

# ARCHIVED REPORT

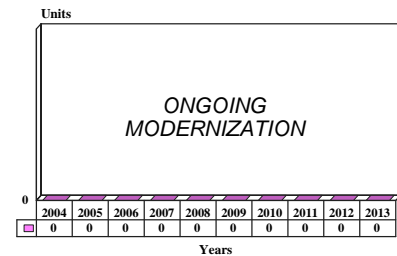
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## Mk 8 4.5-inch Naval Gun - Archived 8/2005

### Outlook

- Production of Mk 8 has ceased
- Future requirements satisfied by upgrades to existing guns
- Extended range munitions introduced
- Exports limited by caliber of weapon

10 Year Unit Production Forecast  
2004 - 2013



### Orientation

**Description.** General-purpose medium-caliber automatic naval gun and mount.

**Sponsor**

Ministry of Defence  
 Procurement Executive CB/Admin 3  
 St. Georges Court  
 14 New Oxford Street  
 London WC1A 1EJ  
 United Kingdom

**Status.** In service, with existing units being modernized and upgraded.

**Total Produced.** About 65 guns are estimated to have been produced to date.

**Application.** The VSEL Mk 8 4.5-inch gun was designed as a multipurpose mounting for short-range air-defense, surface target, and ground force support fire missions, in addition to patrol and policing functions.

**Platform.** This gun and mount can be used on any ship of 800 tons and upwards. The U.K. Royal Navy uses the weapon on the Type 23 frigates and Type 42 destroyers.

**Price Range.** This gun has a unit price of roughly US\$1.5 million.

### Contractors

BAE Systems plc, <http://www.baesystems.com>, 6 Carlton Gardens, London, SW1Y 5AD United Kingdom, Tel: + 44 1252 373232, Fax: + 44 1252 383991, Prime

### Technical Data

	<u>Metric</u>	<u>U.S.</u>
<b>Dimensions</b>		
Barrel Length:	6.22 m	245 in
Barrel Bore:	114 mm	4.5 in
Recoil Length (normal):	0.38 m	15 in
Recoil Length (metal to metal):	0.43 m	17 in
Length of Complete Round:	1.23 m	48.72 in

	<u>Metric</u>	<u>U.S.</u>
<b>Weights</b>		
Weight of Gun and Breech Mechanism:	2,438 kg	2.4 tons
Weight of Elevating Mass (with gun):	6,096 kg	6 tons
Weight of Rotating Mass (with gun):	15,341 kg	15.1 tons
<b>Weights (continued)</b>		
Weight of Components on Fixed Structure:	11,074 kg	10.9 tons
Total Weight (excluding ammunition):	26,170 kg	25.75 tons
Total Weight (including oil reserve):	26,416 kg	26.0 tons
Maximum Lift Weight:	19,711 kg	19.4 tons
Weight of Complete Round:	36.5 kg	80.5 lb
Weight of HE Shell:	21.0 kg	46.0 lb
Weight of HE Filling:	2.5 kg	5.6 lb
Appr. Deck Loads at Pedestal Base		
Max Down Preponderance to Rear:	42,700 kg	42 tons
Max Upward Lift under Muzzle:	26,400 kg	26 tons
<b>Performance</b>		
Rate of Fire:	25 rpm	
Muzzle Velocity:	870 m/sec	2,850 fps
Maximum Range:	21,950 m	24,000 yd
Recoil Force (mean):	30,500 kg	30 tons
Working Circle Radius:	6.07 m	19 ft 11 in
Chamber Pressure:	4,400 kg/sq cm	28 tons/sq in
Training/Elevation Rate:	40 deg/sec	
Max. Acceleration, Training:	40 deg/sec <sup>2</sup>	
Training Limits:	+/- 340 deg	
Elevation/Depression:	+55/-10 deg	
Ammunition Capacity:	16 rounds	
Barrel Life:	3,300 rounds	
Start Up Time:	10 sec	
<b>Electrical Power Requirements</b>		
For Gun Mounting Control:	Ship's supply 440 V/60 Hz/3 ph	
Tracking Load, GSU on Bypass:	82.7 kVa @ 0.36 PF	
Tracking Load, GSU on Load:	105.3 kVa @ 0.59 PF	
Peak Load Slewing, GSU on Load:	19 kVa @ 0.65 PF	
For Winterization, Transfer Pump etc:	440 V/60 Hz:20 kVa @ 0.91 PF	
For Conditioning Services:	115 V/60 Hz/1 ph: 0.5 kW	

