

M.Sc. Marine Engineering Ship Design Exercise 2000



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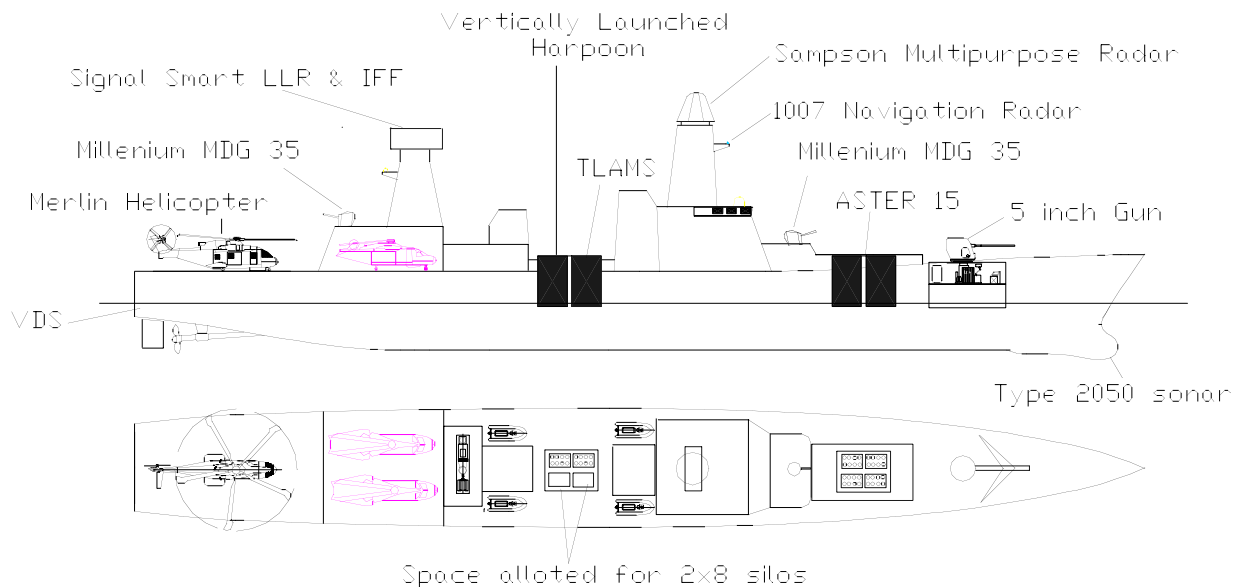
No.	Design	Students
5	MULTIROLE MONOHULL WARSHIP	S May, ME (M) H Bullen, NA P Kulkarni, NA
6	MULTIROLE TRIMARAN WARSHIP (Pentamaran Configuration)	Lt D J M Doull RN, ME(L) Lt Cdr P Terblanche SAN, ME(M) M Pegrum MOD, NA Lt H Khalid PN, NA
7	FAST EXPORT CORVETTE, (Monohull)	Lt M J Rand RN ME(M) Lt Cdr CG Teo RSingN NA
8	TRISWACH GENERAL PURPOSE FRIGATE	Lt J P Burvill RN, MSc ME(M) Lt B T Thorp RN, MSc ME(L) R Boulby, NA T Stiven, NA

MULTIROLE MONOHULL WARSHIP GROUP 5: 2000

S May, MSc Marine Engineering (Mechanical Option)

H Bullen, MSc Naval Architecture

P Kulkarni, MSc Naval Architecture



Introduction

The Strategic Defence Review emphasised that Forces within the United Kingdom must be flexible and be able to deal with global problems rapidly. The Forces must be manned, equipped, trained and supported by modern warfare. Operations are likely to be multinational and involve the deployment of forces over considerable distances. The Royal Navy has a requirement for a ship to carry out multipurpose missions in both open ocean and coastal water areas. When operating close to shore the ship must have an enhanced survivability capability as well as operating in areas of high submarine threat.

