began in 1986, with one gun mounted fore and aft in each vessel.

The Bushmaster was operationally evaluated for wider naval use in mid-1987. Later that year, the Chief of Naval Operations approved procurement to replace obsolete Mk 16 20 mm guns, which were difficult to support (requiring overhaul every 6,500 rounds), and did not use standard NATO ammunition; many rounds were considered unsafe. The Mk 16 had many

undesirable features, including a breech mechanism reportedly notorious for removing its operator's fingers.

As of mid-1988, many Mk 88s were in service in the Persian Gulf, and also equipped the Mk 4 patrol boats in the Panama Canal Zone. Plans laid down in August 1988 by Naval Sea Systems Command, indicated a target acquisition of 460 Mk 38s. Production of Mk 38 25 mm cannon was drastically accelerated in 1987 and 1988 to meet the needs of ships in the Persian Gulf. Much of the work was done at NSWC, the office responsible for the design of the guns.

The Mk 38 has been deployed in the Persian Gulf since 1988, and was used for mine countermeasures and defense against small craft in that theater. During Desert Shield and Desert Storm, US vessels as large as cruisers were equipped with the Mk 38 from central Fleet pools. Eighty systems were provided by the US Naval Weapons Support Center as part of the Gulf effort. The 25 mm weapon is considered ideal for countering the surface threat typical of Gulf-region and other littoral-theater encounters.

During 1992, partly as a result of this experience, the US Navy decided to replace all existing 20 mm and 40 mm mounts with the 25 mm Mk 38 gun in the Mk 88 mount. In effect, this means that nearly all US warships and Coast Guard cutters will have at least two of these guns.

The Mk 38 weapons of the US Navy are now maintained in a rotating pool, available for temporary installation on various deploying ships and for permanent installation on certain amphibious and auxiliary ships, patrol craft, and Coast Guard cutters.

The US Navy has praised the in-service reliability and effectiveness of the Mk 38 and its modest price tag. So far, MDHC has delivered at least 300 naval guns to the US Department of Defense. Some 200 more systems were presumably ordered, some for installation in new US coastal patrol craft of the Cyclone (PC-1) class until the future Stabilized Weapons Platform System (SWPS) is fielded. In addition, the manufacturer foresees potential foreign military funding opportunities for at least 500 additional weapons.

One major setback for the program was the loss of the LPD-17 program that adopted the 30 mm Mk 46 instead. This is the weapons station designed for the Advanced Amphibious Assault Vehicle and adapted for surface ship installation. The reach of the Mk 46 is

understandably longer (about 4,000 yards maximum), probably the decisive factor in selecting it as the weapons choice for these ships. In June 2001, it was

announced that the Arleigh Burke class destroyers would also be refitted with the Mk 46 weapons station in place of their Bushmasters.

Funding

Past procurement of the Mk 38 has included 29 weapons (valued at US\$1.56 million) in FY86; 25 guns (US\$1.35 million) in FY87; 22 (US\$1.18 million) in FY88; 57 (US\$3.078 million) in FY89; 55 (US\$2.97 million) in FY91; and 55 (US\$2.97 million) in FY92, for a total of 243 guns valued at US\$13.122 million.

Recent Contracts

<u>Contractor</u>	<u>Award (\$ millions)</u>	<u>Date/Description</u>
US Navy	2	October 12, 1999 – PGU-32/U ammunition for the Mk 38 shipboard gun (total value of contract with possible options US\$6.5 million).

Timetable

<u>Year</u>	<u>Major Development</u>
1971	Chain Gun® enters US Army service
1977	Operational requirement issued by US Navy
1980	First US Navy trials
1982	US Navy funding allocated
1986	First deployment
1987	Trials for large-ship deployment
1988	Additional procurement initiated
1991	Deployed in Operation Desert Shield and Desert Storm
2009	Upkeep, maintenance to continue, with addition of new upgrade kits

Worldwide Distribution

Bahamas. 2 on Bahamas class OPVs

Israel. 26 being refitted on Super Dvora class

Saudi Arabia. 34 on OPVs

US. 54 on CG-47 class, 70 on FFG-7 class, 8 on command ships, 24 on LHD-1 class, 30 on LHA-1 class, 52 on LSD/LPD, 2 on MCS-12, 26 on PC-1 class, 60 on Mk V SOC, 8 on AOE-6 class, 24 on WHEC-715 class, 19 on WMEC classes, 49 on WPB, 16 on WLB

Forecast Rationale

Small-caliber (30 millimeters or less) autocannon play a major part in providing close-range anti-surface defense for larger warships and as the primary armament of small and patrol craft. In this sense, the Mk 38 appears to have a large potential market open to it. Indeed, its characteristics suggest that it is very well suited to the demands of routine naval use. It and its ammunition are inexpensive, and the gun's design and mounting make it

easy to install. It offers a tempting compromise between the lethality (but high ship impact) of the 40 mm and larger guns, while giving substantial advantages in range, accuracy, and terminal lethality over the 12.7 millimeter weapons in widespread use. A short burst of 25 mm shots, impacting in front of a ship's bow (or ricocheting off the bridge if that warning is ignored), will bring most merchant ships or fishing

vessels to heel very quickly and at little expense. Detaining such suspect ships is a major part of the peacetime activities of most naval forces.

Having said that, a study of the naval deployment of the 25 millimeter Bushmaster shows that its use is still largely restricted to the US Navy and US Coastguard. Exports have been very limited. The 20 millimeter cannon (whether Oerlikon, Mauser, OtoBreda, or any of the other similar weapons) still dominate this market by a very wide margin. The extremely inexpensive Browning M-2HB machine gun remains a popular choice for small craft tasked with policing duties. Between the 20 millimeter cannon and the ubiquitous .50s, the Bushmaster has been effectively squeezed out of the export marketplace.

Although production for land-based applications continues unabated, no recent production contracts have been issued for naval versions of this gun. The US Navy states that the existing 450 weapons it has in its fleet are maintained in a rotating pool from which they

are taken for either temporary or permanent installation on different platforms. This would appear to make sense in light of the smaller size of today's US Navy fleet, which is expected to eventually settle at around 300 units. The Coastguard has a more settled policy, perhaps inevitable in view of the fact that their ships carry the Bushmaster as a primary weapon, not a last-ditch desperation-defense. Existing systems continue to be modernized in the form automatic stabilizers and/or aiming devices on the Mk 38s that are being used or taken into use from outgoing platforms. Also, as this weapon remains in service, ammunition procurement understandably continues.

In more violent confrontations, the Mk 38 has already won its spurs in the Persian Gulf. Naval sources in the area have suggested that it shreds the types of small craft (Boghammar and Boston Whaler-type boats) frequently used in those waters. Nevertheless, the Bushmaster is now to be replaced by the heavier and more capable 30 millimeter Mk 46 weapons station. Consequently, this report will be archived next year.

Ten-Year Outlook

No new production of this series is projected – only modernization and upgrade activity of the onboard systems will continue throughout the forecasting period; the forecast chart is therefore omitted.

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