# The new Dutch Patrol Ship

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### SYNOPSIS

The Royal Netherlands Navy will reduce its number of frigates, replacing them with Patrol Ships. Their operational tasks will differ substantially from those of a combatant. Consequently SEWACO systems and manning are tailored to meeting these new threats and operational environment. Although not as visible as the SEWACO-systems, marine-engineers have seized this opportunity to investigate and introduce new concepts and systems. Leading features of the platform design are low running costs, easy maintenance and compliance with new regulations. Notable features are the integrated mast, the RHIB slipway, the hybrid propulsion configuration, a new helicopter transfer system, platform automation, water mist fire fighting, ballast water treatment and a Membrane Biological Reactor.

### INTRODUCTION

In recent years, with shrinking budgets and peace-keeping operations in both Iraq and Afghanistan, the Royal Netherlands Navy (RNLN) has been confronted with politicians questioning the number of frigates. In this changing world new ships were needed: Patrol Ships.

But what exactly is a Patrol Ship (PS)? Is it a ship painted grey with a gun in front and a task of simply “being there”. As the RNLN had no recent experience with designing a PS, the Armed Forces Planning Staff drew-up a paper with expected scenarios and tasks to perform (Such as coast-guard duties, naval presence, maritime interdiction, disaster relief, evacuation, search and rescue). These analyses revealed that the PS needed a relatively large displacement (3700 tons) to ensure proper seagoing capabilities enabling world-wide operations and making effective use of the embarked NH-90 helicopter. In addition it was found that whilst simply “being there” is an essential aspect of patrolling, the outright speed required from a frigate is not. Therefore it was considered ineffective to invest in a propulsion system capable of propelling the ship to frigate speed in excess of 30 knots. A speed of 20 knots was deemed sufficient for the PS to perform its tasks and to keep-up with frigates operating at cruising speeds when necessary. To compensate for the relative lack of speed, the PS will have an extensive sensor suite enhancing its reaction times to any incidents, an NH-90 helicopter and a ready to launch Interceptor mounted in the stern of the ship and capable of rapid deployment. All operations including control and monitoring of platform systems, are directed from the Operations Control Bridge. The ship will have 50 crewmembers and 40 augmentees for heli- and spec-ops. Additional but limited accommodation is available for 100 evacuees for 72 hours. The first of class is scheduled to start trials by the end of 2010.

### SHIP DESIGN

Initially the displacement was set on 3000 tons with a length of 100 mtr. During the design phase however, the displacement steadily increased to enable a stable platform for helicopter operations at SS 5, to improve standards for crew accommodation, to accommodate ballistic protection and to reduce building costs by adopting DNV Naval Rules. The requirement to provide a stable platform for helicopter operations and the necessity to accommodate a relatively heavy (integrated) mast resulted in a lower length/beam ratio than that for ships of this seize. To reduce the subsequent extra resistance an axebow or bulb was considered but not selected due to the ship’s lower operating speeds negating its effectiveness. Instead the ship was lengthened to 102.4 mtrs; giving it a displacement of 3750 tons.
To improve conditions for watch keepers on both the bridge and in the adjacent Operations Control Bridge, the deckhouse was positioned as close to mid-way along the ships length as possible in order to reduce vertical acceleration to a minimum. Consequently there was limited space to position the funnels whilst still avoiding smoke hindrance on to the helicopter deck or impairing the proper functioning of the sensors in the integrated

mast. To this end extensive wind tunnel test were carried out by the Netherlands Air and Space Laboratory. These tests indicated that the tilted form of the funnels will keep the ship free of smoke. To enable the ship to launch and recover the RHIB at SS 5 valuable experience and advice was given by the US Coast Guard. The research institute MARIN carried out modelling of the slipway to optimise the RHIB handling. A second RHIB will be positioned on the weatherdeck and lowered/hoisted by davit.

**Fig 1** Artist impression of the new Dutch Patrol Ship

## SENSORS AND WEAPONS

The ship's SEWACO systems must assure the ship's self-defence, enable the ship to carry out its tasks and suit its operational environment. As the SEWACO-systems of frigates are optimised for "blue water" the environmental conditions and asymmetric threats close to the coastline differ considerably. To optimise sensors and communication Thales NL developed an integrated mast incorporating the majority of the sensors and communication systems. The integrated mast enables these systems to have an optimal line of sight, minimal interference, fewer interfaces and a reduction of shipbuilding costs.

The integrated mast has several sensors. The SMILE S-band phased array radar for air picture compilation is also suited as surface radar and fire control radar and will also be used for helicopter direction. The SEASTAR is a X-band phased array radar to detect small and slow moving surface objects (Such as frogmen, persons overboard, mines, inflatable boats etc.) Finally the GATEKEEPER sensor combines infra-red sensing and a high definition optical system. The integrated mast also houses the ICAS antenna with VHF/UHF, WYMAX, GSM/UMTS, IFF TR, ESM (Direction Finding), Iridium and the non-rotating LINK16 antenna.

