



Green Bulkers Now and in the Future

Emission reduction, fuel efficiency, energy efficiency

Leif Jacobsen

Director, Grontmij Marine





Grontmij Group - Introduction

- Company founded in 1915
- Multi disciplinary Consulting & engineering company
- 350 Offices World Wide
- 11,000 professionals
- Head Office located in The Netherlands
- Turnover USD 1,5 Billion
- Flexible, dynamic organization
- Public listed on the Euronext, Amsterdam





Grontmij Marine Group - Introduction

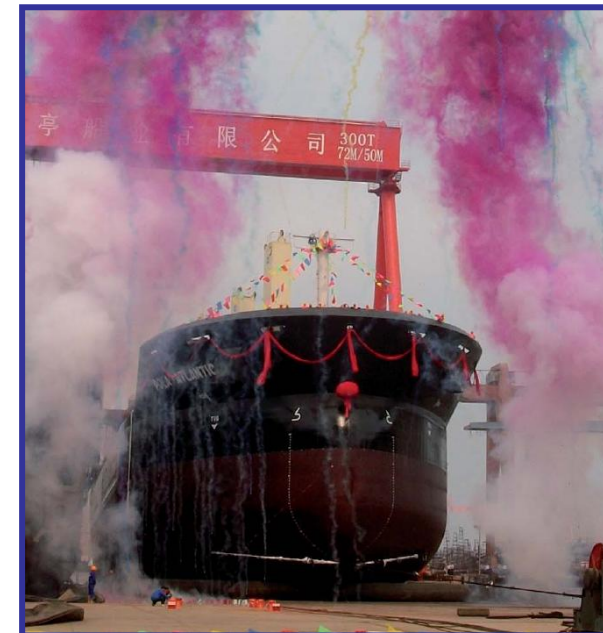
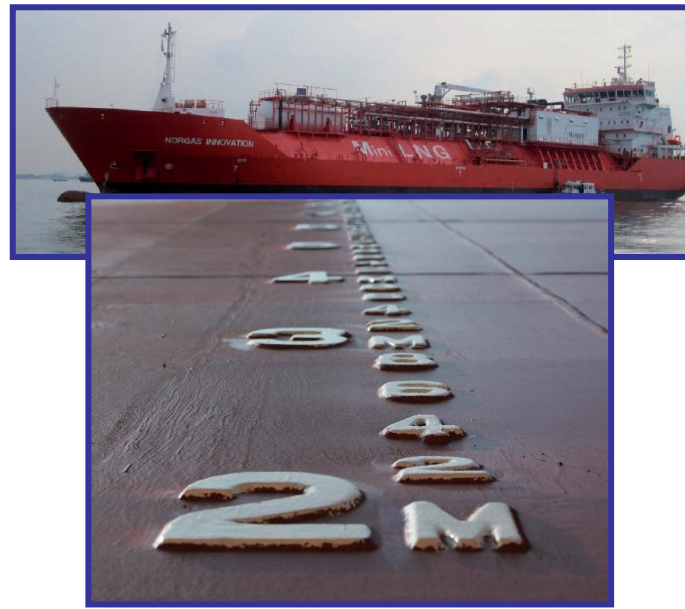
- Ship Design since 1966
- Ship Design, Marine Engineering, Survey & Inspection
- 30 Professional Naval Architects & Marine Engineers
- Head Office located in Copenhagen, Denmark
- Offices in Copenhagen, Odense & Shanghai





Grontmij Marine Group – The History

- Ship design established in 1966 as Dwinger Marineconsult
- Dwinger Marine became part of Carl Bro in 1990
- From 2000 trading as Carl Bro Marine
- Since 2007 part of the Grontmij Group as Grontmij | Carl Bro A/S
- From 29th April 2011 company name changed to Grontmij

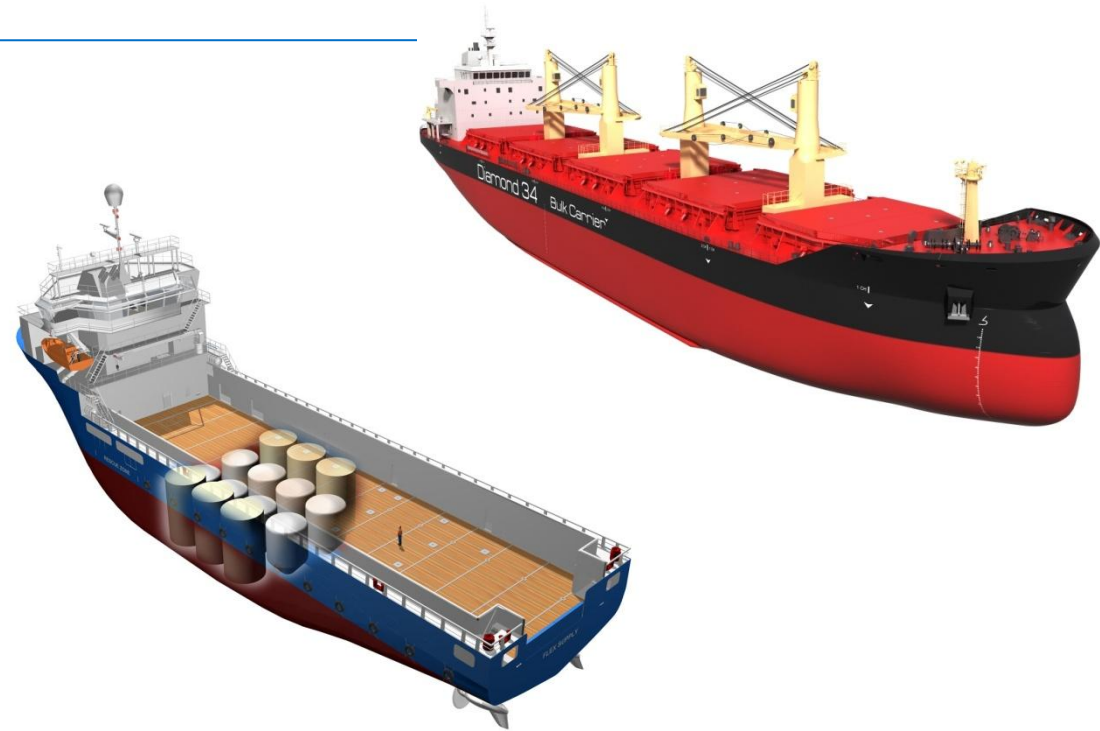




Grontmij Marine

Design of all ship types:

- Tankers
- Bulk Carriers
- Container Ships
- Gas Carriers (LPG / LNG / LEG)
- Ro-Ro vessels
- Passenger Ships
- Offshore Vessels
- Special purpose vessels
- Navy Ships



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Grontmij Marine – Capabilities & Experience

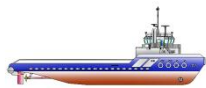
- Competent staff with strong experience base
- Newest tools and calculation software available
- Cutting edge design, based on latest market trends.
- Nearly 300 vessels built according to our design
- Very strong setup in Asia - 150 vessels built in China
- Currently 18 shipyards is building according to our design



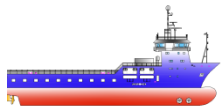
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Grontmij Ship Design & Marine Engineering



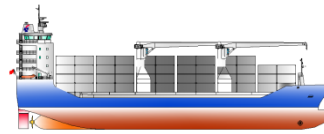
LIGHTERING SUPPORT VESSEL



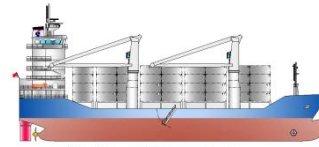
FLEX SUPPLY - 70 M Platform Supply Vessel



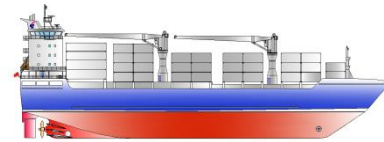
1200 Lane Meter - Roll on Roll off passenger Vessel



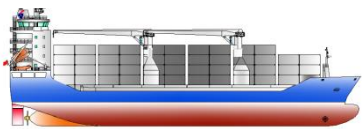
3,500 TDW - Multi Purpose Vessel



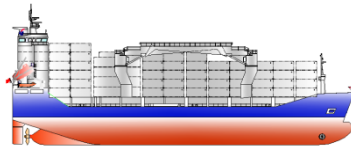
4,600 TDW - Multi Purpose Vessel



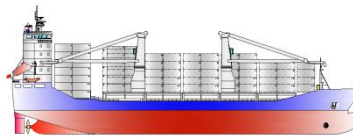
6,000 TDW - ICE 1A Multi Purpose Cargo Vessel



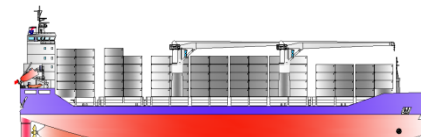
6,900 TDW - Multi Purpose Vessel



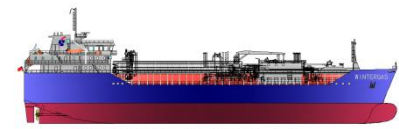
9,000 TDW - Multi Purpose Vessel



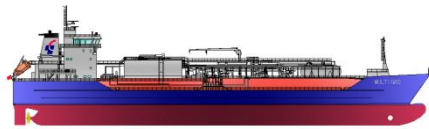
9,500 TDW - Multi Purpose Vessel



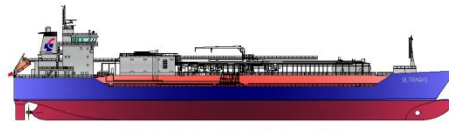
12,000 TDW - Multi Purpose Vessel



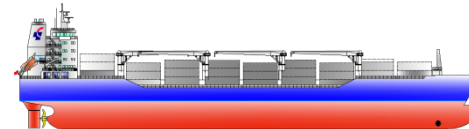
WINTERGAS 9,700 M³ - LPG, LEG & Chemical Carrier



