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Installation of EGC (scrubber) and EGR on
Clipper Harald; Fleet Director Tor Øyvind Ask

Agenda



- Solvang
- Clipper Harald
- EGC + EGR project

A family controlled company – traditional – innovative – a long term shipping partner



7 VLGC



9 LGC



1 MGC



6 (+4) Ethane / Ethylene



- Listed on Oslo stock exchange since 1936
- 65 % owned by Steensland Brun family
- A long term industrial shipping partner

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Solvang fleet list – 27 vessels



Ethylene / Ethane	LGC / MGC	VLGC
 Clipper Viking – 12.600cbm, 1998	 Clipper Star – 59.300cbm, 2003	 Clipper Sun – 82.000cbm, 2008
 Clipper Harald – 12.600cbm, 1999	 Clipper Moon – 59.300cbm, 2003	 Clipper Sirius – 75.000cbm, 2008
 Clipper Hebe – 17.000cbm, 2007	 Clipper Sky – 59.300cbm, 2004	 Clipper Victory – 75.000cbm, 2008
 Clipper Helen – 17.000cbm, 2007	 Clipper Orion – 60.000cbm, 2008	 Clipper Quito – 84.000cbm, 2013
 Clipper Hermes – 17.000cbm, 2008	 Clipper Neptun – 60.000cbm, 2008	 Clipper Posh – 84.000cbm, 2013
 Clipper Hermod – 17.000cbm, 2008	 Clipper Mars – 60.000cbm, 2008	 Hull 2888 – 78.800cbm, 2017
 Hull 8258 – 21.000cbm, 2019	 Clipper Jupiter – 60.000cbm, 2015	 Hull 2889 – 78.800cbm, 2017
 Hull 8259 – 21.000cbm, 2019	 Clipper Saturn – 60.000cbm, 2015	
 Hull 8260 – 21.000cbm, 2019	 Clipper Venus – 60.000cbm, 2015	
 Hull 8261 – 21.000cbm, 2019	 Clipper Odin – 38.000cbm, 2005	

A shipping partner with all core elements in-house, not outsourced to management companies



A fully integrated shipping company, with technical expertise, crewing and commercial in-house



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Solvang Gas Carrier for the future EGR Project



- Solvang started to work with LPG carrier for the future in 2010
 - Type of fuel
 - Design criterias
 - Lowest possible fuel consumption and exhaust gas emmisions.
 - Low opex
- 2011 ordering of Clipper Quito/Clipper Posh
- Clipper Quito awarded as the first ECO LPG carrier in 2013.
- Clipper Quito first LPG tanker in the world equipped with full scale Exhaust Gas cleaning and full term IAPP certificate with EGC
- Clipper Harald upppgrade Retrofit 2014-2015
- Clipper Jupiter, Clipper Saturn and Clipper Venus 2015
- Clipper Freeport and Clipper Vanguard 2017

Clipper Harald



Built 1999

Cargo capacity 12600 M3, –
104 C

Length 146 m

DW 13700 tonn

Main engine 7800 kW

Aux engine. 3 * 1040 Kw



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NOx Cleaning



- If we could combine the Exhaust gas cleaning system with Exhaust Gas Resirculation we would have a very simple and low cost Nox control system.
- Solvang has 6 Vessel with EGC
- Discussion with MAN and Wartsila 2011/2012
 - MAN has High Pressure EGR and not resources for developing Low Pressure EGR.
 - But could act as a consultant to Solvang

Clipper Harald EGC+EGR project



- Contract with retrofit of EGC on Clipper Harald end of 2013
- Installation of EGC and Heat recovery on Clipper Harald September/October 2014
- Engine prepared for LP EGR
 - Turbocharger
 - Air receiver
 - Air cooler box