The ship will have a 76 mm OTO melara gun directed by the SMILE radar to engage surface targets. A remotely operated quick-firing small calibre gun (27-30 mm) is to be used against close distance targets. The gun will be directed initially cued by SEASTAR, SMILE and GATEKEEPER. For self-defence the ship will have two .50 machine guns to be remotely operated as the 30 mm gun. The ship will have two water cannons for non-lethal engagements and 6 MAG machinegun positions.

When using an integrated mast, the interfaces between the SEWACO and platform systems are easier to arrange and cheaper to build than with a conventional set-up. The integrated mast will have common supply of chilled water, ventilation, power and data. Distribution will be arranged within the mast itself.

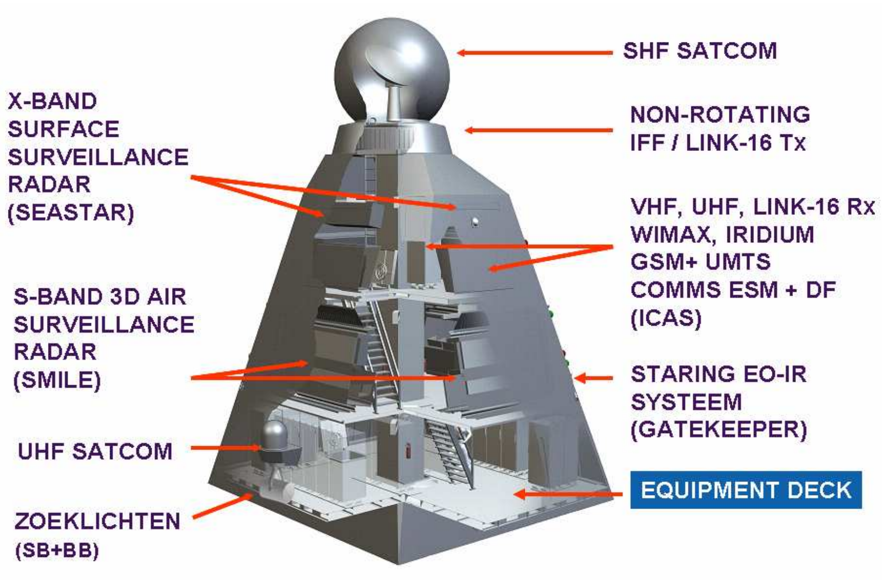


**Fig 2** Artist impression of the integrated mast

## MECHANICAL SYSTEMS

Staff requirements demanded a maximum sustainable ship's speed of 20 knots (6 months out of dock in seastate 4) and a range of 5000 nm at a speed of 16 knots. A specific operating profile was given as stated in the table I

**Table I** Operating profile of the new Dutch PS

| *Speed [knts]* | *Sailing* time [%] |
|---|---|
| 0-5 | 20 |
| 5-10 | 10 |
| 10-15 | 40 |
| >15 | 30 |

To select a suitable propulsion configuration the Defence Materiel Organisation gave due consideration to the ship's ability to sail for prolonged periods at low speed, the minimising of Life Cycle Costs (LCC), the reliability of the propulsion train and the initial investment costs. Although the ship is not a combatant it was decided that the ship should have a DNV notation "RP" (Redundant Propulsion). Three propulsion configurations were selected for further study: diesel-direct (DD) where diesels drive shafts directly through gearboxes, diesel-electric (DE) where diesel generators feed an Integrated Electric Plant, a diesel-hybrid configuration (DH) where a DD is supported by an electro-motor power-take-in.

The results of the study are given in table II

**Table II** Result of study to select propulsion configuration

| | | *DD* | *DH* | *DE* |
|---|---|---|---|---|
| Performance at low speed | | - | + | + |
| Fuel costs | [tons/year] | 4450 | 4380 | 4700 |
| Reliability | | + | + | - |
| Maintainability | | - | - | + |
| Investment costs | [MEuro] | 6.5 | 8.0 | 8.5 |

Diesel engines that run at low power for lengthy periods will have higher maintenance costs therefore DD was given a negative. The DH and DE were assessed as being better, as at low speed both will use electro motors. Fuel costs (80% of LCC costs) are based upon the operating profile. The assessment of the reliability was based upon the number of power conversions. The assessment of maintenance costs was based upon the number of running cylinders. Investment costs have been calculated by an independent engineering bureau and are based on budget quotations. As can be seen the Diesel Hybrid configuration combines the advantages of both DD and DE whilst eliminating their poorer aspects. Therefore Diesel Hybrid was selected as propulsion configuration.

