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Vessels highlighted
Karina
Shabab Oman II

The vision of
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Special
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KARINA

FIRST HYBRID PROPELLED FSIV2000 OF SHIPYARD DE HOOP EXCEEDS EXPECTATIONS

Builder
Shipyard De Hoop, Lobith, the Netherlands

Principal particulars	
Length o.a.	55.17 m
Length bpp.	49.81 m
Length wl.	50.51 m
Beam mld.	9.00 m
Depth mld.	4.50 m
Draught design	3.10 m
Speed trail	21.3 kn

Passenger & cargo capacities	
Deadweight (T = 4.5m)	210 t
Deck area	200 m^2
Passengers (seated)	100 persons
Crew	8 persons

Tank capacities	
Fuel oil	40 m^3
Optional increase to	200 m^3
Fresh water, potable	5 m^3

Around the turn of the year 2012 and early 2013 Shipyard De Hoop signed a contract for the construction of seven Fast Supply Intervention Vessels (FSIVs) with yard numbers 453 to 459. Exactly on schedule, on March 5th and 7th 2014, a double celebration with the successful launching of the first two hybrid propelled FSIVs (YN 455 & 456) was performed in respectively Rotterdam and Waterhuizen, the Netherlands. The sea trails on the first FSIV, mv *Karina*, were conducted during the first week of July 2014 and the results of the tests exceeded expectations. After a short period following the sea trails, the last items were completed.

The delivery schedule of the seven FSIVs has an extremely short lead time: with the first two vessels just completed, the delivery of the other five vessels is spread over the last quarter of 2014 and the first quarter of 2015. The outfitting and commissioning of the vessels will be split between the two De Hoop locations. The hulls of YN453, YN455, YN 357 and YN459 were built in Rotterdam at the CSR facility, whilst the steel plates and profiles have been delivered by De Boer Staal from Uitgeest, the Netherlands. The outfitting of these four vessels will be performed at De Hoop, Lobith. The remaining hulls YN454, YN456 and YN458 were produced at the Pattje yard in Waterhuizen and will later be outfitted at De Hoop, Foxhol. The vessels are powered by a unique hybrid diesel-direct/diesel-electric system and designed to meet stringent environmental control.

The general concept and design

Typical for this De Hoop design, the FSIV2000, is the performance focus on 'speed keeping' instead of 'top speed'. Where other FSVs and FSIVs have a higher top speed that collapses as soon as they take on cargo weight, the full-displacement De Hoop design maintains its speed independent of draught or cargo weight. The power-resistance curve, analysed post sea trails, demonstrates the high efficiency and increased 'bite' of the applied 'high-torque/large diameter/low rpm' propellers. One consideration in using two instead of more (smaller) propellers was the increased resistance of the number of appendages under water versus the efficient blade area. Another aspect was the relative stability of the momentum of these propellers and their independence of draught and cargo weight on board. Water jets were also considered to be unsuitable as their efficiency only reaches its full potential at speeds above approximately 40 knots.

Furthermore, the multi-chine all-steel hull of *Karina* is optimised for fuel efficient operations during both transit and DP modes. The vessel is powered by a sophisticated hybrid diesel-direct/diesel-electric system, which makes it very environmentally friendly from the outset.

The steel hull construction is built according Det Norske Veritas Germanischer Lloyd's High Speed Craft (HSC) rules. To obtain a high-strength lightweight hull the builders used High Tensile Steel in combination with sophisticated construction techniques. However, there were a number of other considerations in constructing the ship entirely from steel. The first considerations were based on the simple facts that steel costs less than aluminium and is easier to repair, requiring less advanced equipment and techniques. Other advantages of steel are its resistance to impacts and its versatility, making the vessel suitable to be further customised for example for fire-fighting purposes. An additional advantage, in a world where terrorism and piracy are ever present, could be that steel is relatively easier to be made bulletproof. That is . . . to a certain extent.

The small entrance angles of the waterlines and the 'long' bowlines have the additional advantage of improved seagoing characteristics and thus less speed loss in more challenging sea states. Even at a speed of 20 knots the accelerations remain well within the comfort levels, while the extended flaired upper bow profile reduces the amount of green water and makes for a dryer ship. This Hybrid propulsion configuration resulted in an impressive reduction in fuel consumption: compared to many other modern FSVs and FSIVs of fellow

"Unique hybrid propelled configuration"

