Extra width for *Blue Marlin* at Hyundai Mipo

A HUGE conversion project on the semi-submersible heavy-lift ship *Blue Marlin,* by increasing the breadth of the hull, required upgrading of its propulsion capabilities. Wärtsilä was one of the main contractors for the task, which included supplying generating sets, two retractable bow thrusters, and a large high-efficiency nozzle with new propeller blades for the main propulsion plant.

Blue Marlin, originally built at CSBC, in Kaohsiung, Taiwan, (newbuilding 726) was delivered in 2000 - her sister, *Black Marlin,* was presented in the RINA annual *Significant Ships of 1999*. The vessel is currently owned by Dockwise, a Dutch company specialising in heavy transport shipping for the oil and gas industries. She was originally equipped with one open Lips CP propeller with a diameter of 6200mm, which was directly driven by a MAN B&W 8S50MC-C low-speed diesel engine delivering 12,640kW at 127rev/min. One Kawasaki transverse thruster was installed in the bow.

The complex conversion task at Hyundai Mipo Dockyard in South Korea required increasing the breadth of the vessel from 42m to 63m. With an enormous unobstructed deck area of 11,227m^2, *Blue Marlin* is now believed to be the largest semi-submersible vessel in the world. The deadweight of the vessel is 78,000dwt, enabling the vessel to transport heavy structures weighing up to 73,000tonnes. With her new dimensions, *Blue Marlin* is able to transport heavier and ultra-large floating production and drilling platforms and larger semi-submersible drilling units.

Propulsion requirements for the much larger converted vessel were investigated in model tests at MARIN in The Netherlands,

Blue Marlin **in drydock at Hyundai Mipo Dockyard, where the enormous extra width of the vessel (exceptionally wide at 63m, compared with 42m previously) only just fitted into the dock.**

The newly constructed Lips nozzle. New CP propeller blades were fitted later. Above and to the left can be seen the remodelled semi-tunnel addition to the hull to provide improved water flow.

where sea-keeping tests revealed that more thrust was required to operate and manoeuvre safely, especially in adverse weather conditions. To obtain this, two new retractable thrusters were proposed for the bow.

However, these two alone could not cover the extra thrust needed, and it was also necessary to upgrade the existing main CP propeller installation. In September 2002, Wärtsilä won the contract to supply three Wärtsilä 8L32-driven generating sets and two electrically driven Lips retractable thrusters. The order to supply a large Lips HR (high-efficiency) nozzle with new propeller blades for the main propulsion train was placed slightly later in October last year. This contract also included model testing of the new propeller design at MARIN.

High-efficiency nozzle increases thrust

A Lips HR nozzle was installed around the existing propeller to increase thrust without changing the power of the engine - the existing main engine, shaftline, and propeller hub could remain in place. A key reason for choosing the HR nozzle was to maximise the benefit of the installation of such a nozzle. According to Lips (today Wärtsilä Propulsion), its HR nozzle differs considerably in shape compared with a conventional nozzle profile.

A curved outer profile and an inner profile that flares out to the trailing edge increases the mass flow handled by the propeller. This leads to a larger pressure difference between the inside and outside of the nozzle, resulting in greater thrust on the nozzle. The Lips HR design is said to have proven to be very beneficial in both free sailing and bollard conditions, providing up to 10% more thrust compared with a conventional 19A nozzle.

New blade design with reduced diameter

The hydrodynamic department of Wärtsilä made a completely new blade design to fulfil the new requirements. The shape of these was challenging since many parameters were outside the normal range applied to nozzles. To limit tip speed, the original propeller diameter of 6200mm was reduced to 5200mm. The wake field at the aft of the ship was investigated by measurements and tuft tests. The wake field is important for propeller design because it determines the inflow and therefore the cavitation behaviour, hull pressure fluctuations, and changes in thrust and torque during each revolution of the propeller blade.

A tunnel-headbox combination was designed by MARIN to improve afterbody flow towards the nozzle. The tunnel-headbox construction makes the wake field very close to homogeneous in the axial direction, which is favourable, and wake field measurements showed the beneficial working of this feature. The measured wake field was used when designing the new propeller blades. When this design was finished, a model was made and several tests were performed at MARIN. The results showed an estimated increase in thrust of approximately 30% in bollard condition.

Two large Lips retractable thrusters of the