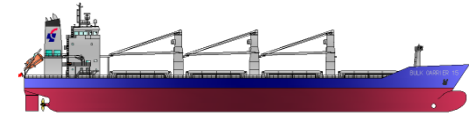
MULTIGAS 10,000 M³ - LPG, LEG, LNG & VCM Carrier



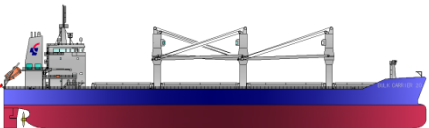
ULTRAGAS 12,000 M³ - LPG, LEG, LNG & VCM Carrier



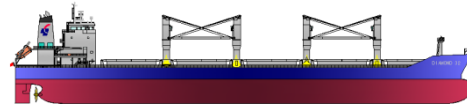
640,000 TP REFFER VESSEL



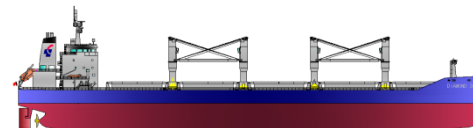
14,000 TON - Bulk Carrier



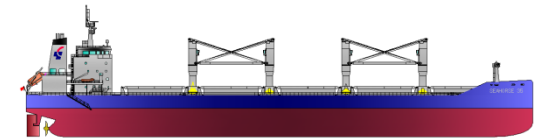
20,000 TDW - Bulk Carrier



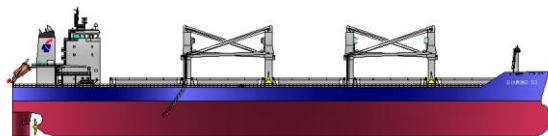
32,000 TDW - Bulk Carrier



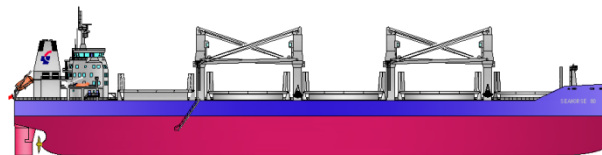
DIAMOND 34 - 34,000 TDW Bulk Carrier



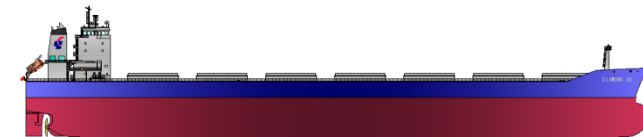
SEAHORSE 35 - 35,000 TDW Bulk Carrier



DIAMOND 53 - 53,000 TDW Bulk Carrier



SEAHORSE 60 - 60,000 TDW Bulk Carrier



80,000 TDW - Bulk Carrier





What is a Green Bulker ?

- Bulker with low emissions to the environment
- Bulker which reuses energy
- Bulker with an effective propulsion system
- Bulker with a ballast water treatment system
- Bulker where Opex and Capex are optimized
- Bulker where lines and capacity are optimized related to fuel consumption
- Bulker where the light weight is optimized
- Bulker with energy saving devices



Seahorse 35 - the vessel for case studies



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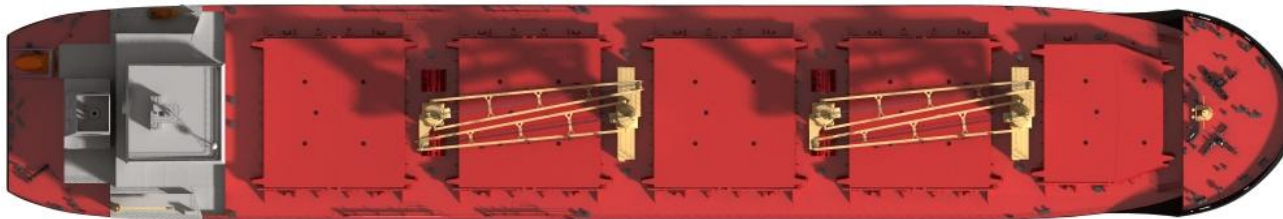


Seahorse 35 – Contract Status

- 26 Effective contracts at 7 different shipyards
- Totally about 60 vessels ordered
- 1 Vessel delivered (August 2011)

- DaoDa Heavy Industries (DDHI), Qidong, Jiangsu
- Chengxi SY, Jiangyin, Jiangsu
- Zhong Chuan Heavy Industry (ZCHI), Zhoushan, Zhejiang
- Jiangdong Shipyard, Wuhu, Anhui
- Nantong Jinghua, Nantong, Jiangsu
- Yangfan Shipyard, Zhoushan, Zhejiang
- Guoyu Shipyard, Yangzhou, Jiangsu

- 2 more yards have signed SEAHORSE 35 contracts but not yet effective

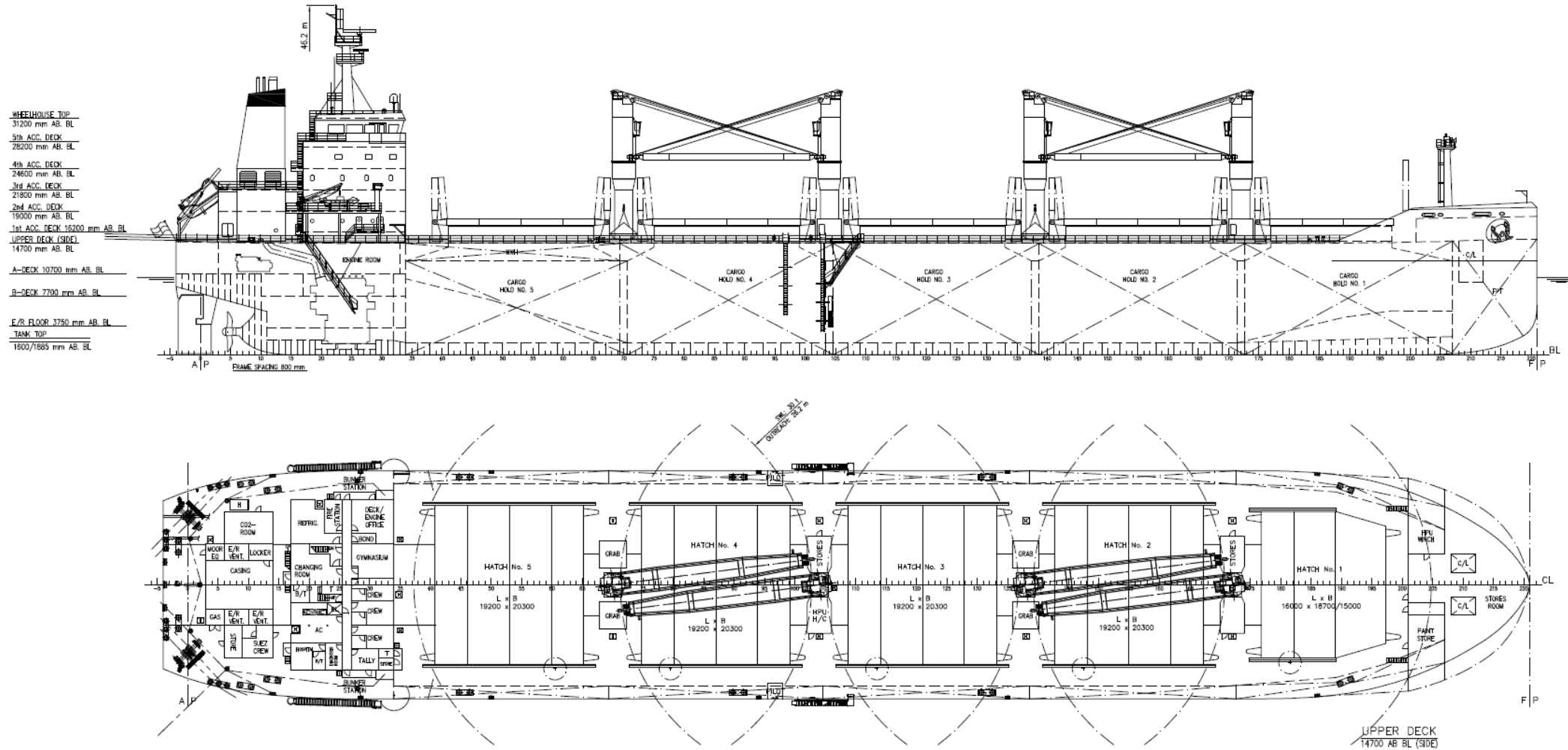




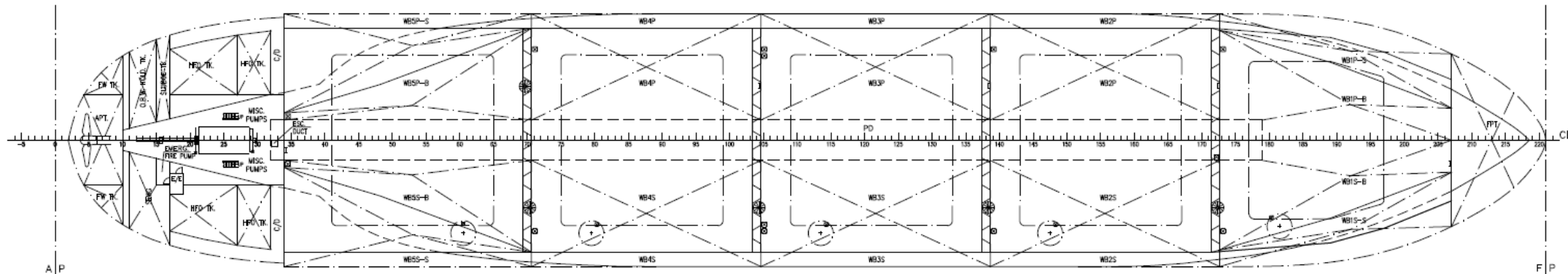
Main particulars – SEAHORSE 35

▪ Length, OA	180.0 m	
▪ Breadth	30.0 m	
▪ Depth	14.7 m	
▪ Scantling draft	10.1 m	
▪ DWT scantling	35,000 ton	
▪ TPC	50.0 t/cm	
▪ Cargo hold capacity, grain	46,700 m ³	(1,650,000 cft)
▪ Cargo hold capacity, bale	45,800 m ³	(1,617,000 cft)
▪ Gross tonnage	24,366	
▪ Net tonnage	11,521	