**Design Features.** The 4.5-inch L55 Mk 8 is a fully automatic single mount for a 4.5-inch gun designed by the Royal Armament Research and Development Establishment (RARDE). The gun itself is an enlarged version of the 105 mm weapon used in the British Army Abbot self-propelled gun. Like the Abbot 105 mm, the 4.5-inch L55 Mk 8 is equipped with a muzzle brake and fume extractor. The ammunition is not interchangeable with the older 4.5-inch Mk 6.

The use of water-cooling for the gun barrel was examined and rejected on grounds that the added weight could not be justified in a system designed primarily for low ship impact. The gun shield was constructed out of fiberglass to reduce costs and weight. This had the (unintentional) benefit of reducing radar cross section. The shield protects the gun from extreme weather

conditions and low-energy shrapnel. The turret houses the on-mounting feed system and the gun barrel.

Below the turret is the gunbay area where fixed ammunition is stockpiled in the feed system. The ammunition is kept in readiness for transfer up the center pivot hoist to the gun during operation. The feed system is powered hydraulically and controlled by a logic system.

**Operational Characteristics.** The gun is intended basically for three different functions: naval gunfire support (NGS), anti-surface warfare (ASuW), and anti-aircraft (AA) defense. In the NGS role, the gun's 22 kilometer range and high degree of accuracy make it suited for standoff bombardment against land-based targets, with or without the use of forward observers for even more precise target acquisition. In surface

warfare, the range and the variety of ammunitions make the gun effective against surface ships, including agile fast attack craft, even at night and in adverse weather conditions. Post-impact delay fuze settings are also used effectively in SW operations, maximizing the destruction of the target once inside the hull. On the other hand, the gun has a wide radius of impact for AA operations as well, particularly when combined with the use of the VT High mode of the N97 multirole fuze.

The gun's feed system is designed so that different types of ammunition can be used without changing the rounds in the ready service magazine. Ready service rounds are carried vertically, in an indexing feed ring, with two spaces 180 degrees apart being kept free for special types of ammunition, such as star shell.

Five types of fixed ammunition are available: high explosive, illuminating, radar reflecting (chaff), surface practice, and anti-aircraft practice. The high-explosive rounds come with fuzes that can be set for direct impact, close proximity, distant proximity and post impact, which allows the shell to explode at a preset time after impact. The gun is remotely controlled and can be operated and fired entirely from the Operations Room (Combat Information Center).

The gun takes a minimum of four crew members for continuous operation, including two loaders, gun captain in the CIC, and a supervisor.

The system requires no warmup period for operation; it can be activated from shut-down status at the press of a button. As a result, the gun can be brought into action without being manned.

The gun's autoloader places the ammunition onto a rotating feed ring, which delivers it to a two-stage hoist for transfer to the on-mounting feed system. A pivoting loading arm raises the ammunition to the gun, where a rammer loads the breech to complete the loading cycle. Used cartridges are discarded from the system onto the weather deck.

Ammunition can be changed quickly on the run, without disrupting the stockpile of ammunition on the feed ring. Consequently, the type of ammunition fired can be changed as desired on very short notice to suit the target and tactics applied.

Routine daily maintenance of the gun can be performed within a few minutes on board the vessel.



4.5-Inch L55 Mk 8 Gun. (Note antenna for experimental course-corrected shell program.)

