
“Study on the Use of LNG as Marine Fuel due to the Strengthened Maritime Environmental Regulations” Based on Performance Analysis

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Green Energy Center

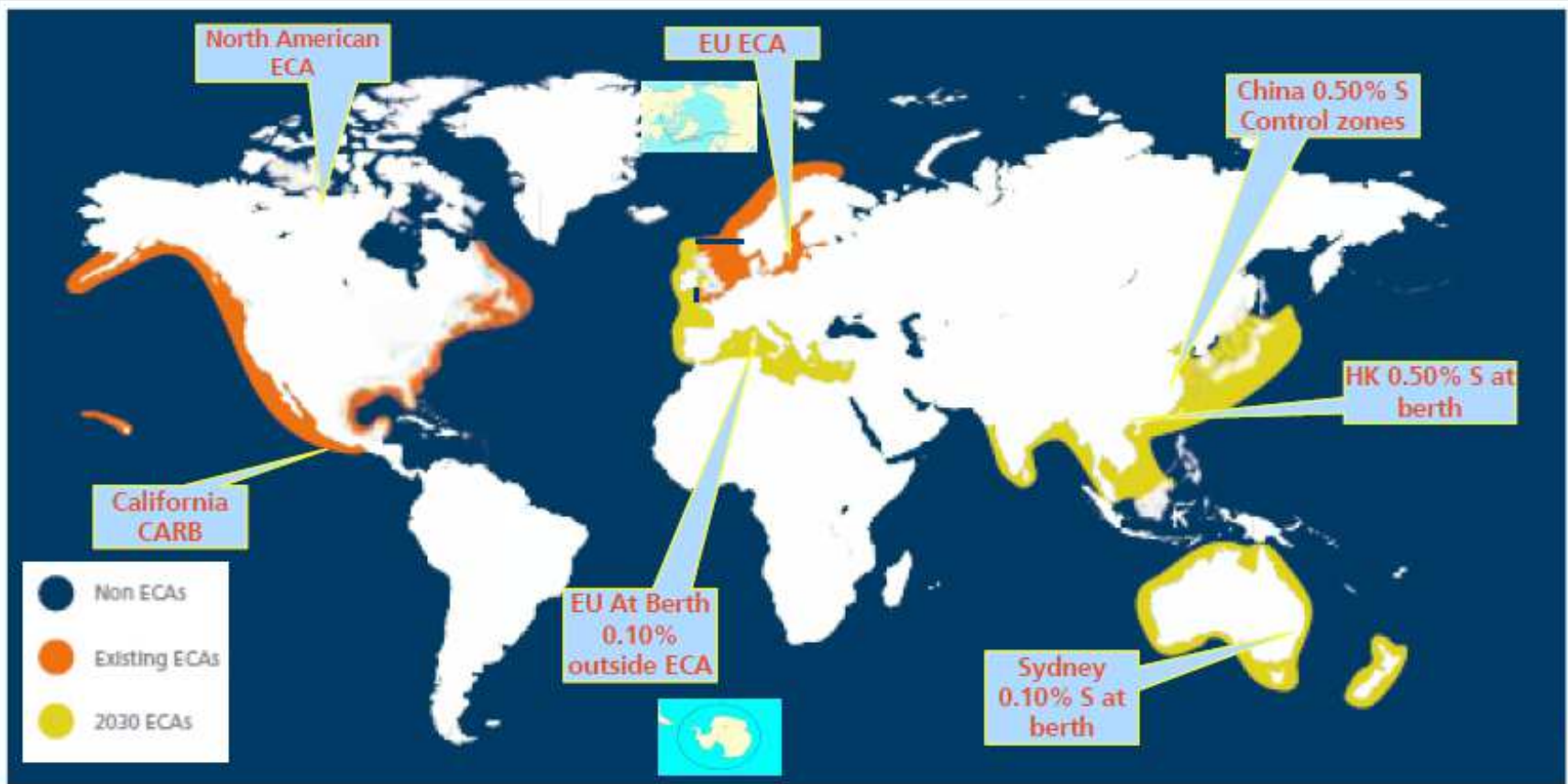
Korea Maritime and Ocean University

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Introduction : Emission Control Areas



Enforcement of current controls already in place in established ECZ's – practised for 0.50%

FOBAS



Source: LR FOBAS, 08. 2018

Introduction : Technology Developments



- ✓ After Treatment: Scrubber
- ✓ Change Fuel: LNG, Low Sulphur fuel
(less 0.5% of Sulphur)



- ✓ Change fuel: LNG or Gaseous Fuel
- ✓ Primary: Engine Tuning(Limited Extent)
- ✓ After Treatment: SCR, EGR

Otherwise fundamental solution is to change fuel to LNG or similar.