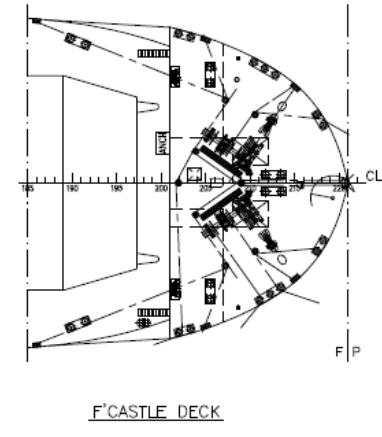
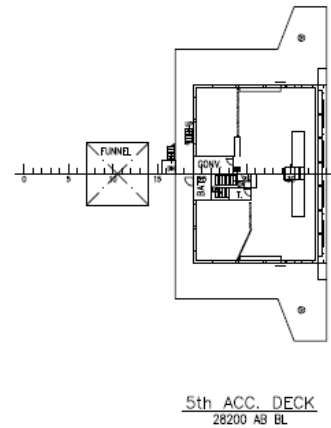
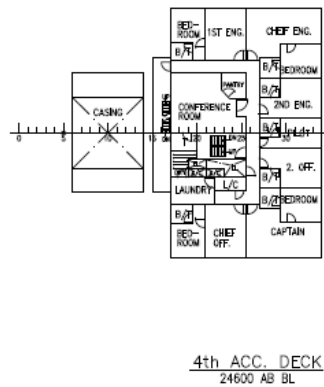
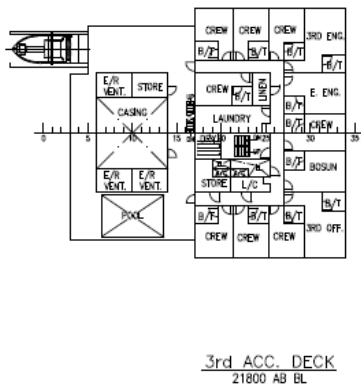
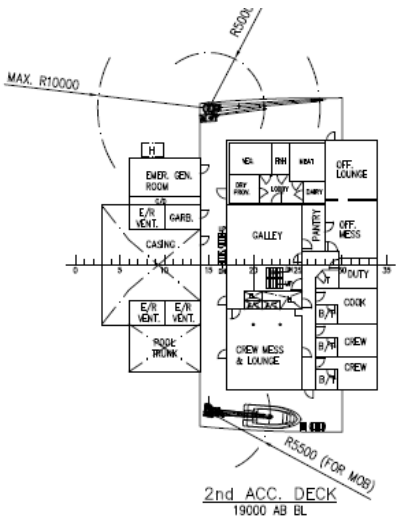
General Arrangement Plan 1/3



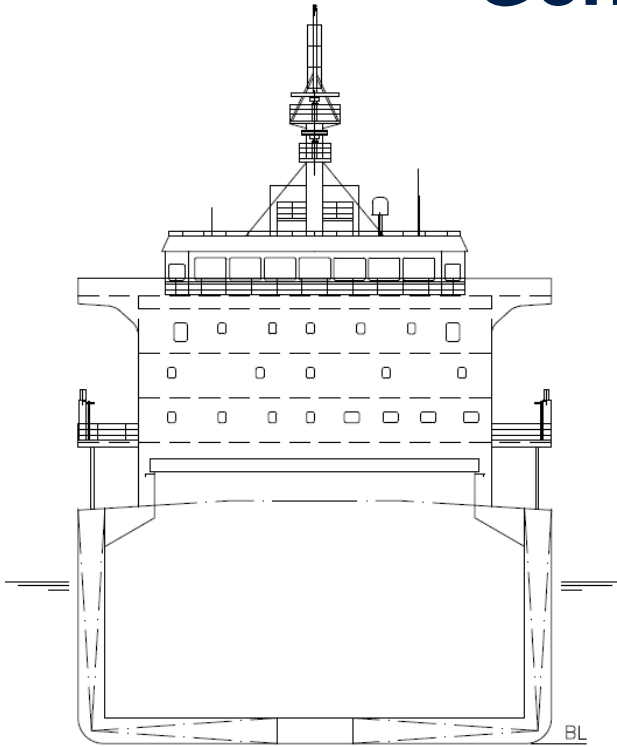
General Arrangement Plan 2/3



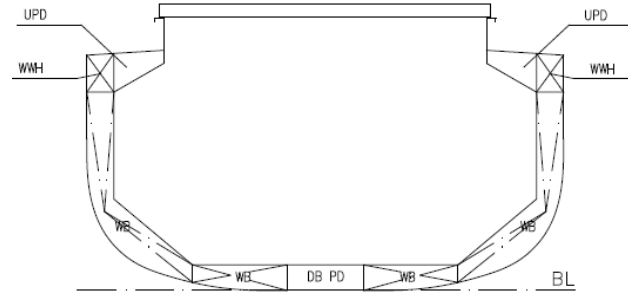
TANK TOP
1600/1885 AB BL



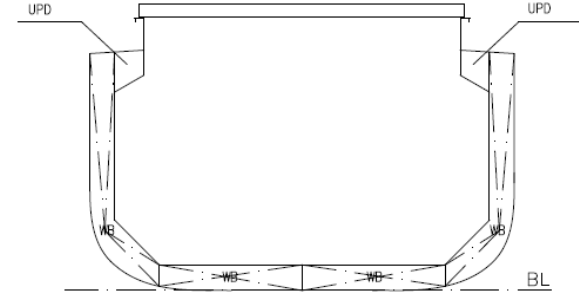
General Arrangement Plan 3/3



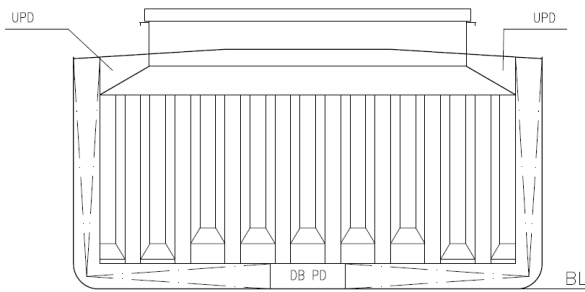
MIDSHIP SECTION



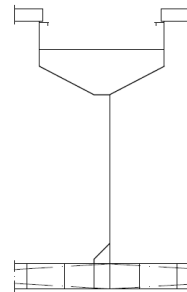
CARGO HOLD NO. 5



CARGO HOLD NO. 1



TRANSVERSE BULKHEAD



Green Ship of the Future



GREEN SHIP of the FUTURE (GSF) :

- Danish Maritime Network works to reduce emission from ships
 - 30% reduction of CO₂
 - 90% reduction of SO_x
 - 90% reduction of NO_x
- GSF presented two demonstrator vessels at the BRIGHT GREEN Exhibition in connection with the COP15 Climate Conference held in Copenhagen December 2009



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Regulations on emissions, Sulphur