Source: Forecast International

## Variants/Upgrades

Mod 1. The Mod 1 upgrade was awarded to GEC Marine's VSEL Armaments division in spring and

summer 1997, to be carried out in three phases. Phase 1, which was contracted in April of that year, was

for the initial development, followed in October by Phase 2, which covered full development and conversion of eight guns. Sixteen more guns were to be converted in Phase 3, which is expected to begin by 2004. The guns are expected to be used on the U.K. Royal Navy's Type 23 frigates until around 2025, and continued support will be provided by the manufacturer until then.

An engineering upgrade of the original Mk 8 gun, the new Mod 1 is designed to address reliability and obsolescence problems, particularly those associated with hydraulic controls and servo systems. It also reduces ship-fit impact and introduces a new low-radar cross section gunshield. The update introduces electric drives (in place of hydraulic controls) for all functions except motions on the elevating mass, thus improving safety, allowing for more efficient power consumption, and cutting weight by 4 tonnes. Below-decks space requirements are substantially reduced, which will in turn free up compartment space on board ship. Maintenance requirements will be reduced, with a computer-based test and fault-finding system forming part of the upgrade. Electronic technical documentation is introduced, and simplified ship fit demands will allow for replacement within a 12-week Type 23 frigate Docking and Essential Defects period. The Mk 8 Mod 1 will also have the capability to fire new High Explosive Extended Range (HE ER) ammunition as RO Defence is developing the new base bleed HE ER round under a contract awarded in June 1997.

Mod 2. This was a fall-back option offered by VSEL for the now-defunct Common New Generation Frigate (CNGF) Project Horizon. The Mod 2 was based on the Mod 1 but dispensed with the feed ring, and it introduced a new hoist assembly. This was intended to allow the loading arm to receive ammunition directly from the magazine. A planned refurbishing program to modernize the removed Mod 0 guns to a Mod 2 standard for use on other ships was canceled.

Munitions. Numerous upgrades have been applied to the munitions, including base-bleed technology and reshaped rounds. These have had the effect of increasing range by 22 percent, while reducing barrel wear.

Besides a completely inert round which is used for non-firing drills, a total of five types of ammunition are offered for the gun:

*High Effect* – designed to cause maximum fragmentation and blast damage with the 2.5 kilogram high explosive.

*Illuminating* – provides a mean output of 40,000 candelas for a 40-second period at a descent rate of 4 meters per second.

*Anti-Aircraft Practice* – features a small flash filling which permits visual verification of fuze functioning.

*Surface Practice* – a completely inert shell and fuze for surface target practice.

*Radar Echo* – available in I- and J-band frequency ranges, this chaff round can be used as a passive decoy or for wind finding.

Fuzes. The Mk 8 4.5 is offered with either of the two type of fuzes – namely, the N7 Time Fuze or the N97 Multi-Role Fuze. The N7 is used with the illuminating and RE rounds, and is mechanically set by hand to set the time of flight. The N97 has four modes, or roles, of operation that are selectable immediately prior to loading the gun. The modes (Direct Action, VT Low, VT High, and Post Impact Delay) are selected to optimize the time of explosion in relation to the point of contact with the target.

The Mk 8 mount itself was substantially modified following its use in the Falklands campaign. This may have led to the modified versions being sometimes designated Mk 8\*.

N114-2000. VSEL at one point announced the N114-2000, a possible successor to Mk 8 4.5-inch using newer technology to simplify the mount and reduce maintenance costs. The autoloader was redesigned, and hydraulics were replaced with electric power. This version was described as particularly well adapted to the new High Explosive/Extended Range (HE/ER) round, which increases range from 22 to 27.5 kilometers.

The gun itself would be unchanged (still being a 4.5-inch L55). The rate of fire is 15 rpm. Maximum train and elevation rates are better than 40 deg/sec. The mount's weight (excluding ammunition) is 23,250 kilograms. Elevation limits are +55/-10 degrees. Barrel life was stated to be 3,300 rounds.

