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Work undertaken by DNV GL for Diamond 2 Ultramax Bulk Carrier

Over a three-month period and utilizing DNV GL's specialized team of hydrodynamic experts based in Potsdam (Germany) and Oslo (Norway), and machinery simulation experts in Piraeus (Greece), a significant study was undertaken. This study, unique to date for bulk carriers, aimed to optimize the hull, propeller and machinery with special focus on the most frequent trading conditions the vessel is likely to encounter based on a DNV GL exhaustive AIS data analysis for exiting Ultramax bulk carriers.

CFD Analysis and Hull optimization

DNV GL's in-house ECO-Lines parametric hull optimisation process was applied, investigating thousands of design variants using state-of-the-art Computational Fluid Dynamics (CFD) analysis and optimization algorithm.

For the selected most promising design variants, the Designer committed a towing tank test program at HSVA in Hamburg (Germany) which has one of the highest reputations for integrity and reliability. Along with other top tier tank testing facilities at the recommendation of the ITTC (International Towing Tank Conference), HSVA has recently adopted a more conservative approach to full scale predictions.

Initial tests with two CFD-optimized, promising design candidates showed very promising resistance figures, but to gain full advantage needed to be further refined by other than a stock propeller. Due to scheduling challenges at HSVA the decision was made to complete testing at SVA Potsdam who had suitable availability and an equally high reputation. The Designer additionally recognized that it was important to gain a full set of results from one tank test facility, therefore a full set of resistance and self-propulsion tests with the design propeller and rudder bulb were carried out at SVA. The full set of results from SVA, including the design propeller, were witnessed and assessed by DNV GL, and were concluded with a full set of speed/power curves for the Diamond 2. The results from these model tests, and work for the machinery configuration optimisation, enabled the Designer to provide fuel consumption information that can be relied upon in service.

COSSMOSS – COmplex Ship Systems MOdelling and Simulation

The DNV GL in-house machinery computer modelling tool, COSSMOS, was used to perform an integrated assessment of the overall fuel savings potential from the baseline vessel, and to assess machinery improvement technology alternatives.

The impact of the hull form optimization outcome was assessed at an integrated system level combined with main and auxiliary engine selection, waste heat recovery and electricity demand improvements. In addition, the impact on fuel consumption of environmental compliance technologies, such as ballast water treatment and exhaust gas cleaning were also assessed by the Designer in co-operation with DNV GL.

With respect to machinery related improvements, the vessel's generator fuel consumption was estimated to gain a reduction by about 6% in transit and 12% at anchor respectively, while the fuel consumption in port when discharging cargo and ballasting was estimated to gain a reduction by up to 23% by the introduction of variable frequency drives. Auxiliary boiler consumption was estimated to gain a reduction by approximately 16%, using economizers on the auxiliary gen-sets.

A digital twin of the Diamond 2 was created which follows the design into detail and contract design and thus into service, where utilizing in-service data it is possible to closely monitor vessel's performance and provide guidance for optimal fuel efficiency for specific conditions and trades.

Energy Efficiency Design Index, EEDI

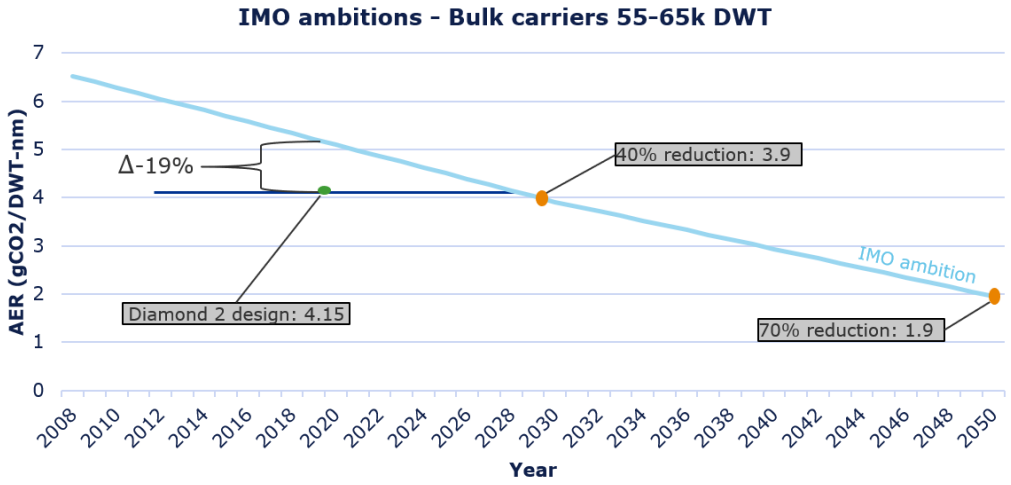
DNV GL has made a preliminary assessment of the EEDI, based on information and data provided by the Designer. This assessment is made prior to engine shop tests and sea trial. The results show that compliance with EEDI Phase 3 (30% reduction rate from 2025) is feasible based on the following input and assumptions:

DWT = 63,300 mt
ME SMCR = 7,000 kW (MAN G type engine)
ME SFOC = 162.448 g/kWh (including 4% tolerance)
AE SFOC = 200 g/kWh
AE power = 350 kW
Speed, Vref = 13.39 knots (estimate includes assumed 3% improvement from a duct type pre-swirl ESD)

Required EEDI : 4,930 g/t nm
Attained EEDI : 3.436 g/t nm
EEDI Ratio : - 30.30 %

Operational performance index benchmarking

DNV GL has assessed the anticipated, theoretical operational performance of the Diamond 2 by estimation of the Annual Efficiency Ratio (AER) index. The plot below illustrates the estimated AER for Diamond 2 compared to the IMO ambition, or trajectory, for CO2 reductions to 2050. It shows that the Diamond 2 will be below IMO's ambition until 2028. Thereafter, a small speed reduction can be applied to be compliant with the 2030 ambitions (40% CO2 reduction compared to the reference year 2008).



The estimation was done by using a large set of AER data for the 25% best performing Crown 63 vessels (the reference design of Diamond 2) currently in operation, as reported to EU MRV, and further by applying the theoretical percentage difference in fuel oil consumption as weighted over the expected operational profile. The estimation is believed to be conservative.

Evaluation by DNV GL

With reference to above description, it is hereby confirmed that DNV GL has actively contributed to the development and evaluation of the Diamond 2 design at a level of detail never before undertaken for a bulk carrier. The resulting speed/power curves are to the best of our knowledge deemed to be correct, and directly correlate to the stipulated fuel consumption figures calculated by the Designer.

For DNV GL AS

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