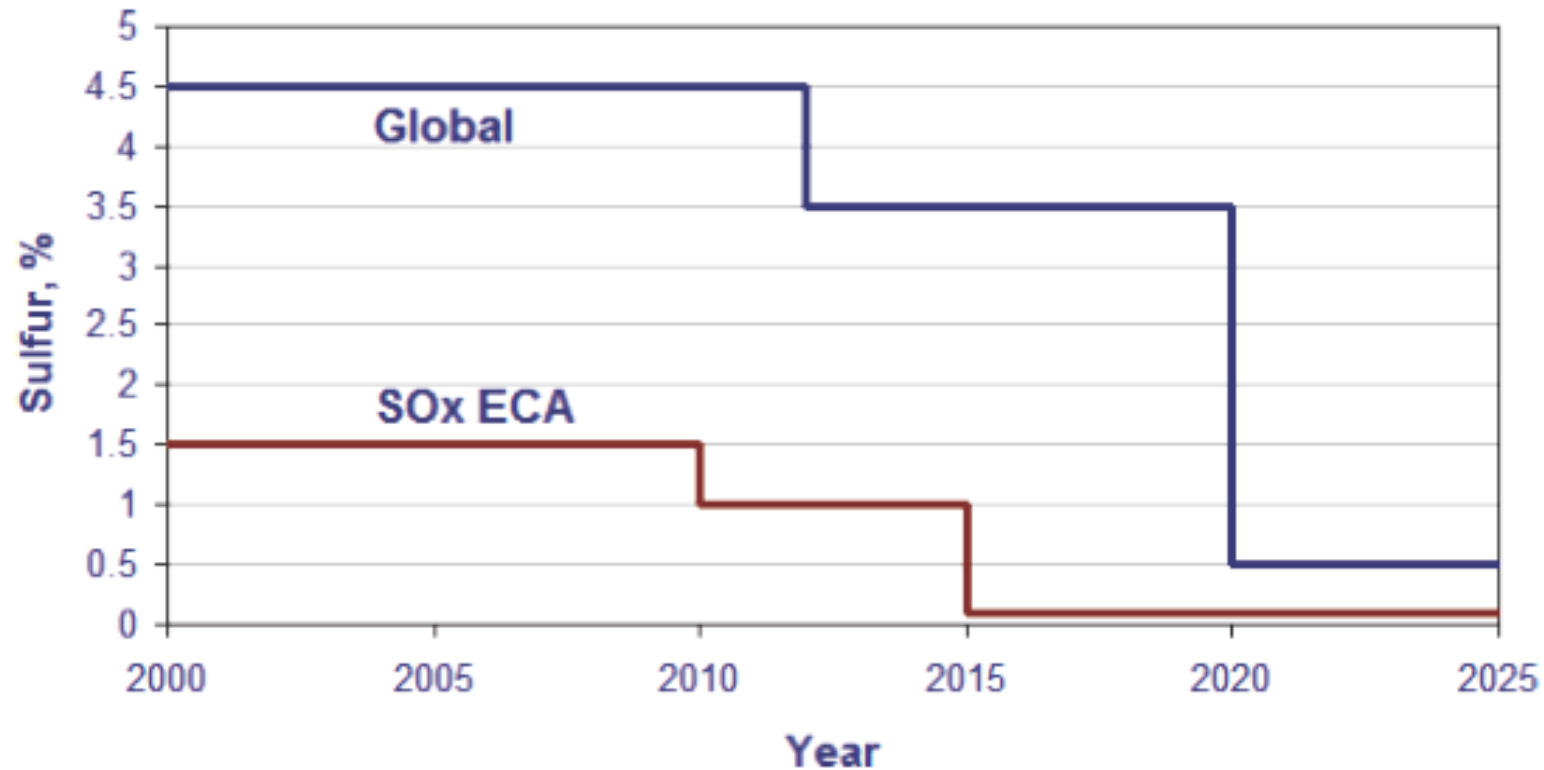


Figure 2. MARPOL Annex VI Fuel Sulfur Limits



Regulations on emissions, NOx

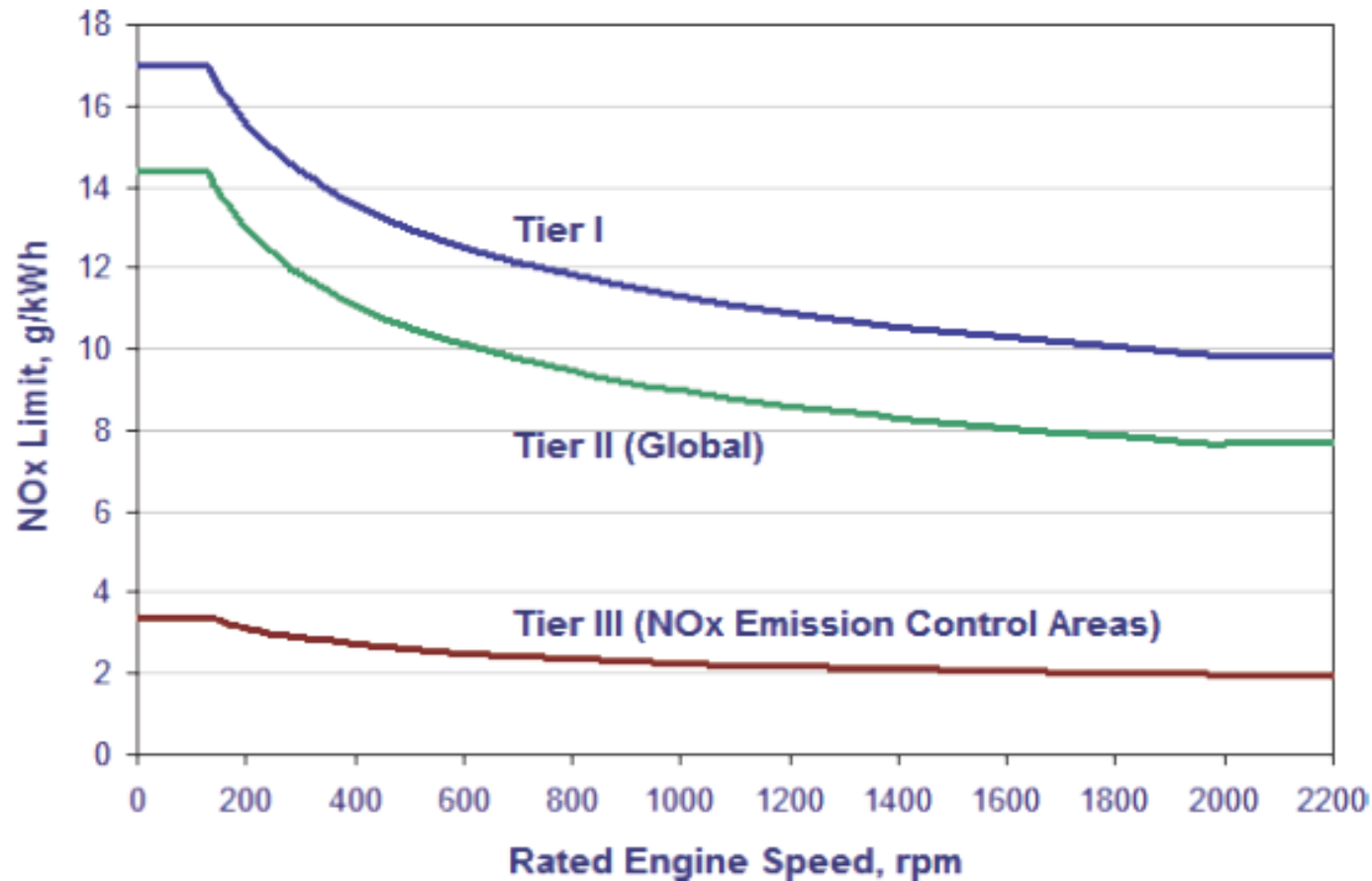


Figure 1. MARPOL Annex VI NOx Emission Limits



Future regulations on CO2, EEDI-Index

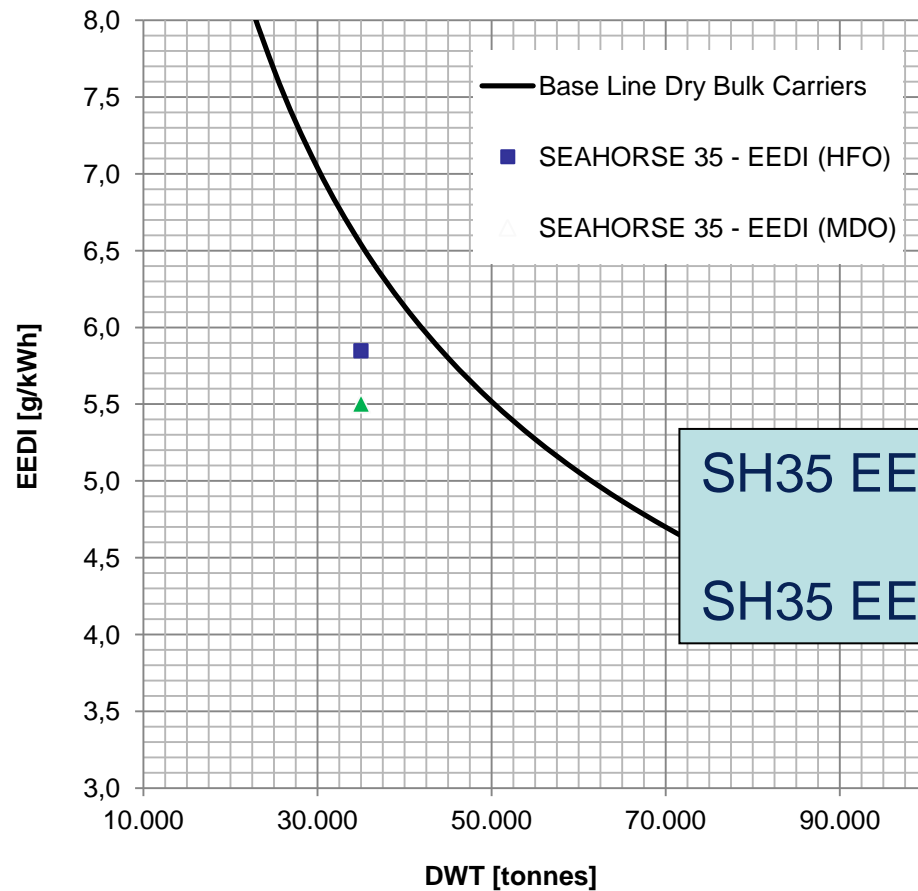
$$EEDI_{Attained} = \frac{C_F \cdot SFC \cdot P}{f_i \cdot Capacity \cdot V_{ref} \cdot f_w}$$



Energy Efficiency Design Index EEDI

- IMO energy efficiency design index Base line (35,000 DWT) : 6.54 g/t-nm

EEDI Base Line Dry Bulk Carriers



SH35 EEDI (HFO) : 5,85 g/t-nm (minus 11%)

SH35 EEDI (MDO) : 5,51 g/t-nm (minus 16%)

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The case study

How low can we go on emissions for a Seahorse 35 Bulker with existing known green Technology?