Introduction

: Supports from Ports

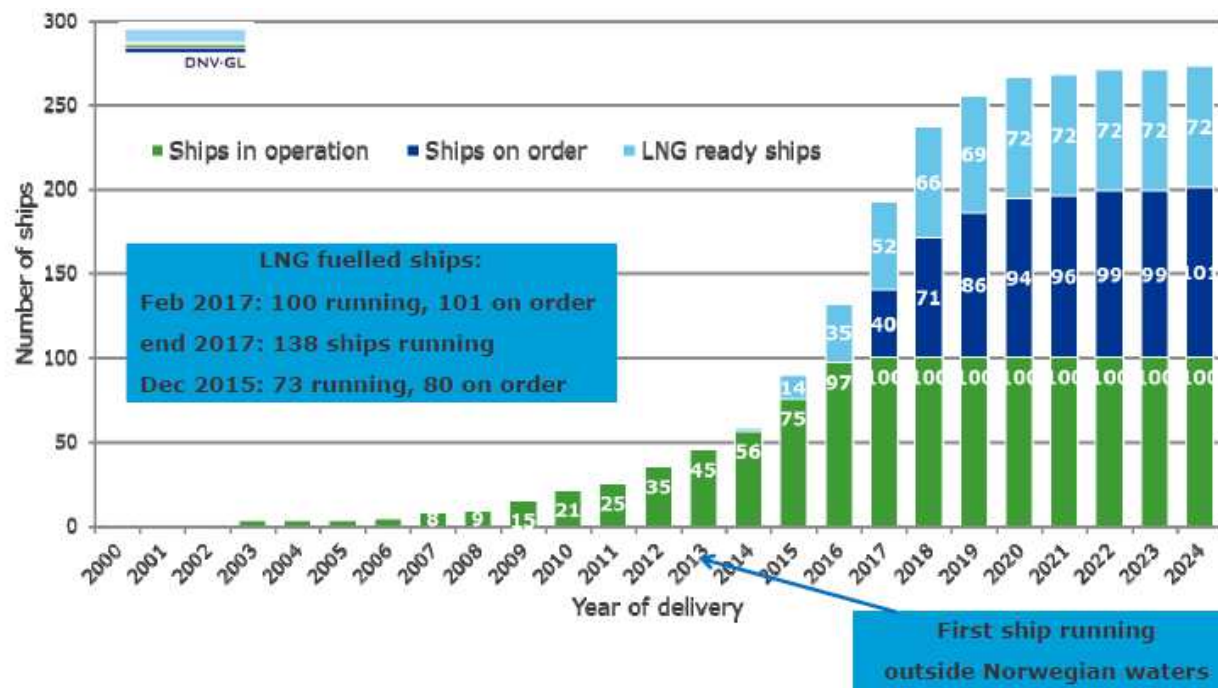
Port	ESI(Environmental Ship Index)	Contents
Port of New York and New Jersey	20 or more	Financial support
Port of Yokohama	30 or more	15% discount on entering, departure fee
Port of Gothenburg	30 or more,	30% discount on port usage for LNG fueled ships (It will be applied until December 2018 and will be reduced by 20% in 2019 and 10% in 2020)
Port of Rotterdam	31 or more/ Eco-friendly vessel	- 10% discount on entering, departure fee - 20% discount on port usage for seagoing vessels-ESI-NOx Score 31.0 or more(LNG fueled vessels included)
Port of Bremerhaven	31 or more	10% discount on entering, departure fee
Port of Antwerp	31 or more	10% discount on entering, departure fee
Port of Los Angeles	Depends on it's score	30~34 Score: 750 U. S dollar incentive
Port of Hamburg	50 or more	Max 2,000 Euro support

*Environmental Ship Index : ESI, established in 2011, is an international program developed through the World Ports Climate Initiative (WPCI) of the International Association of Ports and Harbors (IAPH). The index weighted the environmental Performance of vessels based on their Sulphur oxide, nitrogen oxide emissions and carbon performance.