N155-2000. This concept is a private venture of VSEL based on the 155 mm field artillery and coast defense artillery developments, but intended purely for naval gunfire support. No N155-2000s have actually been produced to date. The weapon would have a 52 caliber air-cooled barrel. The barrel length would be 8.06 meters, and the weapon would be of monobloc construction, featuring a muzzle brake and fume extractor. This model would be similar to the Mk 8 but able to depress farther into enemy territory. Consequently, the turret would have a height of only 3.3 meters. The below-decks components would be similar to those of the N114-2000.

The N155-2000 would have the full range of rounds currently associated with the different 155 mm howitzers, weighing about 43.5 kilograms. The mounting would be capable of bursts of 10 rounds per

minute and would be able to fire at a sustained rate of 3 rpm. The traverse range has been stated as 300 degrees, as opposed to the N114's 340 degrees, while the elevation is from -15 to +80 degrees. Mounting weight has been quoted as 23.5 tonnes, and the muzzle velocity as 945 mps. The projectile weight would be 43 kilograms each, and the rate of fire only 10 rpm, while the range would be 30 km/40 km (the latter with the ER round).

155 mm/52 Future Naval Artillery (FNA). This is a joint development project with France's Giat Industries and DCN, using NATO standard 155 mm ammunition featuring fully combustible "high" and "medium" cartridges. The fully automatic mounting is expected to weigh 35-40 tonnes with magazine and hoists.

## Program Review

**Background.** The U.K. Royal Navy has used the 4.5-inch gun as its standard medium-caliber gun since World War II. Up to the late 1960s, the standard medium-caliber weapons system was the 4.5-inch Mk 6 twin mount. This was an extremely effective dual-purpose system, originally designed at the end of the Second World War. It offered a very high rate of fire and was robust and reliable, but was also very heavy, had major ship impact, and required a large manpower commitment. The RARDE began design studies for a new 4.5-inch gun and mount in 1965. While the Mk 6 had been conceived as the primary armament of its platforms, the new gun would be very much a secondary system, and the thrust of the design was to minimize ship impact at all costs. The new mount was to be automatic, with an uncrewed mount and minimal crewing in the magazines.

VSEL received a contract to design a new mount in 1965/66, and a test model was ready in late 1966. The test model passed all its tests, and construction of the first British and Iranian ships designed to use the new mount began in 1967. The British platform was the new destroyer HMS *Bristol*, designed to accompany the planned new aircraft carrier. This carrier was canceled and the construction of *Bristol* was suspended while its role was reassessed. As a result, the first Mk 8 4.5-inch gun went to sea in May 1971 aboard an Iranian frigate.

HMS *Bristol* was commissioned in March 1973. Fourteen more ships armed with the new gun entered service during the 1970s. The gun received its baptism by fire in 1982. When the Royal Navy went to the Falklands in 1982, 13 ships were armed with the new gun. During the conflict, the gun was used for all its designed missions, often in seas that swamped the shortened forecastles of some British warships, inundating the gun mounts. Because of this immersion and as a result of the light construction of the mount, the Mk 8 acquired a poor reputation for stoppages and non-availability. The failure of the Mk 8 to perform as required led to the curtailment of the preliminary bombardment for the Battle of Goose Green; the Parachute Regiment still attribute some of their casualties to this shortfall. However, the importance of

naval gunfire for supporting amphibious operations was demonstrated, leading to a 1983 Royal Navy decision that the four ships of the Type 22 Batch 3 design would each have a 4.5-inch gun, instead of the all-missile armament of the first two batches.

Argentina's two destroyers equipped with the system did not take part in any combat actions during the Falklands campaign. In the Middle East, Iran's four frigates have seen considerable action. One of the Iranian ships had been sunk by the end of the war, and another badly crippled. During the mid-1980s, Pakistan had considered ordering three Type 21 or Type 23 frigates equipped with the Mk 8 4.5-inch gun, but no orders were placed due to a lack of funds. Pakistan eventually settled on ordering former Royal Navy and U.S. Navy frigates equipped with the 4.5-inch Mk 6 and the 5-inch L38 gun, respectively. In 1986, Brazil began negotiations with Vickers Shipbuilding and Engineering for a license to produce the Mk 8 4.5-inch gun for its Inhauma class frigates.