Founded by the Danish Maritime Foundation





List of primary modifications

- Optimized propeller
- Twisted spade rudder with Costa bulb
- Water in fuel (WIF)
- Exhaust gas recirculation (EGR)
- Waste Heat Recovery system (WHR)
- Exhaust Gas Scrubber
- Ducted/direct air intake for main engine
- Optimised coolers and cooling pumps
- Auxiliary engine operation on marine diesel oil (MDO)
- High capacity fresh water generator
- Installation of Ballast Water Treatment System (BWT)



Emission reduction

	normal at sea %	annual basis %
total ship		
FO consumption	-7,7	-7,2
CO2 emission	-7,7	-7,2
SOx emission	-98,7	-98,6
NOx emission	-81,6	-79,1
PM emission	-90,9	-86,0

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Additional weight (estimate)

160 t



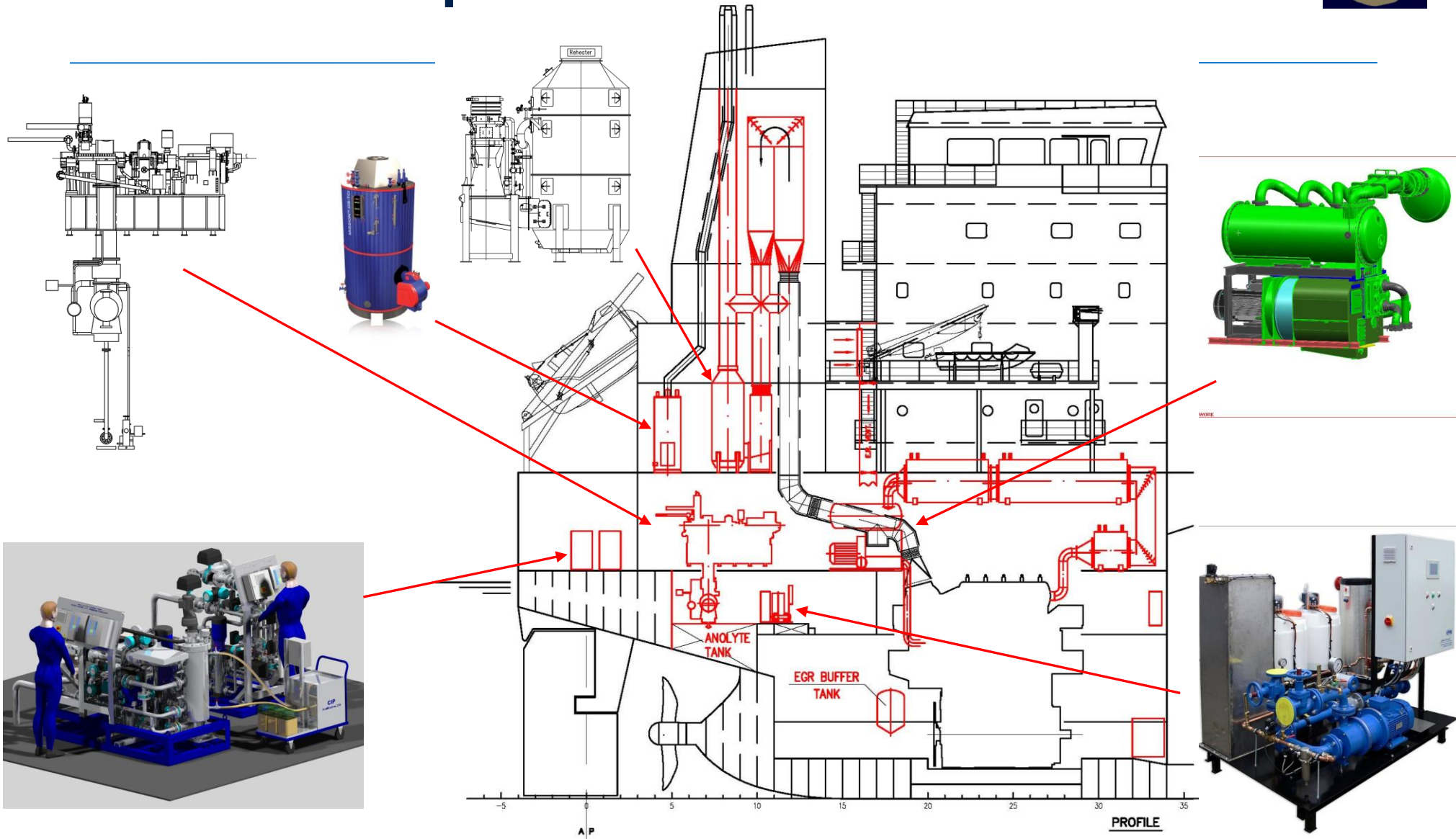
Additional cost (estimate)

	USD
Speed nozzle/optimized propeller	700.000
Twisted spade rudder with Costa bulb	160.000
Water in fuel (WIF)	200.000
Exhaust gas recirculation (EGR)	600.000
Waste Heat Recovery system (WHR)	1.250.000
Exhaust Gas Scrubber	1.200.000
Ducted/direct air intake for main engine	20.000
Optimised coolers and cooling pumps	150.000
Auxiliary engine operation on marine diesel oil (MDO)	-
High capacity fresh water generator	50.000
Installation of Ballast Water Treatment System (BWT)	810.000
	5.140.000

**Estimated price for a Seahorse 35 is 22-25 mill. USD
(Chinese yard)**

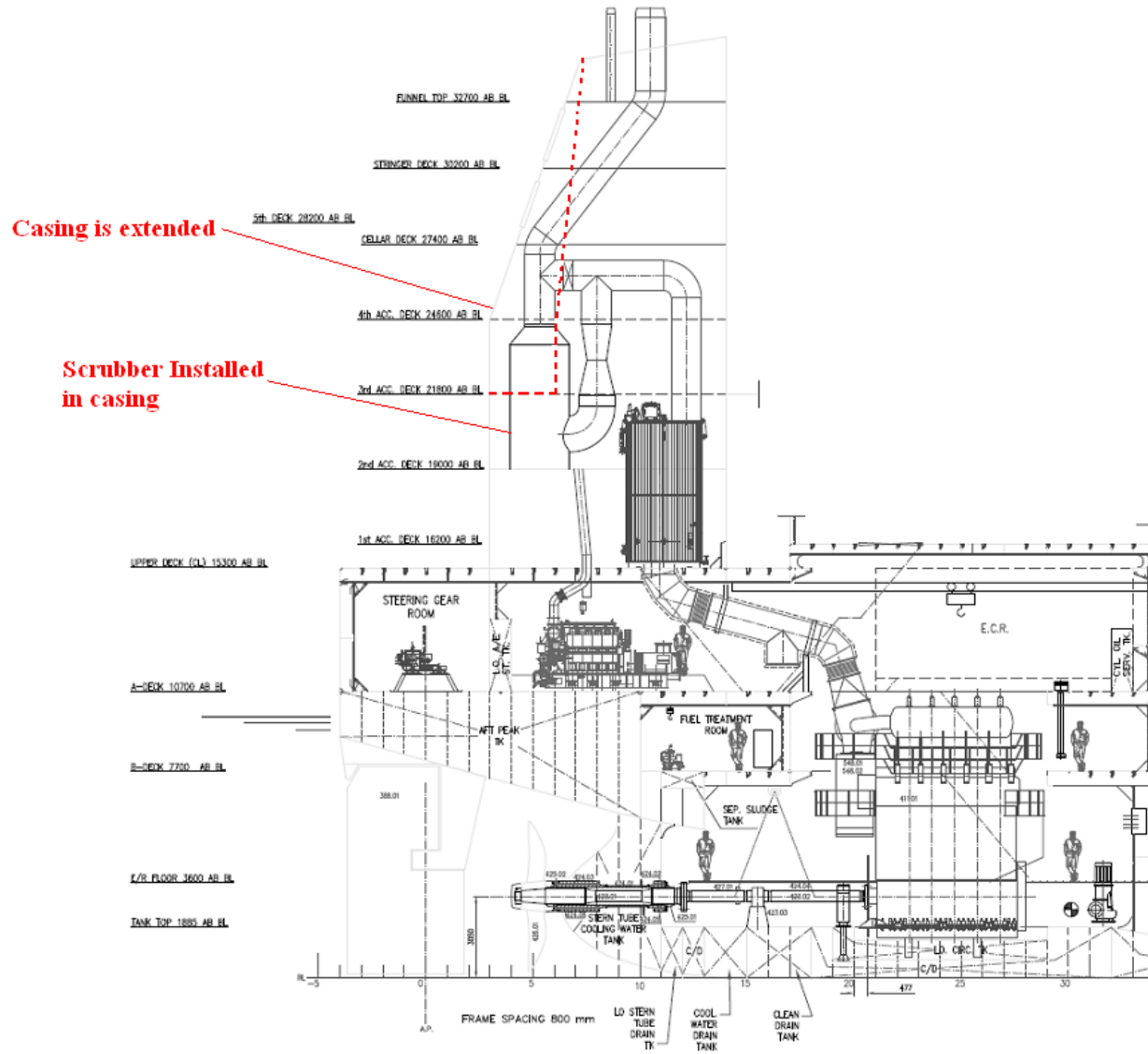


Where do we put it ?





SW Scrubber installed in SH35



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Main system components

	Weight, (t)	
	dry	wet
▪ Scrubber, stainless steel	5	7
▪ System Pumps	3	3,5
▪ Water treatment plant	1	1,5
▪ Piping	1	2
▪ Control and monitoring	<u>1</u>	<u>1</u>
▪ Total weight, loss of DW	11	15



Investments

	mio USD
▪ Scrubber	1,10
▪ Water treatment system	0,10
▪ Transport	0,02
▪ Installation	0,05
▪ Commissioning	0,02
▪ Total cost	<u>1,29</u>

Est. cost is based on new build of ship at Chinese Yard



Cost scenario for MGO operation

▪ HFO price	650 USD/ton
▪ MGO price	900 USD/ton
▪ Annual consumption of fuel(main engine)	5600 t
▪ Annual consumption of fuel(DG's)	800 t
▪ Annual fuel cost HFO:	4,2 mio USD
▪ Annual fuel cost converting to MGO	5,8 mio USD
▪ Annual additional cost for MGO op.	<u>1,6 mio USD</u>



Pay back for SW scrubber solution

- Total investments 1,29 mio USD
- Additional fuel to operate scrubber 110 t/year
- Annual fuel cost, scrubber operation 0,1 mio USD
- Annual additional fuel cost, DG's on MGO 0,2 mio USD
- Total annual fuel cost 3,9 mio USD
- Annual fuel cost if MGO operation 5,0 mio USD
- Annual fuel cost saving for continuous operation on HFO / Scrubber 1,1 mio USD
- Simple pay back: investment / Saving **1,2 years**