Introduction

: LNG as Marine Fuel

- ✓ Ships in Operation: 119
- ✓ Ships on Order: 125
(388 - High pressure: 248, Low pressure: 140_as an accumulated reference including order*)
- ✓ LNG Ready Ships in Operation and on Order: 114



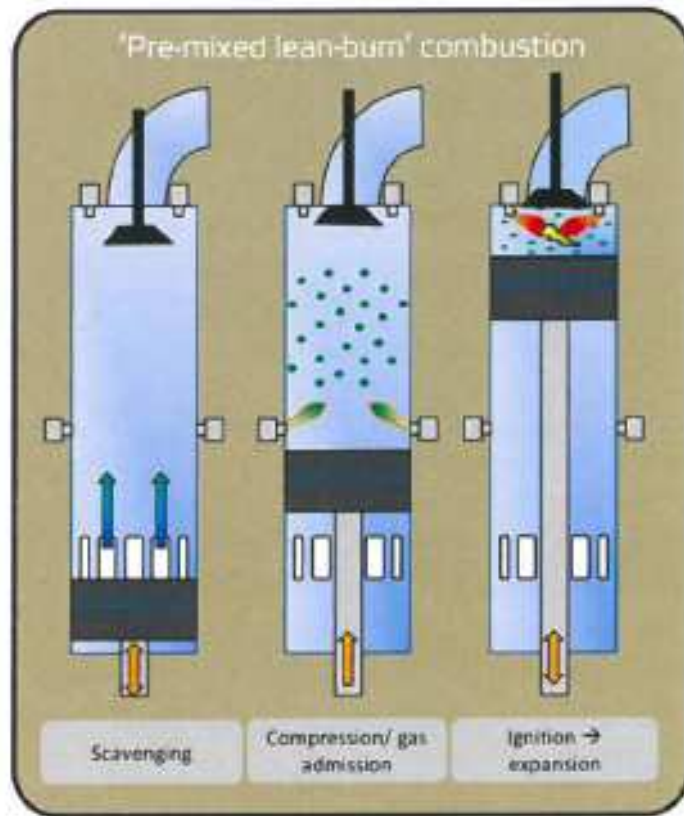
Source: SEA/LNG, 09. 2018

DNV-GL, 2017

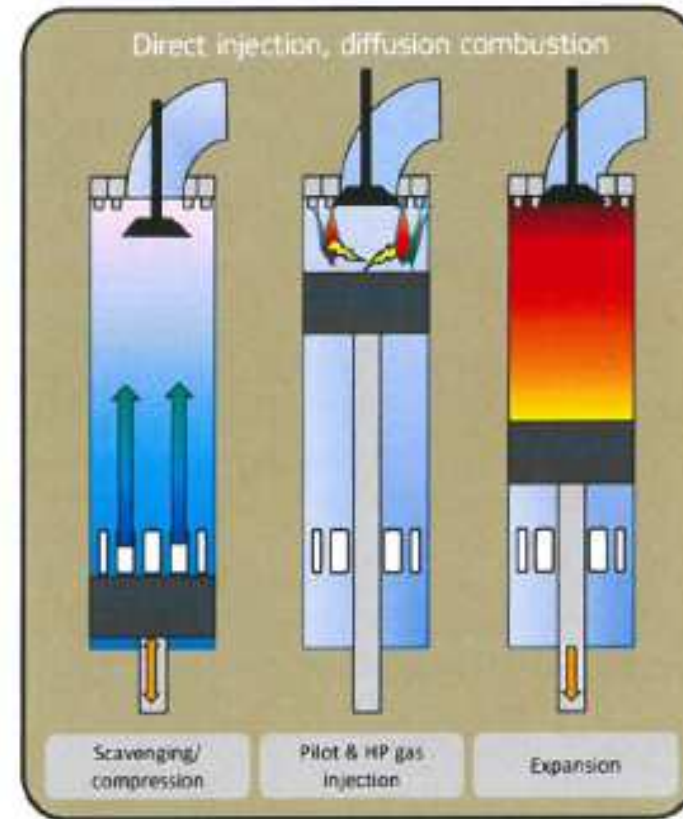
* Cited discussion on CIMAC Congress 09. 2018

Introduction

: Low-speed Dual-fuel Engines



Low pressure gas injection with lean-burn Otto cycle combustion process (WIN-GD)



High pressure gas injection with Diesel cycle combustion process (MAN ES)