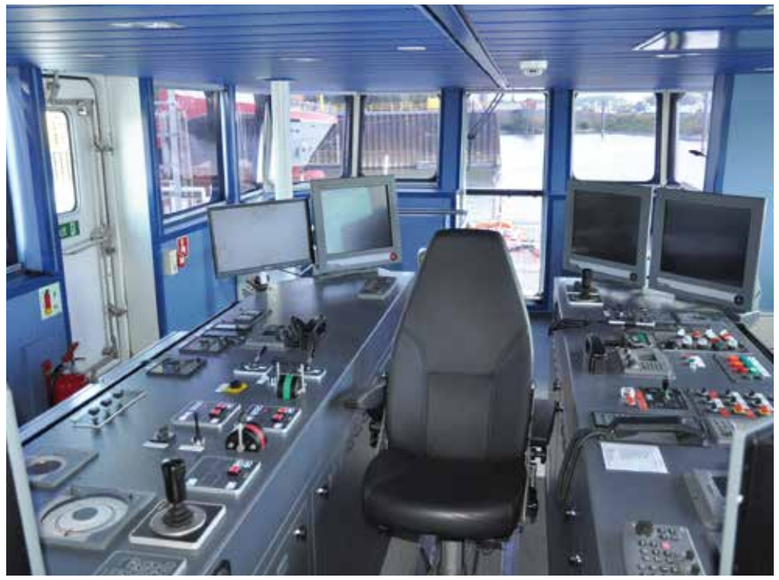
shipyards as much as 40% less fuel consumption is achieved. Further fuel savings in the hull shape are achieved by applying a bulbous bow and the (optional) Hull Vane. The Hull Vane, developed by Van Oossanen Naval Architects, consists of a fixed foil positioned below the hull behind the rudders, fitted by means of struts. For this FSIV a further reduction in power consumption, ranging from 11 per cent to 15 per cent depending on the speed, can be achieved. At higher speeds and increasing wave heights is where the advantages of the Hull Vane come into play. An additional pleasing characteristic of the Hull Vane is the stabilising effect in head seas, due to the inhibitory influence of the foil to the vertical motion: thus reducing heave and pitch. By applying both the hybrid propulsion system and the Hull Vane, De Hoop generated a vessel which, at optimal speed, only requires about half the fuel capacity of other FSIVs in the market.

Cargo facilities

The FSIV2000 is developed for the combined transport of deck cargo and passengers to offshore oil fields.

The vessel boasts a 200 square metres aft main deck, which has the capacity to carry up to 200 tons cargo. This deck mounted cargo is well protected by the forward superstructure, high freeboard and side funnels. A second cargo area of 40 square meters, located forward of the accommodation, is protected to a certain extend by a 'cage-structure', consisting of a high bulwarks/coaming construction and two strong longitudinal tubes at a higher level between the structure and the bow. Fittings and lashing points for sea fastening one 20 feet container are provided on the foredeck.

The hold, between aft peak and engine room, can carry stores, spare parts or equipment, which can be loaded and unloaded through a flush deck hatch. For the transport of liquid cargo, the yard also offers a variety of options for below-decks tank configurations. *Karina* is merely one example of the available cargo configurations and models for this FSIV, ranging in deadweight capacity from 200 up to 400 tons.



Ergonomically designed consoles provide a good view of the instruments and ease of operation

Two Caterpillar diesel engines are connected directly or indirectly to the propellers

Passengers and crew

Below deck, in the hull compartment forward of the engine room, is where we find the crew's accommodation, consisting of four cabins with two berths each. The interior of the cabins is designed to the current standards in the 24/7 offshore industry and access to internet, radio and television is provided. All cabins have individually controlled air-conditioning and adjoining private bathrooms. To the aft of this compartment are the crew's combined pantry and mess/dayroom, as well as a provision storage room.

The superstructure itself comprises of two levels: main deck and wheelhouse deck. It is positioned a quarter of the ship's length behind the bow, where the acceleration levels are at their lowest. The lower superstructure level (on main deck) is fully dedicated to the passengers and is outfitted with 100 luxury seats, ample luggage storage, toilets and a self-service buffet. 'On-demand' music and video entertainment facilities are provided for each passenger in the style of an aircraft business-class cabin. Although *Karina* provides 100 square metres of day accommodation for passengers, alternatively De Hoop offers an accommodation format with passenger cabins instead of chairs. This twin-deck passenger accommodation option provides 'overnight' berths for sixteen people.

On the bridge deck ergonomically designed consoles provide a good view of the instruments and ease of operation of all equipment. The wheelhouse windows are specially designed to provide optimal 360 degree visibility. Whilst the front and side windows are half-height, the aft windows are full height, providing good visibility on cargo loading or unloading activities when on DP. The bridge itself features a central navigation island with two consoles on either side separated by a corridor through which the helmsman's seat can move on rails. The *Karina* is equipped with a comprehensive navigation and communication package, supplied by Alphatron Marine.

