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Vessels highlighted
NH 1816
Arklow Bank

The vision of
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NH 1816

A NEW TYPE OF SEARCH AND RESCUE BOAT FOR KNRM

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Builder
Damen Shipyards, Gorinchem, the Netherlands

Owner
KNRM, IJmuiden, the Netherlands

Design
KNRM/Damen/De Vries Lentsch, the Netherlands

Principal particulars

Length o.a.	19.30 m
Beam o.a.	6.54 m
Depth at sides	1.90 m
Draught max.	1.10 m
Main engines	2 x MTU 8V2000 M84L - 895 kW at 2450 rpm
Generators	2 x 8 kW main engine powered
Top speed (trial)	31 knots
Range	348 Nm
Crew	6 persons
Survivors	120 persons
Fuel tanks	9,800 l


A rubber strip separates the aluminium hull from the composite deckhouse

When the Dutch indemnity insurance company NH 1816 decided to sponsor the Royal Dutch Life Saving Association (KNRM) in 2009, there was no urgent need for a replacement vessel in the KNRM fleet. This created the opportunity to develop a new type of Search and Rescue (SAR) vessel, corresponding to the present-day needs of the association.

While the volunteers of KNRM are very satisfied with their current largest SAR vessels, the Arie Visser Class, there are undeniably points for improvement on this design, which for the past twenty years has braved every storm on the North Sea coast. The main goals for the new design were to reduce noise and vibrations, to reduce the fuel consumption and emissions and to improve the comfort and safety of those on board. For the development, a task force was set up with the following parties:

- KNRM, as a client with a wealth of real-life experience,
- De Vries Lentsch, the naval architects responsible for the Arie Visser Class of vessels,
- Damen Shipyards, international shipbuilding group with an interest to broaden their portfolio,
- TU Delft, renowned university and research institute with a strong emphasis on fast craft.

In the earliest stages, two concepts were developed: an enlarged and improved version of the Arie Visser Class and a new type, which integrated elements of the axe-bow principle developed jointly by Damen and TU Delft. A free-sailing model was built for each of these, along with a third model of the Arie Visser Class, which would remain a benchmark throughout the design. The three models were extensively tested in North Sea wave spectra, both at TU Delft (for bow and stern waves) and at MARIN, were the large wave basin allowed for testing with stern and bow quartering waves.

Sea axe

Research of Lex Keuning (TU Delft) indicated earlier that a ship's speed in waves is mainly determined by what the crew considers acceptable for both their own limbs and the strength of the vessel. This appreciation of the crew is primarily guided by the strength and frequency of extreme vertical accelerations. For endured sailing, the crew will try to keep the acceleration at the helm seats around - or preferably below - 1 g. The research at TU Delft led earlier to the successful introduction of Damen's sea-axe fast crew suppliers, of which derivatives were built in the form of yacht support vessels and catamarans for wind farm maintenance. The dynamics of a much smaller SAR vessel in breaking waves are of course totally different, which justified a detailed study to verify the potential benefits.

Vertical accelerations

By minimising the difference in volume above the waterline and below the waterline, the sea-axe bow makes pitching motions in waves softer, as it avoids the sudden contact of a wider portion of the hull with the water. Certain aspects of the sea-axe design could not be applied on *NH 1816*, such as the deepest point at the bow, which would make beaching impossible. Nevertheless, the adapted sea-axe bow proved efficient: in head seas of an identical wave spectrum, vertical accelerations of 2 g at the bow have a probability of ten percent in the Arie Visser Class, while they only have a probability of three to four percent in the *NH 1816*.

The highest acceleration levels encountered are reduced by 50 percent (from 6 g to 3 g). As a result, the crew will be able to maintain a higher speed, and reach a long-distance target in a shorter time. Or, when sailing at the same speed, the comfort of the crew will be significantly improved. An added benefit of the longer waterline length is the reduction in fuel consumption. While this would be ten to 25 percent lower at the same displacement as the Arie Visser Class, extra systems and functionalities have made *NH 1816* about 4.5 tons heavier. Still the resistance curve up to 30 knots is practically identical to that of the Arie Visser. The extra weight only becomes a factor of importance over 30 knots.

Broaching

Significant attention was given during the model tests to the avoidance of broaching.

Waterjets provide the ideal solution for speed and manoeuvrability in shallow waters

Although the boat has enough power to outrun the waves and thus avoid surfing, which can initiate the sudden uncontrolled shift of heading called broaching, there are times when the speed cannot be controlled at will. Examples are failure of an engine or towing of another vessel. To ensure course stability and the proper balance between the lateral surface in the bow and that in the stern, *NH 1816* is equipped with two fixed fins, made of carbon, in the stern. These can be retracted with a hydraulic system to avoid damage in shallow waters and reduce the turning circle when steering between breaking waves. The blades have been engineered in such a way that they will sheer off in case of contact with an object (or the bottom) without damaging the boat's hull. During model tests, *NH 1816* proved less prone to broaching than the Arie Visser model when the fins are deployed.