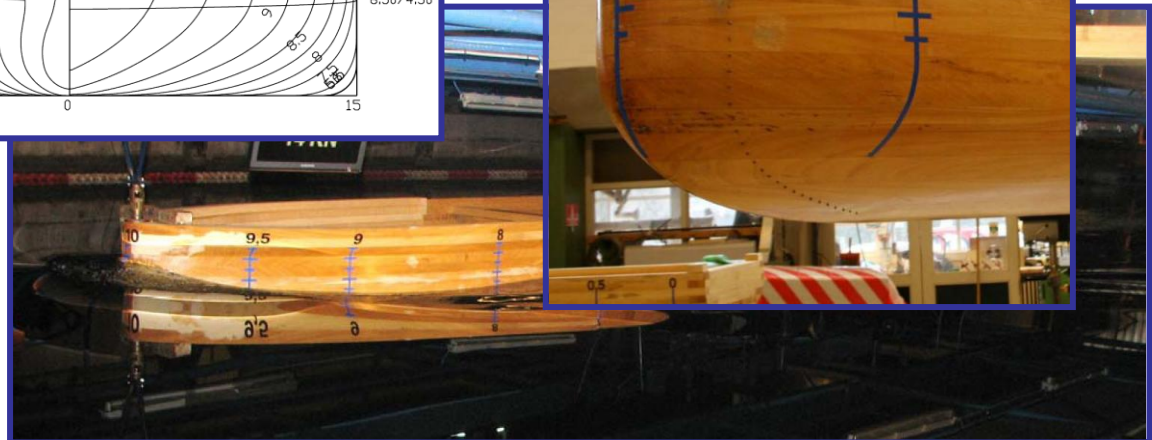
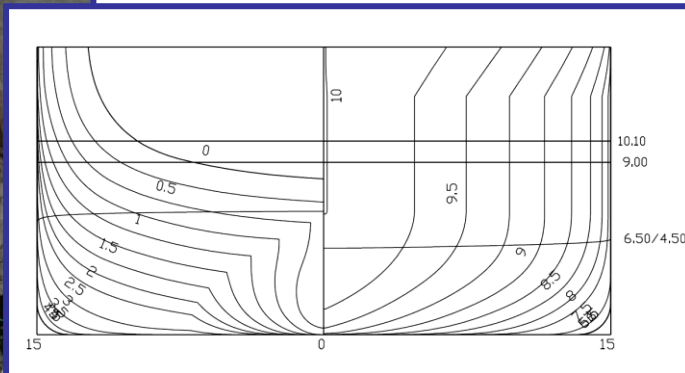
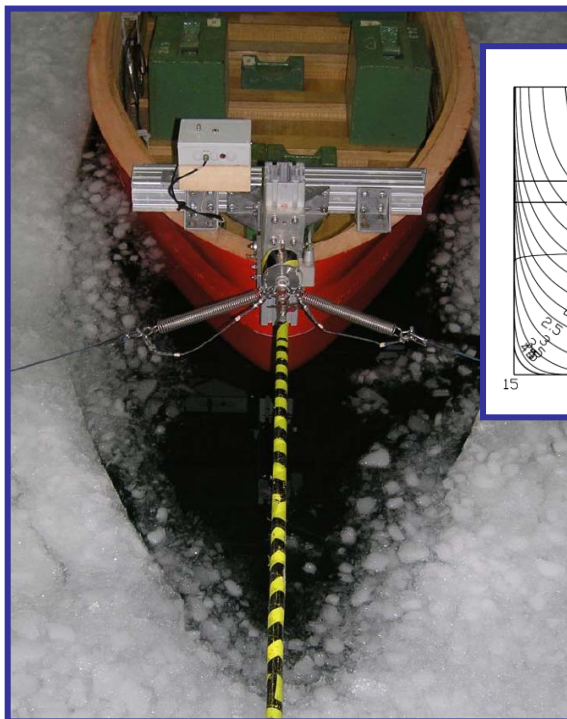
Green Bulkers

- What do we do as Design House for being "Green"?
 - Optimized designs
 - Weight saving studies
 - Propulsion Systems
 - Use of High Tensile Steel
 - Following developments within Green Technology
 - Tank test with new features



Optimized Hullform

- Hull form generated through extensive CFD analysis and Model test
- Vertical Stem design
- Low resistance and optimized wake field – optimum propeller design
- Ice Classed vessel and Ice Model testing

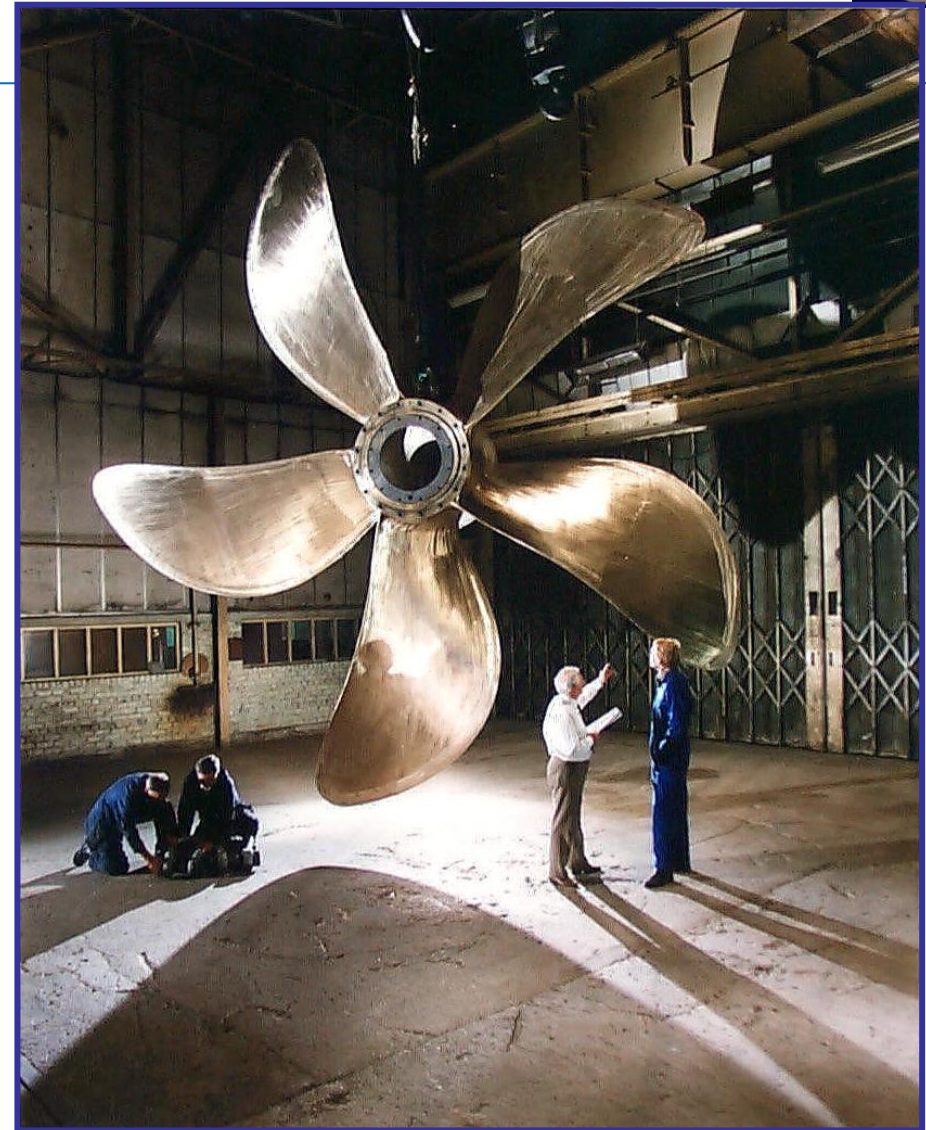


Propeller

- NPT Propeller – New Profile Type

State of the art propeller design

- Low blade section area
- Low propeller weight
- Highly cavitation resistant
- Highest achievable performance



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Fuel Oil Optimization

- MEWIS Duct

~4% - 6% Efficiency Increase



- Propeller Boss Cap Fin (PBCF)