Threat

The threat to the ship can be classified into two sections, open ocean and coastal waters. The open ocean threats are well known to the Royal Navy and are based on the Cold War doctrine that utilises a strike carrier group as its centrepiece. The Multirole Monohull Warship (MMW) must be able to integrate within a Battle Group and provide Anti Submarine Warfare (ASW), Anti Surface Warfare (ASuW) and Anti Air Warfare (AAW) protection. The relatively new concept of operating in coastal waters poses new problems. There are a number of new threats from land attack. These are inshore mines, fighter aircraft, attack helicopters, coastal batteries and small patrol boats. The ships sensors will need to cope with additional clutter and its systems must be able to respond to rapid information gathering and target the enemy swiftly.

Tasks

The tasks of the MMW are as follows.

- Prosecute long range inland targets.
- Support tactical amphibious landings.
- Detect, track and prosecute submarine, air and surface threats.
- Transport and deploy a small detachment of troops.
- Provide self defence from air attacks.
- Perform general support tasks in peace and in war.
- Assist in rapid response to disaster relief.
- Search and Rescue
- General Naval tasking.

Payload

The MMW is fitted with a variety of weapons and sensors that will allow it to carry out its tasks. The ship can launch Tomahawk Land Attack Missiles as well as Harpoon ASW missiles. To provide self-defence from air attacks Aster 15 missiles are fitted along with two 30mm guns and two Millennium guns. In attack against submarines the ship can use its Magazine Torpedoes and its two Merlin Helicopters. When assisting in Naval Gunfire Support the 5-inch Mk 45 gun is used. Countermeasures include, Seagnat, deflectors and a towed decoy. The combat system is the most up to date using the BAeSEMA SSCS Integrated AIO.

Machinery

The MMW utilises the most up to date propulsion system, Integrated Full Electric Propulsion. There are four gas turbine alternators, two WR21 (25MW each), one Tempest (9.5 MW) and one TM2500 (2.5 MW) all capable of providing electrical power for both domestic services and propulsion. The ship can utilise the single engine prime mover concept to reduce engine running hours and maintain maximum fuel economy. In the case of Total Electrical Failure the MMW has two batteries that provide a ride through time of 30 minutes for essential supplies. Propulsion is produced by two fixed pitched propellers that are driven by two 25 MW Permanent Magnetic Motors and two 25 MW Pulse With Modulation Converters. Astern propulsion is achieved by reversing the shafts. The majority of the propulsion control system is automated which allows the Marine Engineering Department to be minimised.

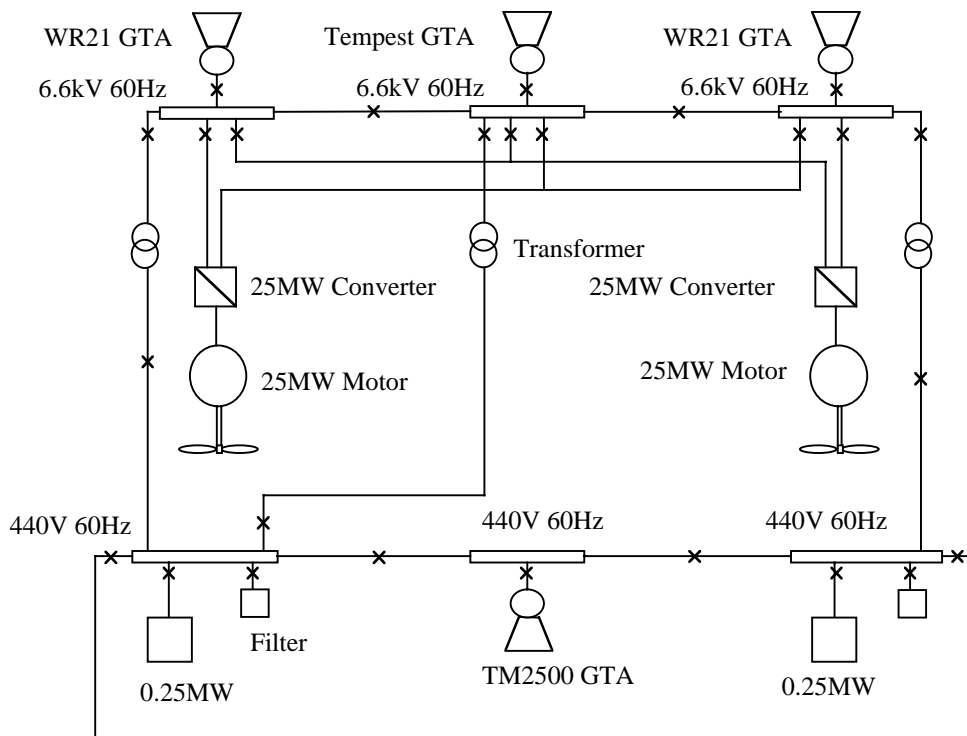
The auxiliary machinery consists of four Chilled Water plants, two Reverse Osmosis plants, two High Pressure Air Compressors, two Low Pressure Compressors, a Sewage Treatment plant, a Plastic Processing Machine, and six High Pressure Salt Water pumps.