Fenders

Contrary to her predecessor, *NH 1816* does not feature inflatable tubes, but a large foam-filled fender. More compact and positioned slightly higher, the fender will have less of a braking effect in oncoming waves, and the space on the side deck is significantly increased. There is also no risk of puncturing the tube. The bow is about 40 centimetres higher and entirely closed, resulting in more buoyancy in the bow, in spite of the lack of flare and overhang.

Composite deckhouse

Another important design goal was the reduction of noise onboard, which went from 93 dB(A) to approximately 75 dB(A). The largest contributor to this is the flexibly mounted composite deckhouse, built by North-Line in the Netherlands. It is joined to the aluminium hull (built in Poland) with adhesives and a rubber strip as vibration isolator. A bolted connection provides a backup in case the glued connection would fail. The composite deckhouse, with sandwich construction, provides better insulation and less weight than an aluminium deckhouse. During trials the sound level was measured at 72 dB(A) at full speed.

The crew's comfort is also improved with an air-conditioning installation, consisting of a fancoil unit mounted above the ceiling. The windows are glued on the superstructure from the outside, which gives larger viewing angles than the window frames used before. Another advantage is that the glued windows contribute to the structural integrity of the deckhouse.

Waterjets

Essential for manoeuvrability, shallow-water operations and the safe recovery of persons at the stern, propulsion with waterjets was a given from the start. On *NH 1816*, each Hamilton 571 waterjet is powered by an MTU 8V 2000 M93 main engine, good for 895 kW each. A flexible Centa coupling on either side of a carbon intermediate shaft between engine and waterjet, allowed the main engines to be flexibly mounted. The main engines were supplied in the so-called 'rough kit' version, which includes the possibility to keep on running when they are upside-down for a short period of time. When a vessel roll exceeding 90 degrees is detected, the engines automatically go into idling mode, and a gate valve is partially closed to ensure that the exhaust flow has enough pressure to keep water out of the exhaust lines.

Manoeuvring tests were carried out with the models, and in these *NH 1816* performed smaller turning circles than the Arie Visser Class when her fins were up, and larger when the fins are down. With hydraulic control from the wheelhouse, the choice between optimised course stability or optimised manoeuvrability will always be at the helmsman's fingertips.

Ergonomics

The designers also paid a great deal of attention to the ergonomics of the bridge, with the assistance of consultant Fysergo. The guiding principle here was not to overload each person with information they do not need, but rather tailor each section of the console to the tasks of the person who will be manning it. The output to the touch screens is interchangeable.

For unobstructed visibility and minimal distraction, the helmsman is seated slightly further forward than his two wingmen. A full size mock-up of the bridge was built and scrutinised by the KNRM skippers. The jockey seats feature a semi-active progressive shock mitigation system.

The ruggedised main engines can sustain operation upside-down for a short time

An important addition to the communication systems is the transfer of data over VHF. This allows the shore base to transmit coordinates and other information without the imprecision and inefficiency of voice communication.

Engine redundancy

The engine room is divided in two separate compartments by a watertight bulkhead on centreline. Nevertheless, there is ample space around each of the engines for maintenance. Each main engine also has a completely individual fuel supply, with for each a small gravity tank automatically topped up by a fuel transfer pump. The watertight integrity of the vessel is exemplary. Even with two compartments flooded, the damaged stability criteria are met. The bottom can be damaged for 50 percent of the waterline length without catastrophic loss. The boat is also self-righting in the event of capsizing.

The electric system is also built to be redundantly and has two power sources. Each consists of a 230 VAC hydraulic generator, with hydraulic oil pressure generated in a PTO pump on the gearbox. Plugging into shore power is also possible. This allows the accommodation to be air-conditioned and the engines' block heating to be kept running for immediate starting.