The Royal Navy commissioned its first Type 22 Batch 3 frigate in April 1988, with the remaining pair following in 1989. In July 1988, the Royal Navy ordered three additional Type 23 frigates. The 1990 order for eight guns was the single largest order received for this gun. The eight systems were delivered between 1992 and 1995.

During this period, VSEL started researching various improvements to the Mk 8, among them the development of a new family of base-bleed munitions for use in the naval fire support mission. These rounds were developed in response to a Royal Navy requirement and drew on an earlier, abortive, development with the now-defunct Belgian PRB Company. A more fundamental upgrade is the N114-2000, which uses newer technology to simplify the mount and reduce maintenance costs. The autoloader has been redesigned and the mount hydraulics replaced with electrical power. The improved mounting is designed to exploit the capabilities of the extended-range rounds now being developed. The gun itself remains unchanged.

With the production of the last guns for the British Type 23 frigate program, the Mk 8 faced a watershed in its career. Experience had shown that 4.5 inches is too small to permit the adoption of guided shell or submunitions technology. This limitation severely restricts the growth potential of the gun and the desirability of installing it in future construction. The crux was the medium-caliber gun to be installed upon the Project Horizon Common New Generation Frigate being designed for the British, French, and Italian navies. Although the gun dispute was overshadowed by the more serious debates that eventually brought about the cancellation of the program, it remained a point of contention. The British wanted a medium-caliber weapon that would be effective for shore bombardment and other general duties, preferably a new-design 155 millimeter weapon. The Italians and French were happy to settle for a 76 millimeter gun for anti-air work.

When Project Horizon collapsed, the British were free to pursue their own preferences for their new Type 45 Daring class destroyers. In choosing the guns for these ships, two factors were in conflict. On the one hand, the 4.5-inch Mk 8 was seen as being obsolescent and incapable of fulfilling the required roles. On the other hand, the delays resulting from the abortive CNGF program meant that time was critical and the design of new systems undesirable. Eventually a compromise

was reached by which the first batch of three Type 45s, the HMS *Daring*, HMS *Dauntless*, and HMS *Diamond*, would receive refurbished and upgraded Mk 8 Mod 1 guns, while the remaining nine ships would get the new 155 millimeter weapon. This decision appears to mark the end of the Mk 8 as a production item.

The first example of the new Mod 1 variant of the 4.5-inch Mk 8 was installed on a Type 23 frigate for trials in mid-2001. At that time, it was suggested that, as an economy measure, all 12 Type 45 destroyers could receive refurbished Mk 8 guns, with the installation of the 155 millimeter weapon held open as a later option. In August 2002, HMS *Iron Duke* completed a year-long refit at Babcock, Rosyth where she was fitted with a new 4.5-inch Mk 8 Mod 1 gun.

At that time it was confirmed that the first three Type 45 destroyers will be fitted with the 4.5-inch Mk 8 Mod 1 medium-caliber gun system for shore bombardment, supplied to the program as Government Furnished Equipment (GFE). Other GFE items will include the Outfit DLF and Outfit DLH decoy systems. By February 2003, the first six 4.5 Mk 8 Mod 1 medium-caliber naval guns had been delivered and were entering service with the Royal Navy. These deliveries were in compliance with a 1998 contract covering the supply of an initial eight gun systems, with a requirement to update a further 17.

## Funding

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This program is funded by the Ministry of Defence for the U.K. Royal Navy.