Features

Displacement (Deep)	7290 Tonnes
Displacement (Standard)	6340 Tonnes
Length	156.9 meters
Beam	19.6 meters
Depth of Hull	12.3 meters
Draught	5.49 meters
Cost	£ 241.93M
Mission Duration	60 days

Range	7000 Nm @ 18knots
Maximum speed	30 knots @ 47.5MW
Maximum Activity Load	3.9MW
Normal Cruising Load	2.8MW
Number of class	Total 12, Batches of 3
In-Service date	2015
Compliment	170 + margin
Accommodation	Up to 230

Propulsion layout



MULTIROLE TRIMARAN WARSHIP (PENTAMARAN CONFIGURATION) GROUP 6: 2000

Lt D J M Doull RN, MSc Marine Engineering (Electrical Option)

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M Pegrum MOD MSc Naval Architecture

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Description

The Multirole Trimaran Warship (MTW) is designed to operate as the Royal Navy's Future Surface Combatant, with the first of 12 vessels entering service in 2015. In order to respond to an ever-changing military environment, the corner stones of the design are the flexibility and adaptability of the vessel, which has high endurance levels and the ability to conduct fast transits over long distances, remaining operational on completion.

In terms of payload, the MTW can conduct a wide variety of military tasks ranging from long-range land attack missions to ASW operations in the littoral environment. With two large capacity aircraft and dedicated accommodation for up to 30 combat troops, which may also be used as medical or command and control facilities, the MTW has the ability to integrate fully with operations ashore. The net result is a flexible unit, capable of functioning in a high intensity battlespace, either autonomously or as part of a joint operation.

Following a remit to investigate other multi-hull configurations, a Pentamaran hull form was selected by the Design Group's Naval Architects, with increased damage stability and lower resistance at high speeds cited as the main reasons behind the choice. The propulsion system is a COGLAG arrangement, designed to maximise efficiency at both low and high speed operation and to provide an ultra-quiet mode of propulsion. Incorporating the new WR21 ICR Gas Turbines for efficient mechanical drive, the design also includes many of the recent advances in electrical propulsion technology.

Role

Projection of Power Ashore. As part of a multinational (e.g. UN, NATO, EU) or national force to provide land attack, shore bombardment and support to tactical amphibious landings.

Sea Control. To provide Sea Control when operating alone or as part of a Joint Task Force; with particular emphasis on ASW operations in a littoral environment.

Naval Presence. To provide flexible response and naval presence in areas where there is little support, or to contribute to a large multinational task force operating all over the world at short notice.