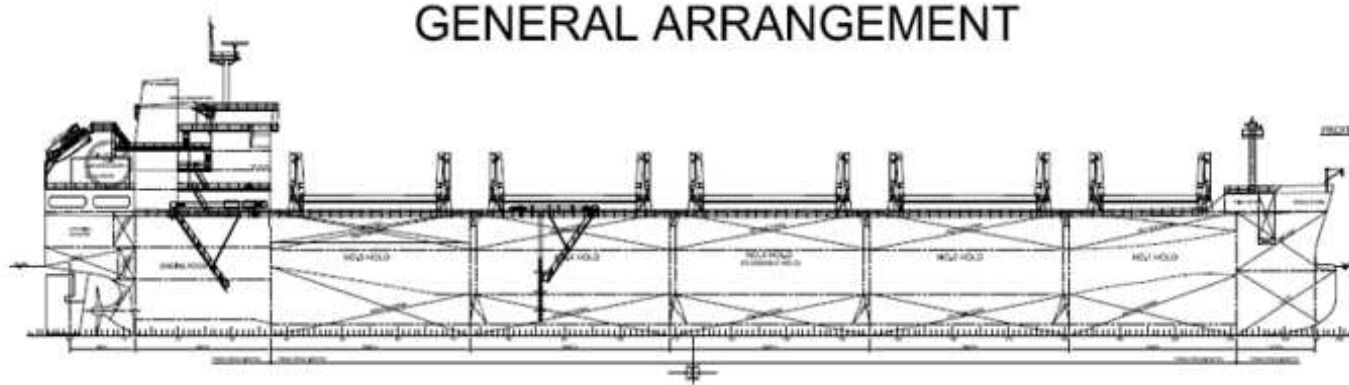
Performance Analysis

: LNG Fueled dwt 50,000 tons Bulk Carrier with High-Mn tank

The MV "Ilshin Green Iris"

The First IMO IGF Code applied Ship !

GENERAL ARRANGEMENT



Design Draft : 10.15 m
Scantling : 12.00 m
Speed : 14.0 Knots
DWT : 50,000 Tons
L.O.A. : 191.00 m
L.B.P. : 184.00 m
Breadth : 32.26 m



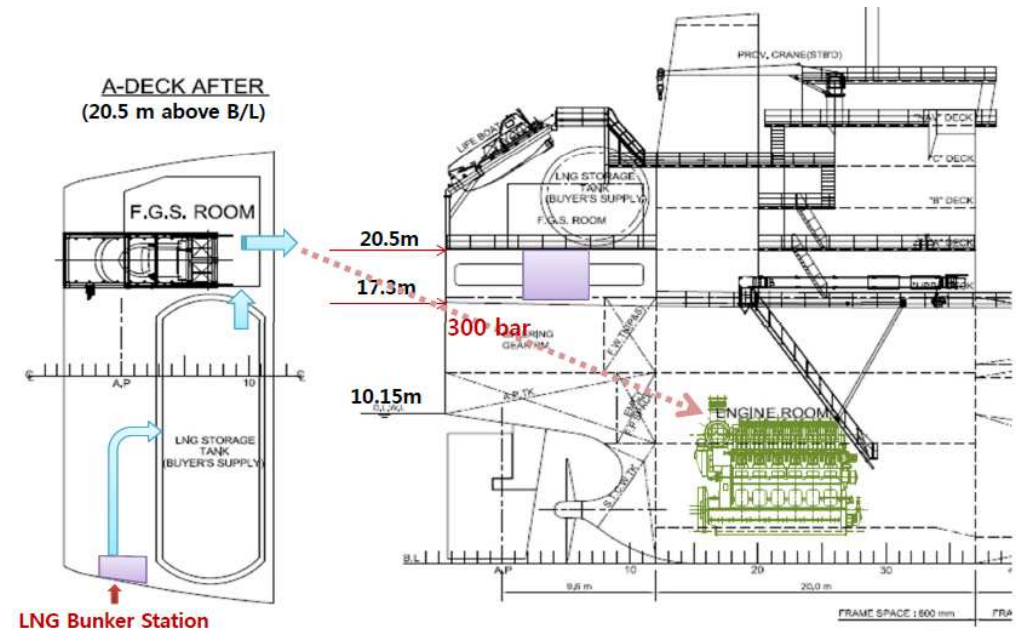
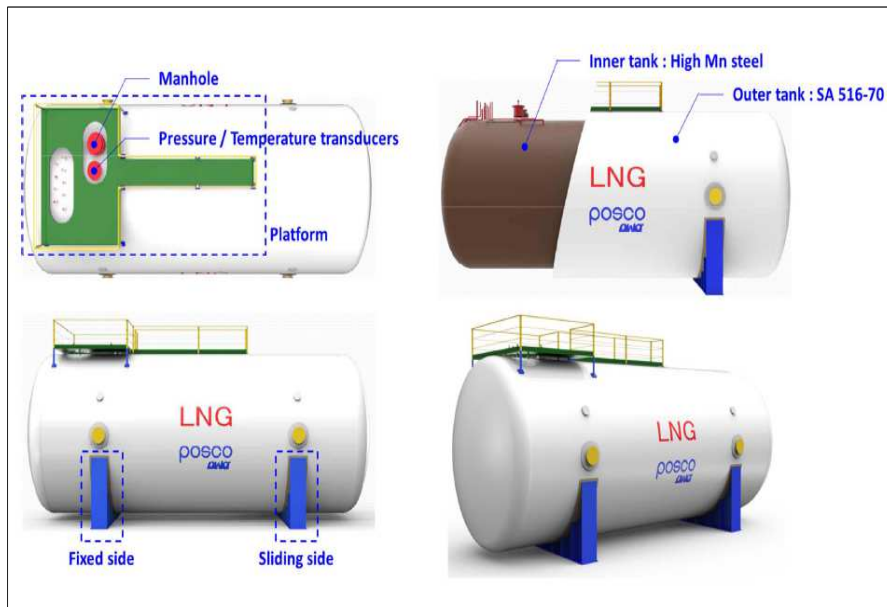
Performance Analysis