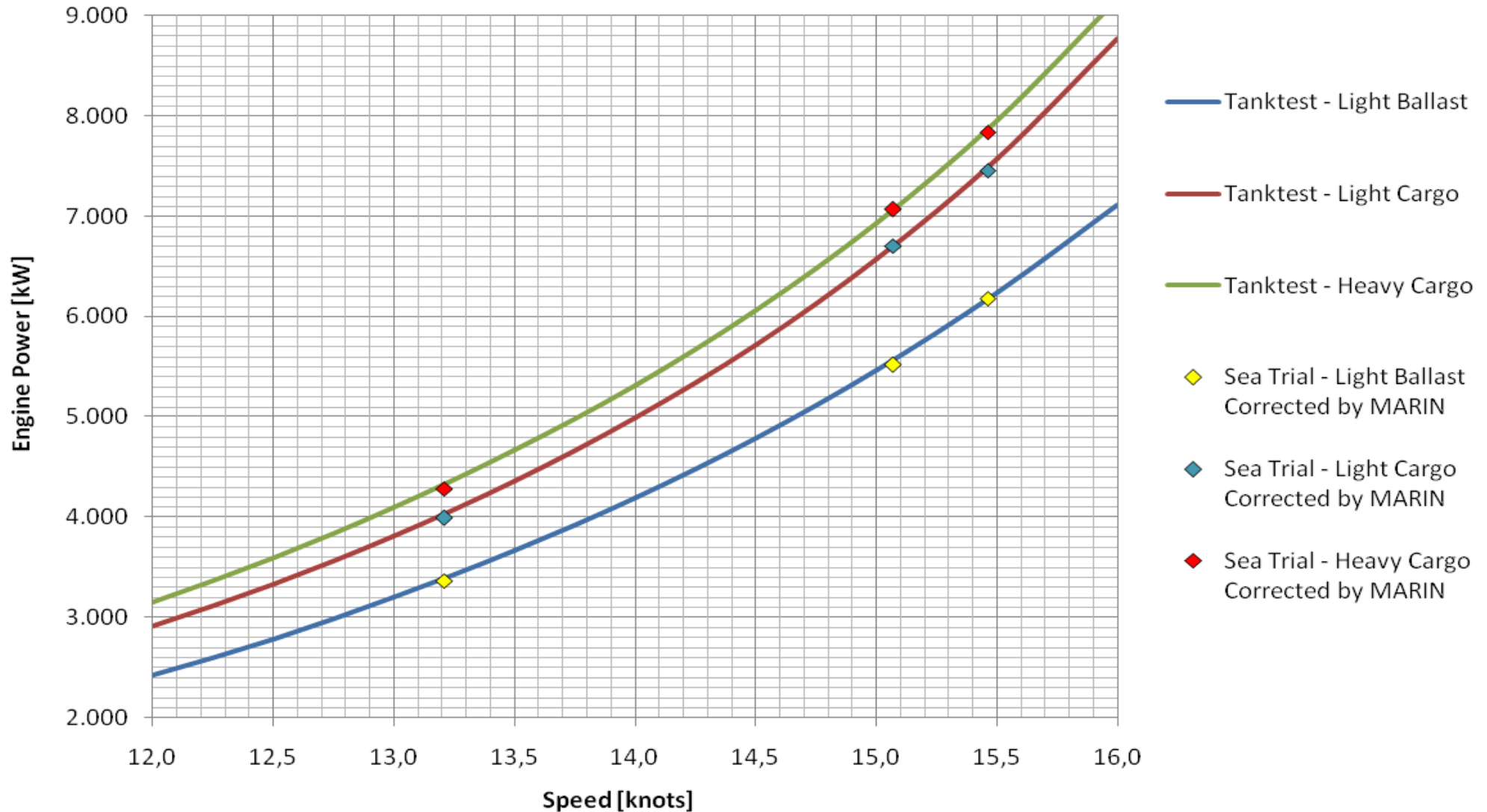
~1% Efficiency Increase

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Tanktest vs Sea Trial

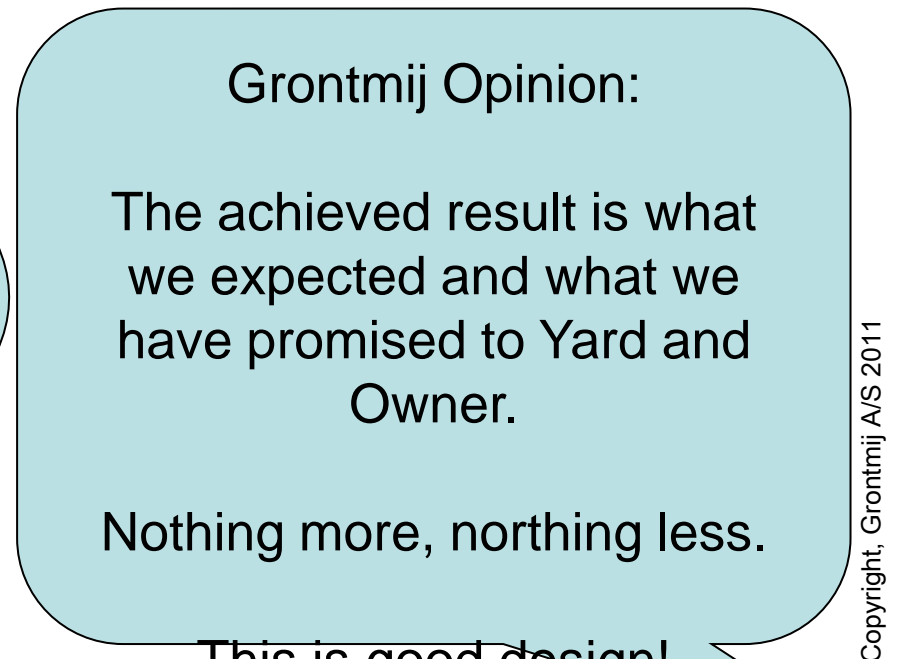
SEAHORSE 35 - FORCE Tanktest vs DDHI DD017 Sea Trial





Tanktest vs Sea Trial - 3

- Conclusion: The measured result is “SPOT ON” the expected values measured in the model test basin.
- The test result confirms that we have obtained very accurate correlation between model test and full scale.



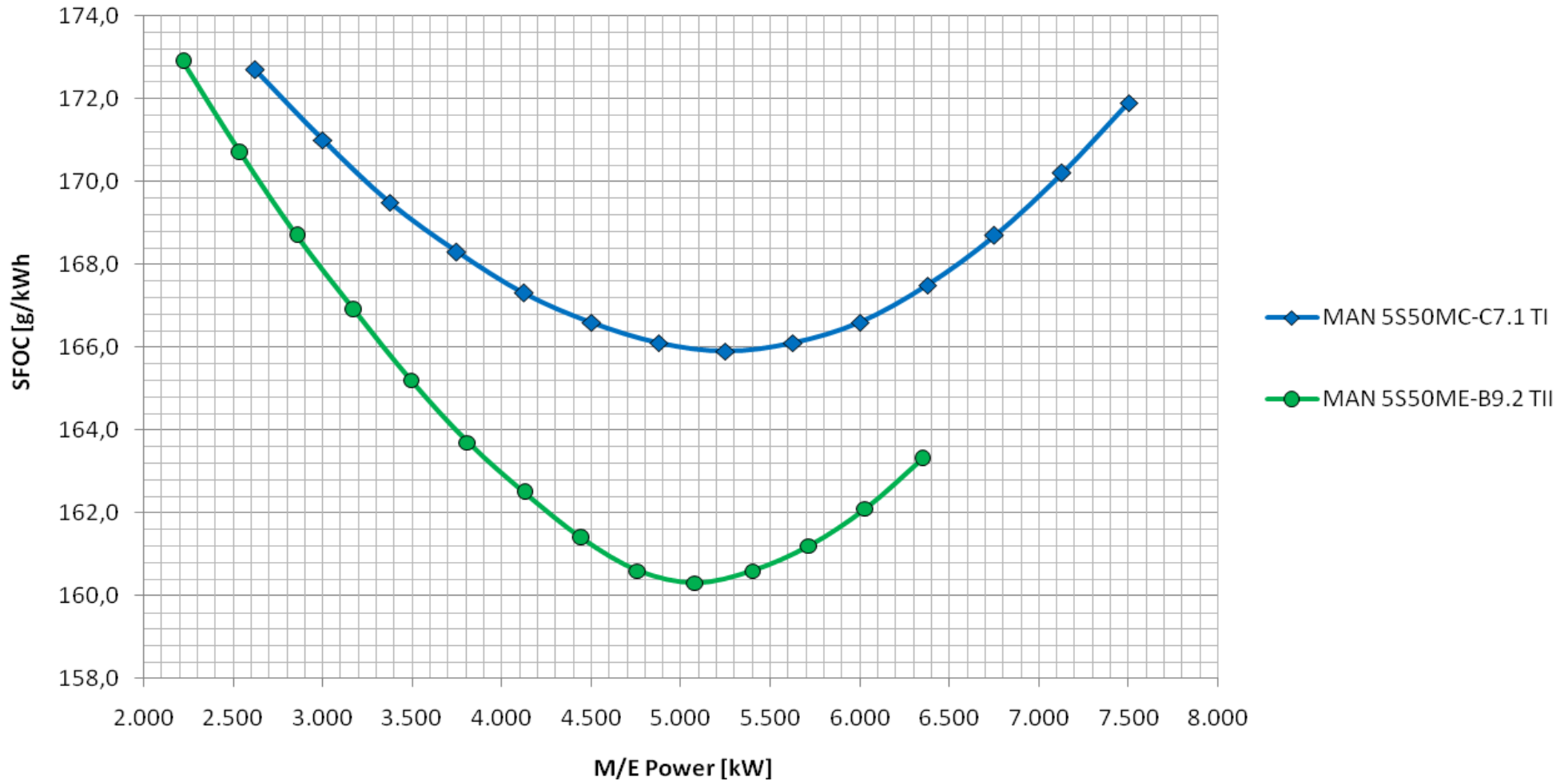
This is good design!

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Fuel Oil Optimization

MAIN ENGINE - Specific Fuel Oil Consumption (SFOC)