The interior of the cabins is designed to the current standards in the 24/7 offshore industry

On both sides of the open deck aft of the accommodation are the engine room ventilation casings. The life rafts are to be found in dedicated cradles forward on wheelhouse deck. Outside on B deck (wheelhouse deck) is the Man-Overboard-Boat (MOB) complete with its dedicated davit installation on portside.

With this technically advanced ship, Shipyard De Hoop's knowledge and experience in luxury cruise vessels is reflected in the high standard of accommodation outfit. This includes low noise and vibration levels to provide everybody on board with an exceedingly high level of comfort. As a result of the design of the vessel and its propulsion configuration, in combination with a sophisticated insulation system, none of the accommodation exceeds a sound levels of 58dB(A) at full speed.

"Focus on 'speed-keeping' instead of 'top-speed'"

Anchoring and mooring equipment

Anchoring and mooring equipment is provided as is required by authorities. The semi-sheltered foredeck features a bow anchor, controlled by an electro-hydraulic anchor winch with a steel wire storage drum. The layout of the forward anchor equipment is also provided with a windlass on portside for handling mooring ropes. Furthermore, to the deck sides are two bollards, one on each side, for mooring purposes.

On the main cargo deck on either side are two more bollards: one of which is just aft of amidships, whilst the other is aft near the stern and integrated in the bulwark, for mooring purposes.

The anchor is a super high holding power Pool TW anchor of 185 kilogrammes capacity. The complete anchor and mooring assembly is delivered by Machine- & Lierenfabriek Kraaijeveld from Sliedrecht. The anchors are provided by Wortelboer from Rotterdam.

Engine room and propulsion

Karina has a fully hybrid propulsion system, which drives the vessel in diesel-electric mode at low(er) speeds and in diesel-direct mode at high(er) speeds. Power is generated by two Caterpillar 3516 diesel engines of 2,350kW at 1,800 rpm each, which are connected directly or indirectly to two fixed-pitch large diameter propellers as is required. This versatility ensures fuel consumption is reduced to a minimum, while 'speed-keeping' is guaranteed whatever the draught or cargo weight.

At low speed and during manoeuvring, only the portside diesel engine will be used to drive a generator. The generator, in turn, delivers power, via a DC-bus switchboard, to two electric motors. These e-motors are coupled to the gearboxes that each drive a propeller shaft. Hence, in this 'low-speed'-mode with both diesels disengaged from the gearbox, the two high-torque propellers are electrically driven. In this mode the starboard engine is completely shut down, providing fuel savings at low speed up to approximately twelve to 13 knots and when in Dynamic Positioning mode. For this reason, the maximum speed in diesel-electric mode is restricted to 13 knots. To achieve this speed, a mere 410 kW of power is required, which is reflected in a fuel consumption of less than 150 litres per hour.

At higher speed, both Caterpillars will engage with the gearboxes to provide their power directly to the two propellers. In this 'high-speed'- or 'diesel-direct'-mode, the two propellers are capable of producing up to 3.7 mW

The lower superstructure level, fully dedicated to the passengers, is outfitted with luxury ScheGro seats

with 200 metric tons payload in total. This allows the FSIV to realise a maximum speed of 21.3 knots with these particular propellers. As an option for this type of vessel, De Hoop also offer a configuration with 'fast' (high rpm) propellers, providing a maximum speed of over 25 knots. However, in this configuration, the additional speed slightly reduces the 'speed keeping'-qualities of the vessel.

When going from lower speed to full-throttle the smart power-management system automatically switches from diesel-electric to diesel-direct mode, resulting in rapid acceleration. The side funnels on either side of the cargo deck house the wet exhaust lines of the diesel engines that go overboard above main deck.

The harbour generator set, a Caterpillar C4.4 of 99kW, is located in the engine room to starboard side.