Payload

2 x (8 missile) TLAM (VLS) Modules	1 x SAMSOM MFR
2 x (4 missile) Harpoon Modules	1 x 1007 Navigation Radar
1 x 5" MK 45 L54 Mod 4 Medium Calibre Gun	1 x 1008 Navigation Radar
4 x (8missile) Aster 15 (VLS) Modules	1 x Communications Fit
2 x EH101 Helicopters (ASW)	1 x EW Fit
2 x Phalanx CIWS	1 x SSCS Command System
2 x MSI DS 30 B Small Calibre Guns	1 x SCOT Satellite Comms
2 x STWS	Sea Gnat Missile Decoys
1 x 2050 Hull Mounted Sonar	Type 182 S Towed Decoy
1 x Variable Depth Sonar	

Ship Characteristics

Maximum Speed:	31.6 Kts
Endurance:	15000nm @ 16 knts 4000nm @ 30 Kts + 8 days @ < 16 knts
Operational Area:	Worldwide
Stores Endurance:	60 Days

COGLAG Propulsion System

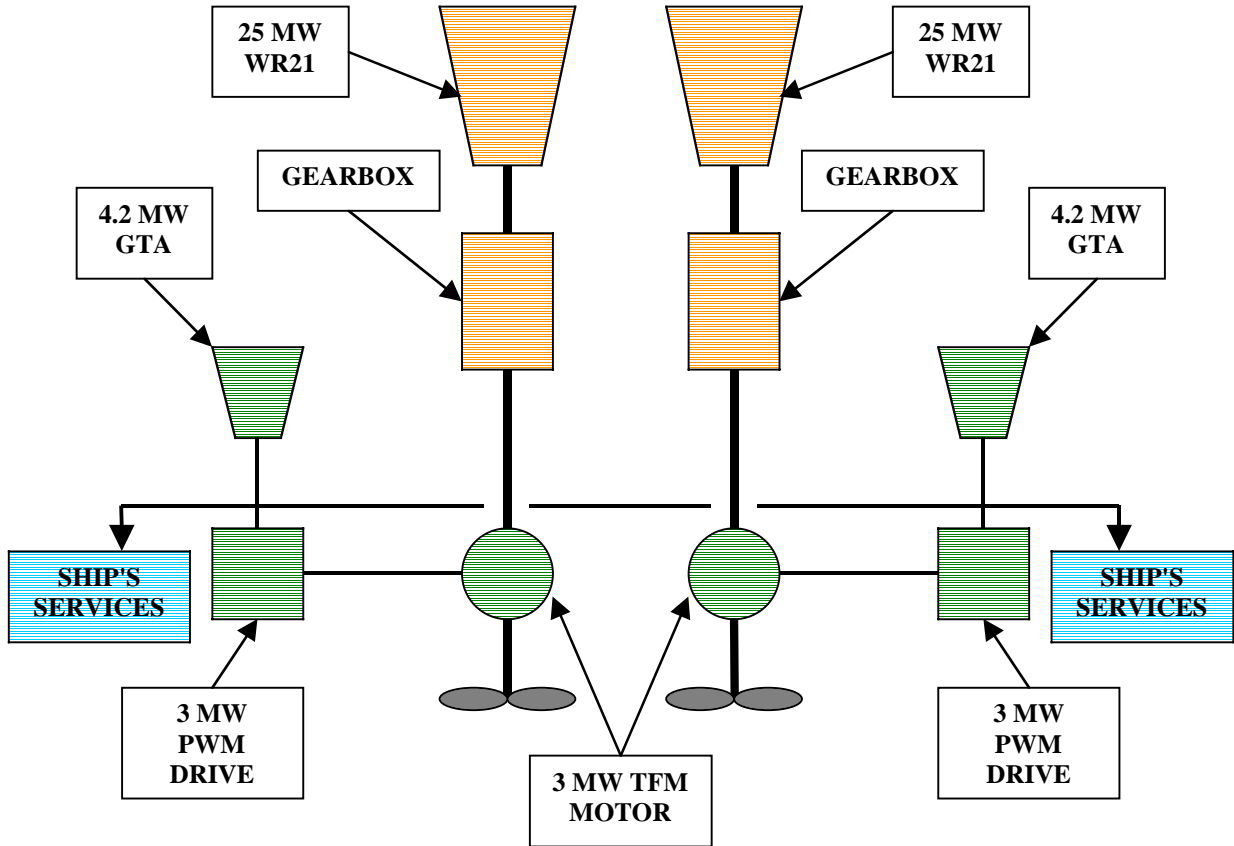
Mechanical

- 2 x WR21 (M) (25.2MW) Gas Turbines
- 2 x Gearboxes
- 2 x Fixed Pitch Propellers

Electrical

- 2 x 4.2 MW Mercury 50 GTAs
- 1 x 1.8 MW Turbomecca GTA
- 2 x 3 MW Pulse Width Modulated Drives
- 2 x 3 MW Transverse Flux Permanent Magnet

Motors



Principal Dimensions

Main Hull Characteristics.