To recover survivors from the water, a basket can be hydraulically lowered

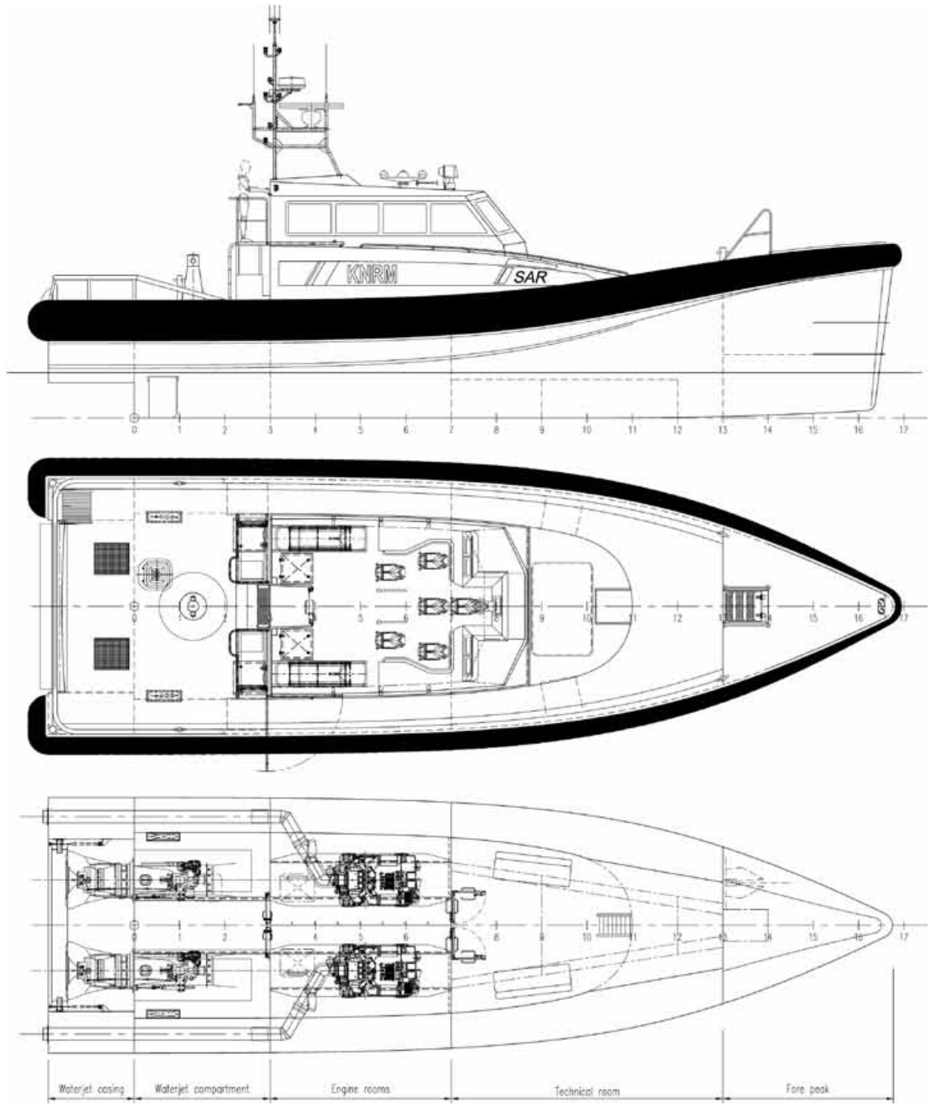
Damage analysis

The axe-bow principle has been imitated a lot, but Damen Shipyards' design and proposal engineer responsible for the project, John Nieboer, is keen to point out that a scientific approach - read number crunching and testing - is essential for a satisfactory result.

For the structural design, the rules from classification society Lloyd's Register were only a minimal starting point. To put a number on the dynamic effects encountered when receiving a large boiling mass of whitewater head-on, damages on the current KNRM fleet were analysed. Damen's engineers calculated how much pressure is needed to create certain indents found onboard the vessels and these were used as design pressures for the structure of *NH 1816*.

The new vessel will now be extensively tested over the next six months by KNRM's experienced skippers in a variety of conditions. If the design proves to be as successful in the real world as the model testing indicates, it may well become the new benchmark for SAR vessels.

Bruno Bouckaert



Subcontractors and suppliers of equipment fitted on board the *NH 1816* - YN 535501

AMW-Marine, Hendrik-Ido-Ambacht	: *Hamilton* waterjets; *MECS* electric controls
Centa Nederland, Stellendam	: shaft with flexible couplings
De Keizer marine engineering, Zaandam	: electrical system design and installation
Femtec, Eindhoven	: FEM calculations aluminium hull
Fender Innovations, Den Helder	: foam-filled D-fender
Hydrosta, Zwartsluis	: hydraulic driven generators
Lloyd's Register EMEA Marine, Rotterdam	: classification
MARIN, Wageningen	: free sailing model scale testing
MTU Benelux, Dordrecht	: main engines; *ZF* gearboxes
Northline, Harlingen	: composite wheelhouse
Servowatch, Essex, United Kingdom	: ships ships information and management system
Solico, Oosterhout	: FEM calculation composite wheelhouse
TU-Delft, Delft	: hull linesplan, model scale test programme
Tilse, Hamburg, Germany	: windows
Winel, Assen	: WT and WET musketeer doors
Wisla, Poland	: aluminium hull