The option to combine the power-take-in (PTI) with a power-take-off (PTO) to generate electric power when sailing, was studied. Findings were that using a PTO does not improve sailing on low power as the ship already runs its electric drive. Fuel costs were slightly lower due to better load distribution for the propulsion diesel engines when sailing on slow speed. As combining PTI-PTO for a ship that frequently changes speed and shaft revolutions was considered by industry to be a development risk, reliability was rated negative (PTO is used in commercial shipping where constant shaft revs are maintained for extended periods). The use of a PTO could spare a diesel generator reducing investment and maintenance costs. Reducing the number of diesel generators would however impair the RP notation. Therefore PTO was not selected.

In selecting the propulsion diesel great care was taken to ensure that the margin between propeller curve and diesel curve was sufficient to avoid regular overloading when turning, accelerating or in heavy seas. It was calculated that to minimise overloading a margin of 30% was required. The MAN BW 28/33D 5400 kW was selected as propulsion diesel engine.

Although the electric drive enables the ship to sail prolonged periods on low speed, it is not intended to be used when manoeuvring. When leaving port, coming alongside, anchoring etc. full power on propulsion diesels must be available. Therefore the ship will have Controllable Pitch Propellers. Manoeuvring is aided by a 400 kW bowthruster.

In order to minimize the effect of smoke upon the ships sensors, ships side mounted exhausts were considered. Water-injected exhausts on the waterline would reduce the infra-red signature and partially clean the exhaust gasses. Yachts and fast ferries make use of a combined system with an underwater exhaust that makes use of the scoop effect when sailing fast and an above water bypass when the ship is sailing slowly or is stopped. Discussions were held with the German Bundesamt für Wehrtechnik und Beschaffung to discuss the exhausts in the ships side of the new German corvette K130. Although exhaust in the ships side has its advantages the risks that exhaust gasses would hinder personnel during Heli-ops and launching/recovering of the RHIB on the slipway, was considered too great. Therefore tilted, conventional funnels were selected.

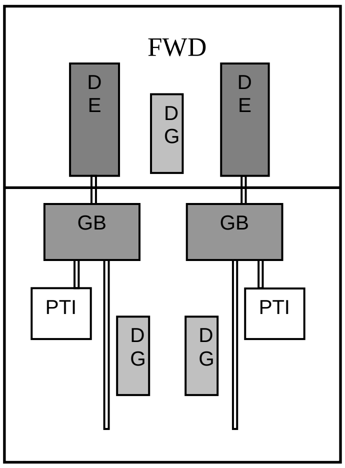


**Fig 3** Propulsion configuration

## ELECTRICAL SYSTEMS

Adopting the "n-1" rule i.e. all service conditions can be met with one diesel down for maintenance or repair, it was decided to have three diesel generators, two in the aft engine room and one in the fwd engine room. A comprehensive load balance was produced to plot the load from harbour conditions to full electric propulsion. At full electric propulsion both electro motors will have the equivalent power of one propulsion diesel at around 20% load. Three Caterpillar 3508 B TA 910 ekW each will be installed for power generation.

The PTI's 400 ekW electric motors will be of a standard induction type directly coupled to a Renk Type ASL 85 double helical gearbox.

The converters for electrical propulsion and bow-thruster are based on standard technology. An active front converter is used to minimise harmonics.  New is the introduction of a “DC-bus”: by splitting the three converters into one active front-end and a central DC-bus feeding 3 on-site individual inverters, volume and costs could be saved. The DC-bus will be protected against “EMI”. Standard “Emergency Lighting” is backed up by “contingency lighting”, fixtures with build-in batteries that provide light even when the emergency system is down.

## PLATFORM AUTOMATION

To make maximum use of technical personnel, the ship has no manned Machinery Control Room. While sailing, the technical watch keeper is mobile. He is working or resting. He can be alerted by a portable communication device. Critical (safety) alarms will be sent directly to the navigation bridge and the technical watch keeper’s portable. The Officer of the Watch will be advised on first actions and after confirming the advice an automatic sequence will start up to safeguard an incident. Meanwhile, the technical watch keeper will man the platform management system on the Operations Control Bridge to take further action. Non critical technical alarms will only be sent to the technical watch keepers portable. Warning-only alerts will not be sent but will be logged in the platform management system to be presented to the technical watch keeper on demand. For routine actions the technical watch keeper can make use of limited working stations in both the engine rooms.

On the Operations Control Bridge, the technical watch keeper will be offered an overview of the relevant systems on large screens. When systems fail possible consequences are presented on the screen. When the ME-department is unable to solve a malfunction, specialists ashore can assist using satellite communication enabling them to monitor the platform management system.