WL Length:	190.26 m	WL Beam:	13.44 m
Depth:	13.2 m	Draught:	6.88 m
Cp:	0.62	C _M :	0.833

Side Hull Characteristics.

WL Length:	38.05 m	WL Beam:	3.51 m
Depth:	5.38 m	Draught:	2.06 m
Cp:	0.62	C _M :	0.833

Overall Hull Characteristics.

Deep Displacement:	9560 Tonnes	Beam:	29.22 m
Wet Deck Clearance:	3.32 m		

Complement and Cost

The total complement of the vessel is 220, with full facilities for a further 30 man troop detachment. The overall cost of the vessel is £238.6 million.

FAST EXPORT CORVETTE, (MONOHULL)

GROUP 7: 2000

Lt M J Rand Royal Navy, MSc Marine Engineering (Mechanical Option)
Lt Cdr CG Teo Republic of Singapore Navy, MSc Naval Architecture

Expanding and emerging Navies are actively looking at and ordering Corvettes as they come to appreciate the limitations of their present small attack craft. Not only is the Corvette a capable ship killing platform that has a range of offensive weapons but also has the ability to effectively defend itself from air, surface and sub surface threats. Not as expensive as a Frigate or requiring such an expensive support infrastructure, the Corvette provide frigate like capabilities at a much reduced initial and through life costs. Attractive, having a blue water capability, ocean endurance and the flexibility to perform a wide range of peace time and war fighting roles the worlds Corvette Ship Building order books are growing. It is into this expanding market that the Fast export Corvette is aimed and well suited for.

The operational roles the Corvette has been designed for are:-

Sea Control

- (i) To provide Sea Control when operating alone or as part of an Amphibious Task Force in a low threat environment.

Naval Presence

- (i) To provide rapid and flexible response and naval presence in areas, where there is little support, or to contribute to a large multinational task force operating all over the world at short notice.
- (ii) Undertake policing/coastguard interception and protection duties.

Projection of power ashore

- (i) To provide limited Naval Gun Support (NGS) to tactical amphibious landing.
- (ii) Able to embark, accommodate and deploy small numbers of military forces for special operations.

The ship is armed with a 76mm Oto Melara medium calibre gun for rapid NGS and anti air warfare using either the MESAR Spectra Multi-function radar or Optical Director. Eight Exocet Surface-to-surface missiles, a magazine launched Stingray torpedo system and two 20mm Oerlikon small calibre guns make up the offensive teeth of the Corvette. For defence a Vertical Launch Seawolf Point Defence missile system and one Phalanx Close-In-Weapon System are fitted. As many countries will have preferred weapons systems and infrastructure in place the Corvette has been sized so it is able to be fitted with a variety of different weapon systems including Harpoon, Goalkeeper close in weapons system and Barak point defence missiles. In addition the Corvette has a flight deck and is able to support a Super Lynx helicopter (or similar) autonomously for up to 20 days of intensive flying. A fully capable and flexible sensors outfit is installed.

Having an integrated propulsion and electrical generation architecture powered either by gas turbines or diesel engines the corvettes machinery outfit is flexible and reliable with low maintenance and fuel burn costs. A high degree of automation and good reliability gives the corvette a high availability and allows reduced manning levels. Installed auxiliary machinery has a high degree of redundancy and the ability to fully zone the ship fwd and aft considerably improves survivability. The corvette is able to comply with all current and proposed environmental legislation.