: High-Mn type 'C' LNG tank

Why High-Mn?

High-Manganese steel meets all mechanical requirements and characteristics corresponding to Nickel and resources are available widely on the globe.

→ The use of High-Mn steel was reported by the IMO at IMO CCC 5 (10~14 September 2018)

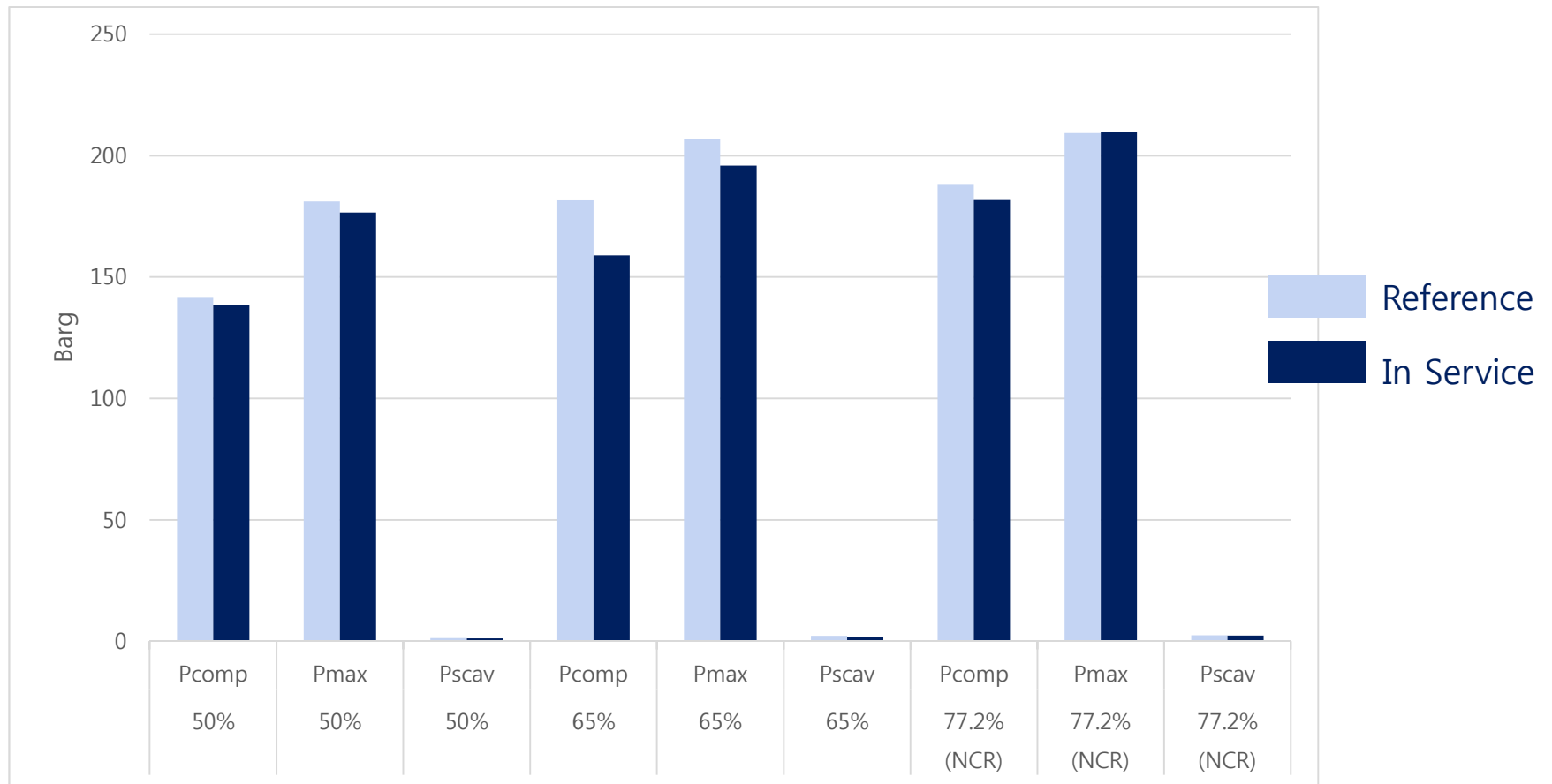


Source: Ilshin shipping, 2017

Performance Analysis

: Engine Performance

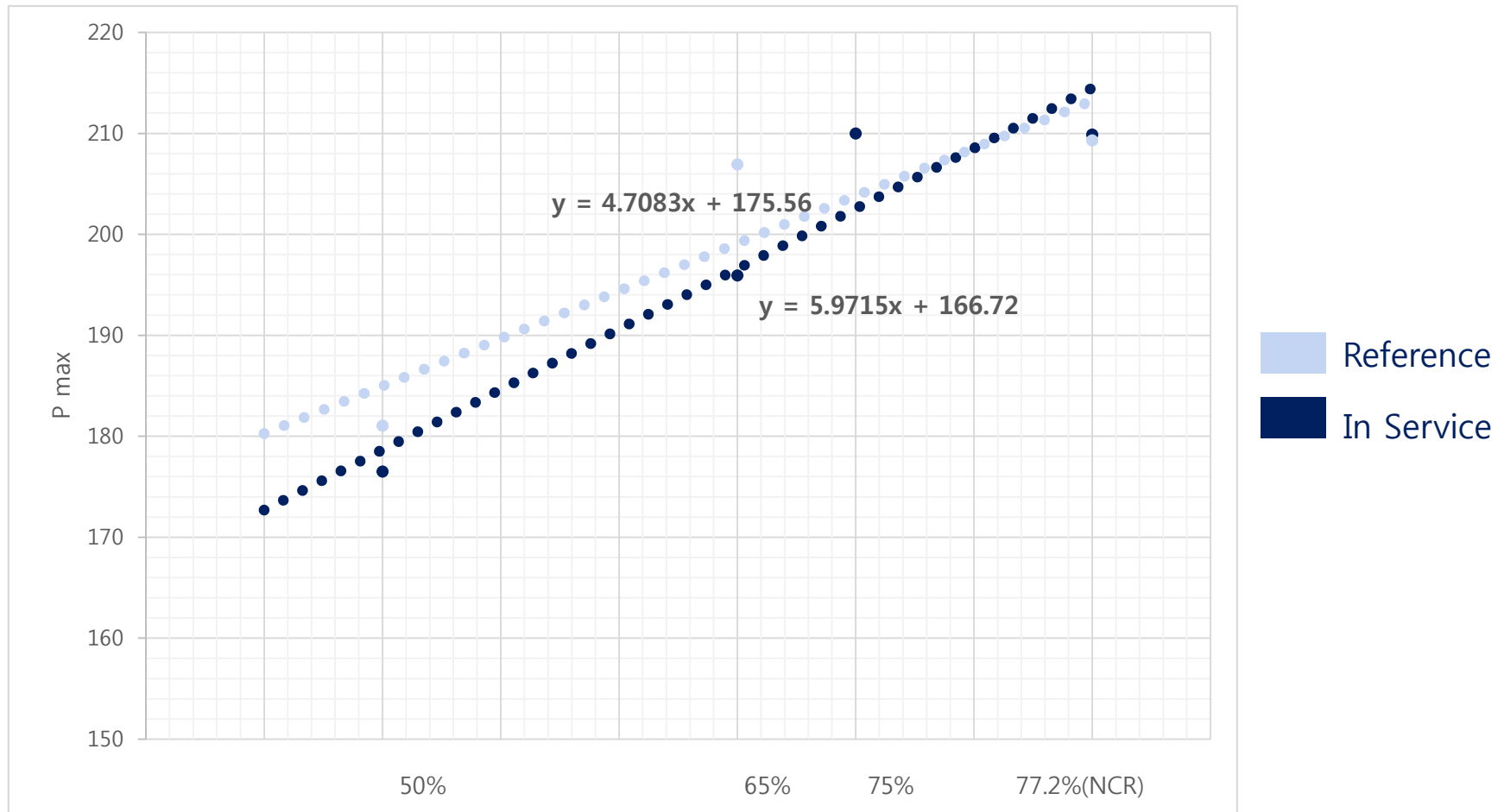
Main Engine: MDT 6G50ME-C9.5-GI, Tier II
(MCR: 7,250 kW x 88.7 RPM/ NCR: 5,597 kW x 81.4 RPM)