## DAMAGE CONTROL & FIRE FIGHTING

When compared with a combatant few people are available for Damage Control and Fire-Fighting. Therefore policies and procedures have been adapted with C2 facilities having been improved. In order to act immediately in case of a fire the ship has been equipped with sensors in all compartments that will start the 100 bar watermist system without human interference. A fire is “confirmed” when two different kind of sensors, for instance temperature and smoke, are activated. To reduce the numbers involved in fire-fighting, traditional equipment will be partially replaced by new “ready to use” equipment with hoses on reels that are easy to handle.

Damage Control and Fire-Fighting will be coordinated from the left side of the Operations Control Bridge enabling effective liaison with the command. A large interactive screen in the ops- room provides the IC´s with a General Arrangement Plan, mimics, CCTV pictures and on demand manuals and technical support.

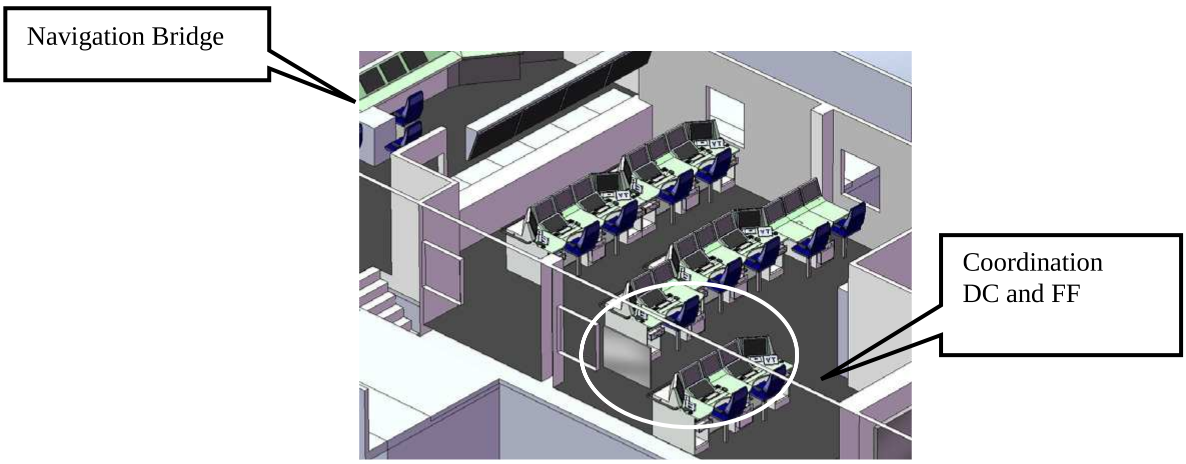


**Fig 4** Artist impression of the Operations Control Bridge

## MISCELLANEOUS

With the introduction of the NH-90 helicopter the RNLN was faced with the need to introduce a new helicopter transfer system for both the Patrol Ships and its remaining M-class frigates, including both M-class frigates that were sold to Belgium. As none of the common manufacturers of these systems had developed a certified system in 2004 Bosch Rexroth was asked to design a system that would be more agile and more user-friendly than current systems. The Bosch Rexroth helicopter transfer system is working on rails that use two easy to handle beams. The front beam fixes the front wheel and allows easy steering of the helicopter. The aft beam secures the strongpoint whilst still allowing easy across movement when moving the helicopter into position.

The Patrol ship will be the first ship of the RNLN that will comply with MARPOL International Convention for the Control and Management of Ships Ballast and sediments. The technology to be used will be certified by DNV and is based on eliminating organisms by radicals produced through the hydrolysis of the treated water. The Ballast Water Treatment (BWT) installation will reduce living organisms to D2-level.

Black and grey water will be treated in a Membrane Biological Reactor (MBR). The MBR technology is based on the consumption of the organic material in the waste streams by micro organisms in an aerobic environment. This process is followed by a filtration phase using membranes. The use of this technology generates a very clean effluent that makes the reuse of this effluent, as technical water, possible. The technology meets the IMO MARPOL requirements mentioned in resolution MEPC 159(55), adopted on October 13th 2006.

## CONCLUSIONS

1. The SEWACO systems and the manning of the Patrol Ship differ substantially from that of a combatant.
2. The propulsion system is tailored to the operational profile enabling it to sail on low power for prolonged periods.
3. Platform automation ensures effective Command and Control of the platform whilst watch keeping duties are kept to a minimum.
4. To compensate for the reduced manning extra C2 facilities and FF-DC equipment are available to ensure effective action in case of emergency.
5. New techniques are introduced to comply with latest IMO regulations.

**Author's Biography**

CAPT (E) RNLN Marcel Hendriks Vettehen joined the RNLN in 1974 as a midshipman. He served as DMEO and MEO on board of frigates and LPDs. He held several posts ashore including jobs in the United Kingdom and in Germany. He currently works for the Defence Material Organisation/ Sea Systems in The Hague and is responsible for marine engineering.

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