Principal Dimensions	Length	97.5 m
	Max Beam (WL)	11.4 m
	Max Draught	4.65 m
	Displacement	2340 Tonnes
Complement	Officers	9
	Senior Rates	21
	Junior Rates	28
	Flight	7
	Special forces	8
	Total	73 (58)
Endurance	12 Knots	4860 Nm
	16 Knots	4000 Nm
	24 knots	1800 Nm
	Stores	20 Days
	Aviation	20 Days (intensive flying)
Cost	£131M (first of batch)	
In Service Date	2006	
Maximum Speed	35 Knots	
Power requirements	Propulsion	31.6 MW at Full Power
	Auxiliary	1.2 MW Max Tropical Load
Propulsion Plant	Integrated Combined Gas Or Electric (ICOGOL)	
	Diesel option available	
Main Prime Movers	2 x Rolls Royce Spey SM1C Gas turbines (19 MW max rating)	
	1 x Rolls Royce Alison 601 - KB11 Gas Turbine Alternator (7.9 MW max rating)	
	1 x ABB Hurricane Gas Turbine Alternator (1.5 MW max rating)	
Transmission	Twin Shaft Line.	
	Controllable Pitch Propellers	
	2 x Spey Gas Turbines each driving through double reduction gear box	
	2 x Motor Generators each driving through half of the double reduction gear box	
Electrical Generation	Gas Turbine Alternators (as above)	
	2 x Motor Generators driven through gearbox by Spey Gas Turbines	
	UPS Battery Back Up	
Propulsion Electric	3.3 kV, 60 Hz, 3ph	
Domestic Electric	440 V, 60 Hz, 3ph	
Auxiliary Systems	4 days Fresh Water Holding Capacity	
	Hi-Fog Water Mist Fire Fighting System	
	Fully Environmental Compliant Waste Processing	
	Fully NBC Transit Capable	
	3x CWP, 2x HPAC, 3x HPSW Pp,	
	Ability to substitute Spey Engines with either LM 1600, LM 2500, GT35.	
Special Features		

TRISWACH GENERAL PURPOSE FRIGATE GROUP 8: 2000

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 Lt B T Thorp RN, MSc Marine Engineering (Electrical)
 R Boulby, MSc Naval Architecture
 T Stiven, MSc Naval Architecture

In the current global climate the military threat has become politically and geographically diverse. Modern warships must be able to contribute to the full spectrum of military operations from defence diplomacy to peace enforcement and high intensity warfare. The aim of the project has been to design a new general purpose frigate utilising a TRISWACH hull form. There are to be 8 ships in the class with the first due in service in 2015. The primary role of the ship is to provide a high level of ASW capability when operating in a support role for a multinational or national Task Group in the open ocean and littoral environments. Secondary roles include projection of power ashore to support tactical amphibious landings and providing a naval presence with the versatility to contribute to low key operations worldwide.

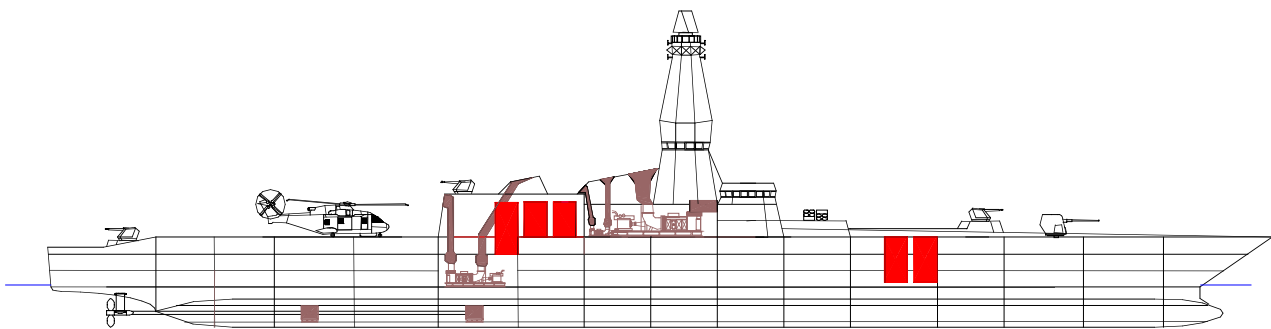
TRISWACH is an acronym meaning Trimaran Small Waterplane Area Central Hull. It is effectively a trimaran with a submarine-like central hull completely submerged below the water surface. The principle advantages of the TRISWACH hullform over a conventional hull are increased deck area and internal volume per unit displacement and improved seakeeping and transverse stability. The inherent stability is attractive since it provides a steady weapons platform and permits aircraft operation in a wide range of sea states. Whereas conventional mono-hulls are prone to slamming, the TRISWACH hull remains virtually unaffected in all but the roughest seas, hence hull mounted sonar performance is greatly enhanced. The increased breadth of the ship allows a versatile approach to internal and external design.