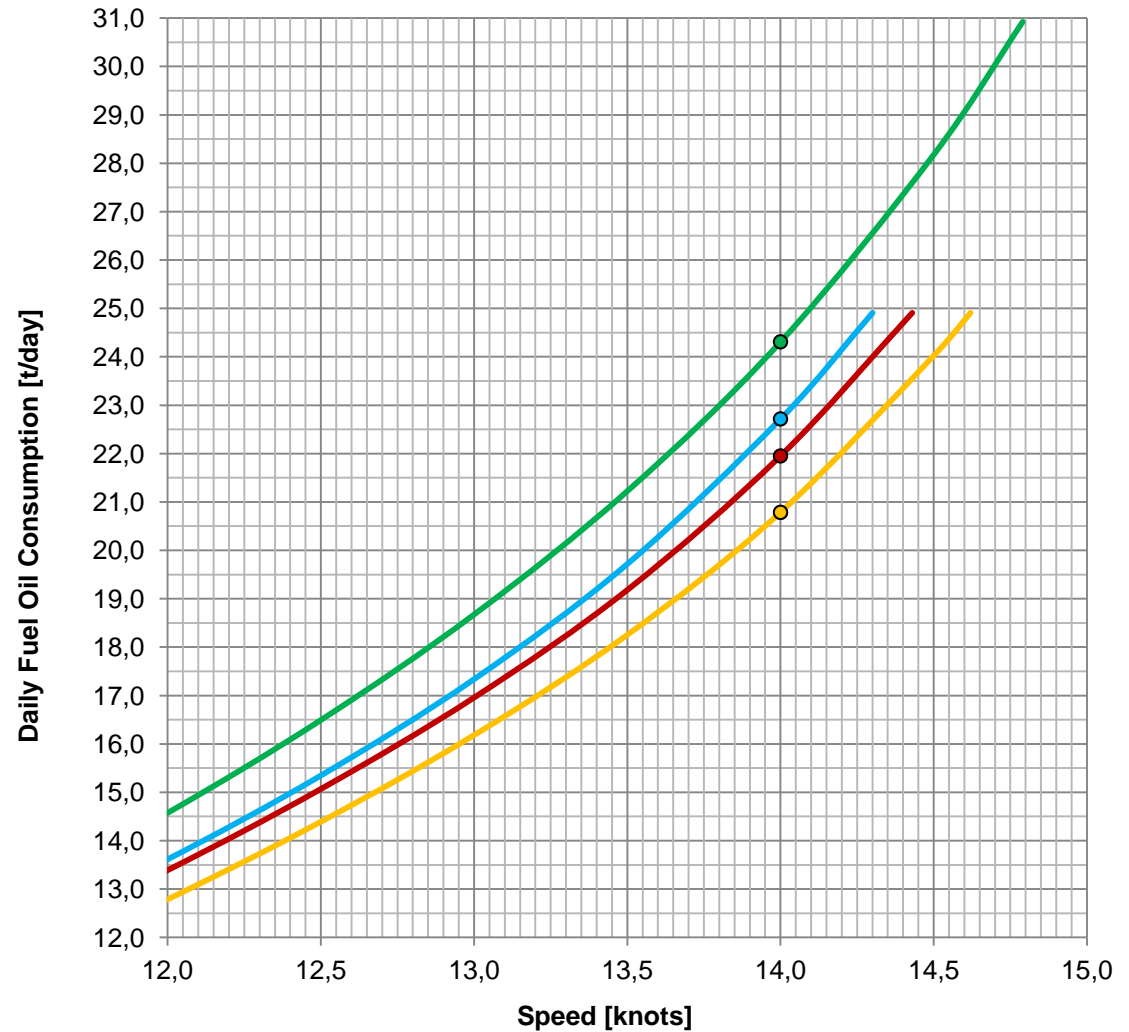


Fuel Oil Optimization

SEAHORSE 35

Daily Fuel Oil Consumption (MDO, 42.700 kJ/kg) at Scantling Draft (T = 10,1m) incl. 15% Sea Margin

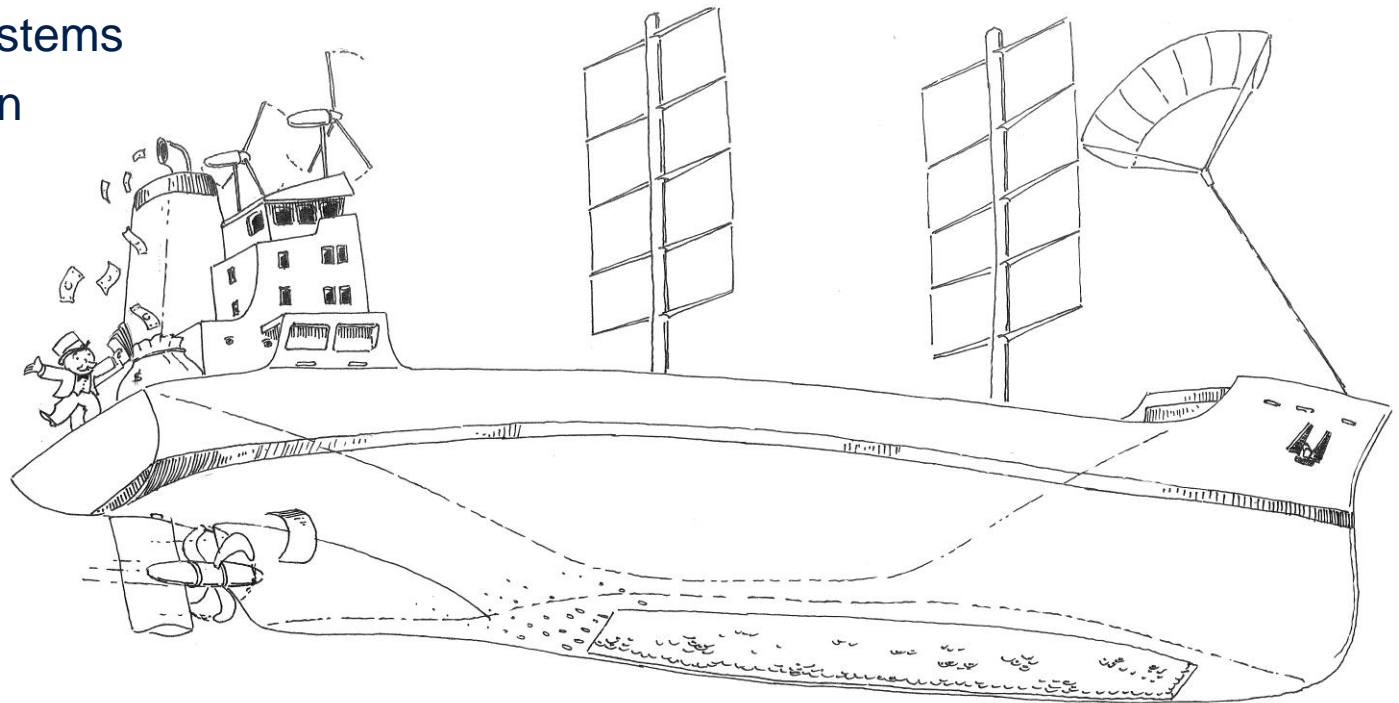
- Green line:** M/E: MAN BW 5S50MC-C7.1 TI
SMCR 7.500 kW @ 121 RPM
5,54 m NPT Propeller
● 24,3 t/day
- Blue line:** M/E: MAN BW 5S50ME-B9.2 TII
SMCR 6.350 kW @ 110 RPM
5,8 m Wärtsilä Propeller
● 22,7 t/day
- Red line:** M/E: MAN BW 5S50ME-B9.2 TII
SMCR 6.350 kW @ 99 RPM
5,9 m NPT Propeller
● 21,9 t/day
- Yellow line:** M/E: MAN BW 5S50ME-B9.2 TII
SMCR 6.350 kW @ 99 RPM
5,9 m NPT Propeller
MEWIS Duct + PBCF (-5%)
● 20,8 t/day



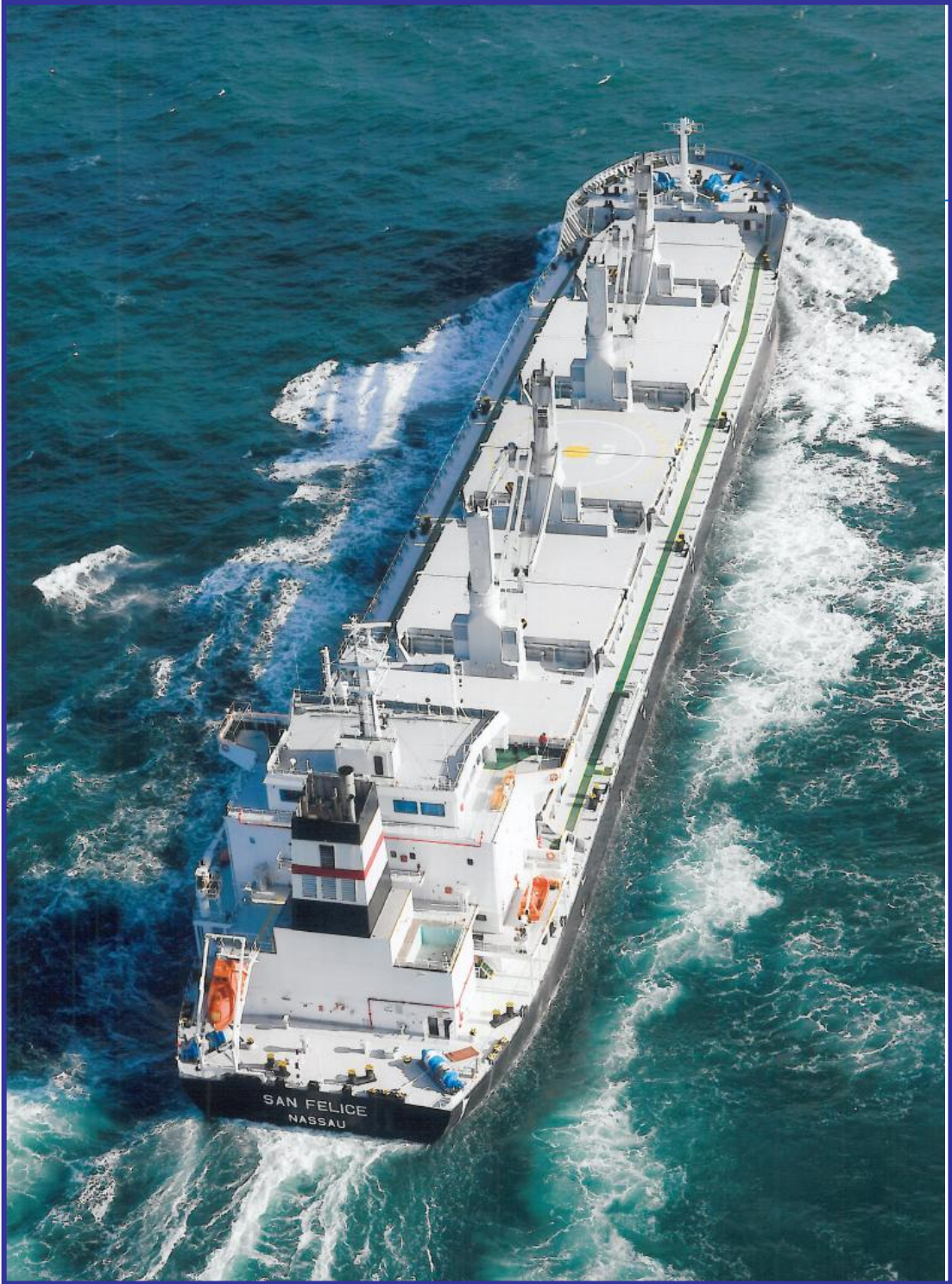


Future developments

- Sails
- Solar Cells
- Fuel Cells
- Using weather forecast to optimize route planning
- Low friction systems
- New painting systems
- Trim optimization



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THE END

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planning connecting
respecting
the future