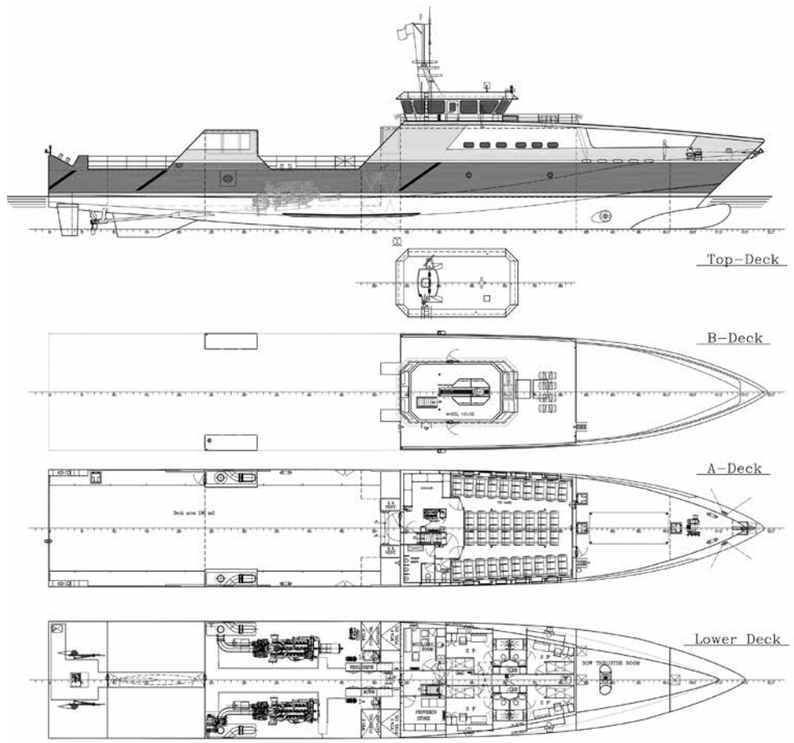
The tunnel bow thruster, a fixed pitch Veth VT-150 unit driven by an electric motor of 135 kW, completes the propulsion system. Basically having a DP1 notation, this hybrid propulsion configuration offers the optional advantage of an easy upgrade to DP2.

Evidence provided

Following successful trail runs, the De Hoop concept of two high-torque propellers with a larger diameter under a multi-chine hull must be acknowledged as a proven configuration. Achieving what theoretically was believed impossible with this type of hull, being reduced hull resistance, low bow wave crest and the 'speed-keeping' characteristics, their colleagues in the industry must look upon the De Hoop designers with a new respect.

Tom Oomkens

As the design of the FSIV allows for lifitng it with a crane, docking has become almost obsolete



Subcontractors and suppliers of equipment fitted on board the *Karina* - YN 455

Alphatron Marine, Rotterdam	: nautical navigation and communication equipment; thruster controls
AMW-Marine, Hendrik-Ido-Ambacht	: propellers
Anchor Insurance Rotterdam, Rotterdam	: building insurance
Axces, Tholen	: exhaust silencer
Chemetall, Oss	: anodes
Datema Nautical Safety, Delfzijl	: safety plan; life saving equipment; fire fighting equipment
Boer Staal, De, Uitgeest	: steel plates and profiles
De Vries Piping & Construction, Krimpen aan den IJssel	: piping installations
Delade, Doetinchem	: cabinetry
Det Norske Veritas Germanischer Lloyd, (DNV-GL), Rotterdam	: classification
ECC, Ede	: preservation work
Econosto Nederland, Rotterdam	: valves
Technology, Kolham	: electrical installation; electro motors
Facet International, Almere	: bilge water separator
Famos, Gdansk, Poland	: doors incl. locks
Gevier Dales, Doetinchem	: sanitary systems; bathrooms
Heinen & Hopmann, Bunschoten-Spakenburg	: HVAC
Intercontrol, Arnhem	: volume and flow gauges
Jac de Vries Gesta, Middenbeemster	: boiler
Jan de Witt, Bussum	: ceilings
Kieboom, Werkendam	: helmsman's seats
Kraaijeveld C, Machine- & Lierenfabriek, Sliedrecht	: anchor winch
Kroeze Maritiem, Delfgauw	: mud box
LiteCore, Aars, Denmark	: interior and steel panelling
Metos, Ruurlo	: galley equipment
Minimax, Almere	: FM 200 system
NRF, Mill	: coolers
Pharos Engineering, Vlissingen	: hull construction drawings
Pon Power, Papendrecht	: *Caterpillar* main engine
Poseidon, Barendrecht	: propulsion and steering systems
Reikon, Spijkenisse	: *Azcue* pumps and *Ueberall* UV sterilizer
Reintjes Benelux, Antwerp, Belgium	: *Reintjes* reduction gearbox
Rietveld Hydraulics, Sprang-Capelle	: hydraulic piping for steering gear
Roelofs, Nijverdal	: st.st. railing work
Rubber Design, Heerjansdam	: flexible suspensions
Schegro, Zwijndrecht	: passenger seats
S.I.N., Oranjewoud	: propellor shaft system
Temaro, Rotterdam	: sun blinds
TOP Training, Boskoop	: SOPEP manual
Trinoxx, Hardinxveld-Giessendam	: modular interior bulkheads; floors; welded window frames
VDI Isolatie, Ridderkerk	: delivery and installation of insulation materials
Verhagen IT Group, Lobith	: satcom and internet
Veth Propulsion, Papendrecht	: bow thrusters; Z-drives
Viking Life-Saving Equipment, Zwijndrecht	: life rafts
Winel, Rotterdam	: flame arrestors
Winteb, Winschoten	: air pipe heads
Wortelboer, Rotterdam	: bow anchor and steel anchor wire