The selection of the propulsion plant was dictated both by the operating profile and the space and layout constraints imposed by the TRISWACH hull form. The ship uses an IFEP propulsion system which transmits power to the water using a twin shaft arrangement with conventional Fixed Pitch Propellers. The prime movers used are four simple cycle GTAs. A 1.8MW Turbomeca GTA provides the shore and low speed cruise power. The main cruise capability is given by a 6.5MW Allison GTA and two RB211 GTAs provide the sprint capability to a maximum speed of 30 knots. The endurance that can be achieved using the selected plant is 7000 nm at 18 knots. Manoeuvrability is provided using rudders fitted on the submerged hull. Compliance with current and future IMO legislation has been a feature of the design.

Key Features

<i>Principle Dimensions</i>	Length (bp): 173.41m	
	Length (oa): 184.21m	
	Beam (main hull): 11.68m	
	Beam (extreme): 31.32m	
	Depth of hull: 13.5m	
	Draught (mean): 6.68m	
	Cp (main hull): 0.8m	
	Cm (main hull): 0.64m	
	Flare/tumblehome - amidships: 10 ⁰	
	Height of lower hull: 4.30m	
	Box clearance: 3.52m	
	<i>Range and Endurance</i>	7000nm @ 18 knots
	<i>Complement</i>	Officers: 20
CPOs: 26		
POs: 32		
JRs: 152		
	Total: 230	
<i>Cost</i>	£278.45m	
<i>In service date</i>	2015	
<i>Ships in class</i>	8	

<i>Prime movers</i>	Rolls Royce RB211 25MW GTAs (x2) Allison 6.5MW GTA Turbomeca 1.8MW GTA
<i>Propulsors</i>	Twin shaft arrangement using Fixed Pitch Propellers
<i>Electrical Distribution</i>	IFEP system 6.6kV AC propulsion busbar 450V AC auxiliary ring
<i>Missiles</i>	SLCM: Mk 41 VLS for Tomahawk, 16 cells (fitted for) SSM: Mk 41 for Harpoon, Sea SLAM; updateable to Tomahawk, 16 cells SAM: Mk 41 VLS for Aster 15, 32 cells A/S M: 8 Otomat Milas (2 quad)
<i>Guns</i>	1 x 5inch/54 Mk 45 Mod 4 ERGM 3 Millennium MDG351 CIWS
<i>Torpedoes</i>	2MTLS Stingray (2 twin)
<i>Weapons control</i>	SAMSON MFR
<i>Radar</i>	Air surface search, Sea giraffe
<i>Sonars</i>	Type 2050 hull mounted active search and attack Type 2087 towed array passive search Type 2007 Flank Array Type 2070 Shipboard submarine torpedo defence
<i>Aircraft</i>	2 Merlin HM1 2 Dornier Seamos VTOL UAV
<i>Maximum speed</i>	30 knots
<i>Power at max speed</i>	45 MW
<i>Hotel load</i>	1.2MW – 2MW depending on action state
<i>Auxiliary systems</i>	5 Hamworthy KSE 400 tonnes/hour HPSW pumps 2 Compair Reavell 276 bar HP air compressors - Model 5436 2 Cyclon 7 bar LP air compressors – Model 110 series



TRISWACH General Purpose Frigate Main Machinery Layout