Averaged Pressure Measurements at Various Engine Loads in ISO conditions

Performance Analysis

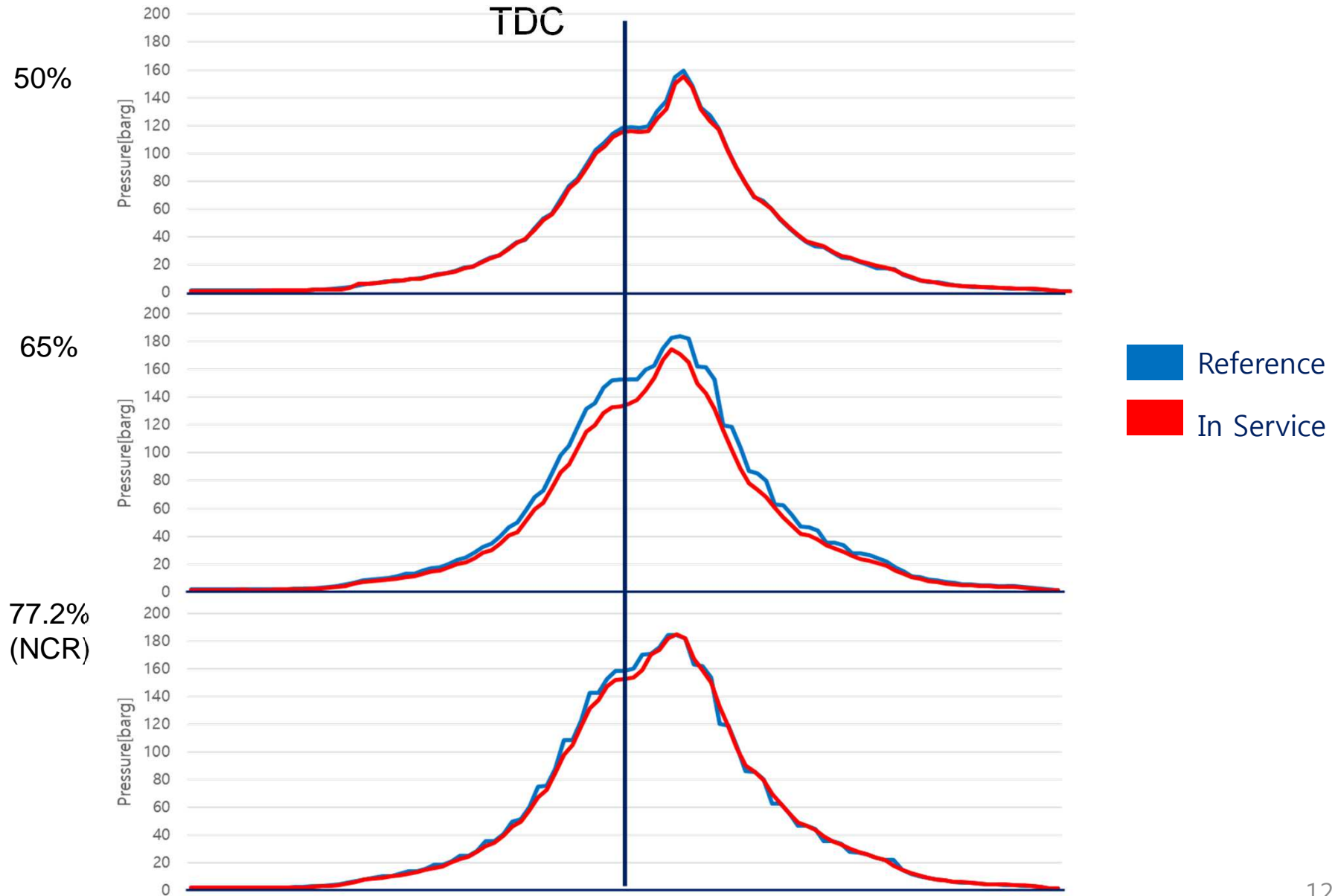
: Engine Performance



Maximum combustion pressure at various engine loads in ISO conditions

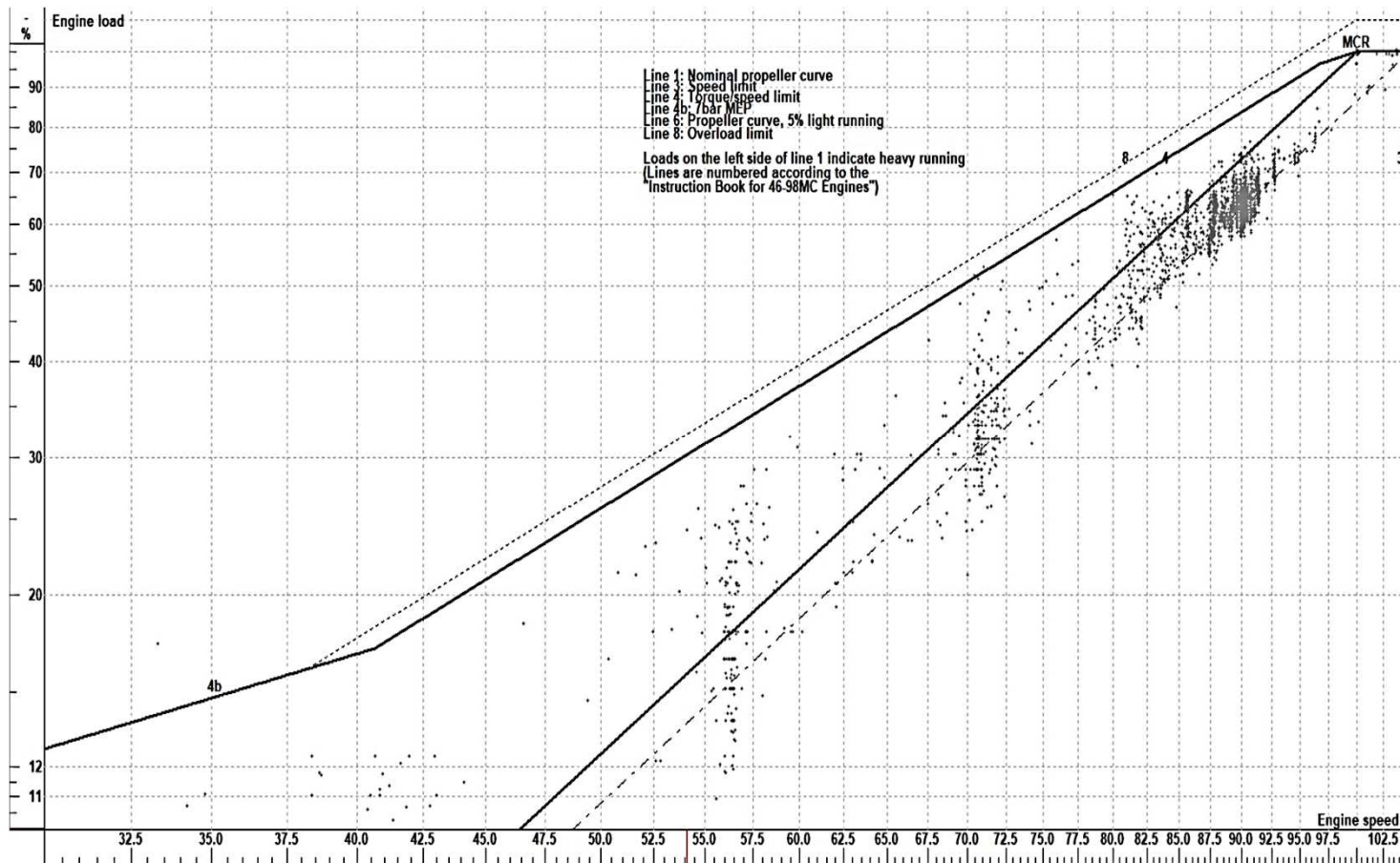
Performance Analysis

: Engine Performance



Performance Analysis

: Overall Performance



Engine Load Diagram and Measurements (MDT CoCos EDS)

Conclusions

: LNG as Marine Fuel

- ✓ LNG combustion is as operationally efficient as HFO. Yet, LNG combustion characteristics are different from HFO, but minor.
- ✓ Dual fuel engines perform nearly as equal as conventional marine engines.
- ✓ LNG High-pressure system is operationally safe.
- ✓ High-Mn LNG tank performs as equally operational and safe as conventional LNG tank.

Introduction Greener Team

Thank you!



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