## Recent Contracts

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<u>Contractor</u>	<u>Award (\$ millions)</u>	<u>Date/Description</u>
VSEL	38	1990 – Eight guns for the Royal Navy Type 23 frigates.
Marconi RCS	N/A	1991 – Provision of eight sets of gun control equipment to VSEL.
VSEL	3.2	June 1995 – Enabling contract for the refurbishment of four 4.5-inch guns.
DML	3.2	June 1995 – Enabling contract for the refurbishment of four 4.5-inch guns.
VSEL Armaments	1.6	April 1997 – Phase 1 of a three-stage upgrade contract for 24 RN guns, covering initial development. To be followed by Phases 2 and 3 later.
Royal Ordnance	80	July 1997 – Design, development, and production contract for provision of ER ammunition for RN applications.
GEC Marine	50	October 1998 – Phase 2 of the April 1997 contract to upgrade eight guns to Mod 1 standard.
Royal Ordnance	N/A	October 1998 – A further 10,000 rounds of ammunition (exercising an option from the summer 1997 contract).

## Timetable

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<u>Month</u>	<u>Year</u>	<u>Major Development</u>
	1965	Design studies begin
	1965	Vickers receives contract to design the new gun
	1966	Test model passes all tests
May	1971	The first ship with the new gun put to sea
	1982	The gun sees action in the Falklands War
	1983	Decision made to install the gun on all Type 22 Batch 3 ships
	1987	Research begins on new ammunition
Jun	1995	Refurbishment contracts for VSEL, DML
Apr	1997	Upgrade contract for modification of eight guns on board Type 23s to Mod 1 standard
Jul	1997	ER ammunition development contract awarded to BAe's Royal Ordnance
Oct	1998	Phase 2 of Mod 1 upgrade program begins
Jan	2001	Mk 8 selected for first three Type 45 frigates
Jul	2001	First Mod 1 gun installed

## Worldwide Distribution

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**Argentina.** 2 on Type 42 Batch 1 Mod destroyers

**Brazil.** 4 on Inhauma frigates; 8 on Niteroi frigates

**Iran.** 4 on Vosper Mk 5 frigates – 1 of these sunk by USN

**Libya.** 1 on Vosper Mk 7 frigate; probably not in use

**Pakistan.** 6 on Type 21 class

**Thailand.** 2 on Makut Rajakumarn frigate

**U.K.** 14 on Type 42 destroyers; 16 on Type 23 frigates; 4 on Type 22 Batch 3 frigates

## Forecast Rationale

It is now clear that all 25 4.5-inch L55 Mk 8 Mod 1 guns to be supplied to the Royal Navy are updated versions of existing mounts and do not, therefore, represent new production. While the possibility of arming all 12 Type 45 destroyers with these guns has been raised, the proposal would also involve using existing weapons taken from storage and refurbished to Mk 8 Mod 1 standard. It is therefore probable that production of the 4.5 inch L55 Mk 8 has ended and will not be resumed.

While the Mk 8 saw some limited success on the export market, it never really overcame the problems caused by the highly eccentric decision to retain the 4.5-inch caliber for the gun. The ammunition is not interchangeable with older British 4.5-inch weapons. These were, in fact, 4.7-inch weapons and were designated 4.5-inch to avoid confusion with an earlier 4.7-inch that fired ammunition incompatible with the later gun. These guns should also not be confused with a contemporary Royal Navy 4.5-inch (really) anti-aircraft gun that was

also incompatible with both the 4.5-inch and the 4.7-inch, while a British Army 4.5-inch gun (really a 4.7-inch) used totally different ammunition from any of the above. The Royal Navy 4.7-inch anti-aircraft gun was a short-barreled weapon that used a unique round (113 millimeter) not in service elsewhere.

The sad lesson of this somewhat bizarre tale is that navies have to look beyond their own requirements if the systems designed for them are to succeed as export items. Here, the Royal Navy decision to retain a nominal 4.5 inch weapon merely served to shut the gun off from the huge supplies of American-produced ammunition. A more rational decision would have been to adopt the U.S. 5-inch L54 ammunition and design the gun around that parameter. This would have taken advantage of the large production runs and diverse ammunition family of that weapon, reducing long-term costs.

Since no additional production of this gun is forecast, this report will be archived next year.

## Ten-Year Outlook

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No new production is projected – only modernization and upgrade activity of existing systems will continue throughout the forecast period; the forecast chart has therefore been omitted.

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