EGR project

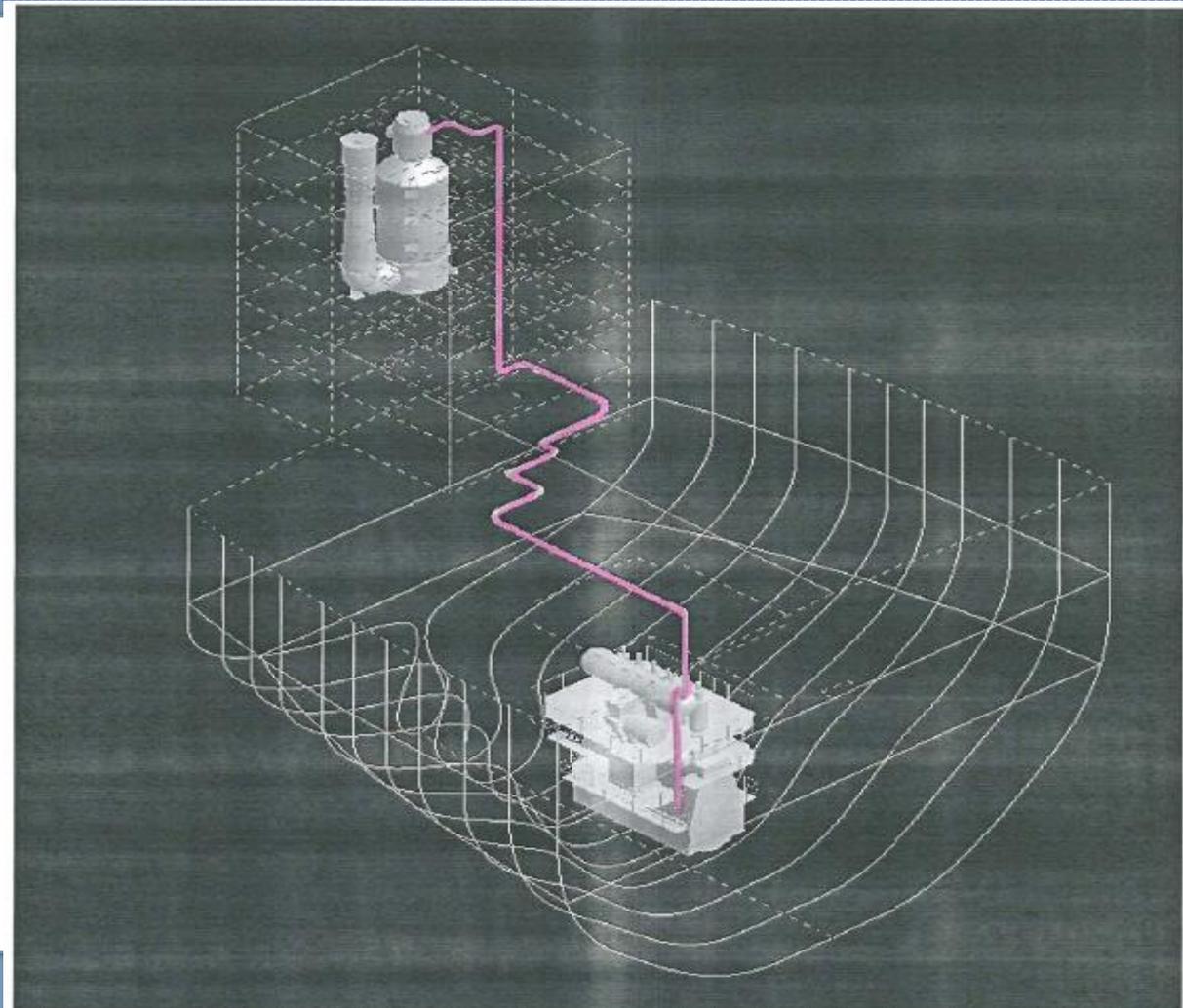


- Clipper Harald (IAPP 12-12-2014)
 - EGC Continuous running since mid December 2014
 - Installation of EGR system Q2 2015
 - Pipes, valves, fan, filter etc.
 - EGR Control system etc
 - Testing summer august – sept 2015
 - Ordinary running since 1 of October
 - MARINTEK NOx measurement end Dec 2015.



- Two main techniques
 - EGR
 - SCR

Solvang EGR: Clipper Harald



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EGC innstallation



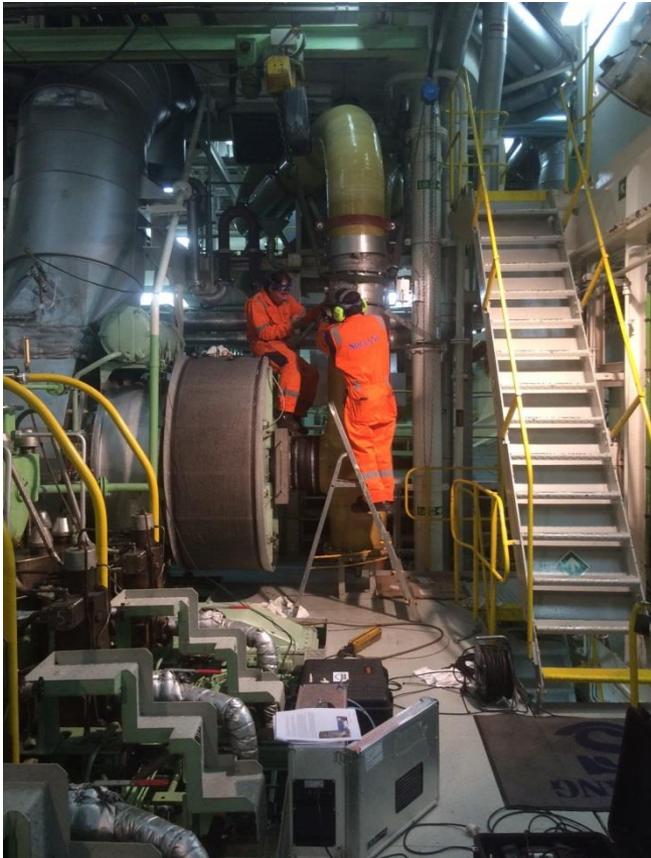
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Remotova Job completed



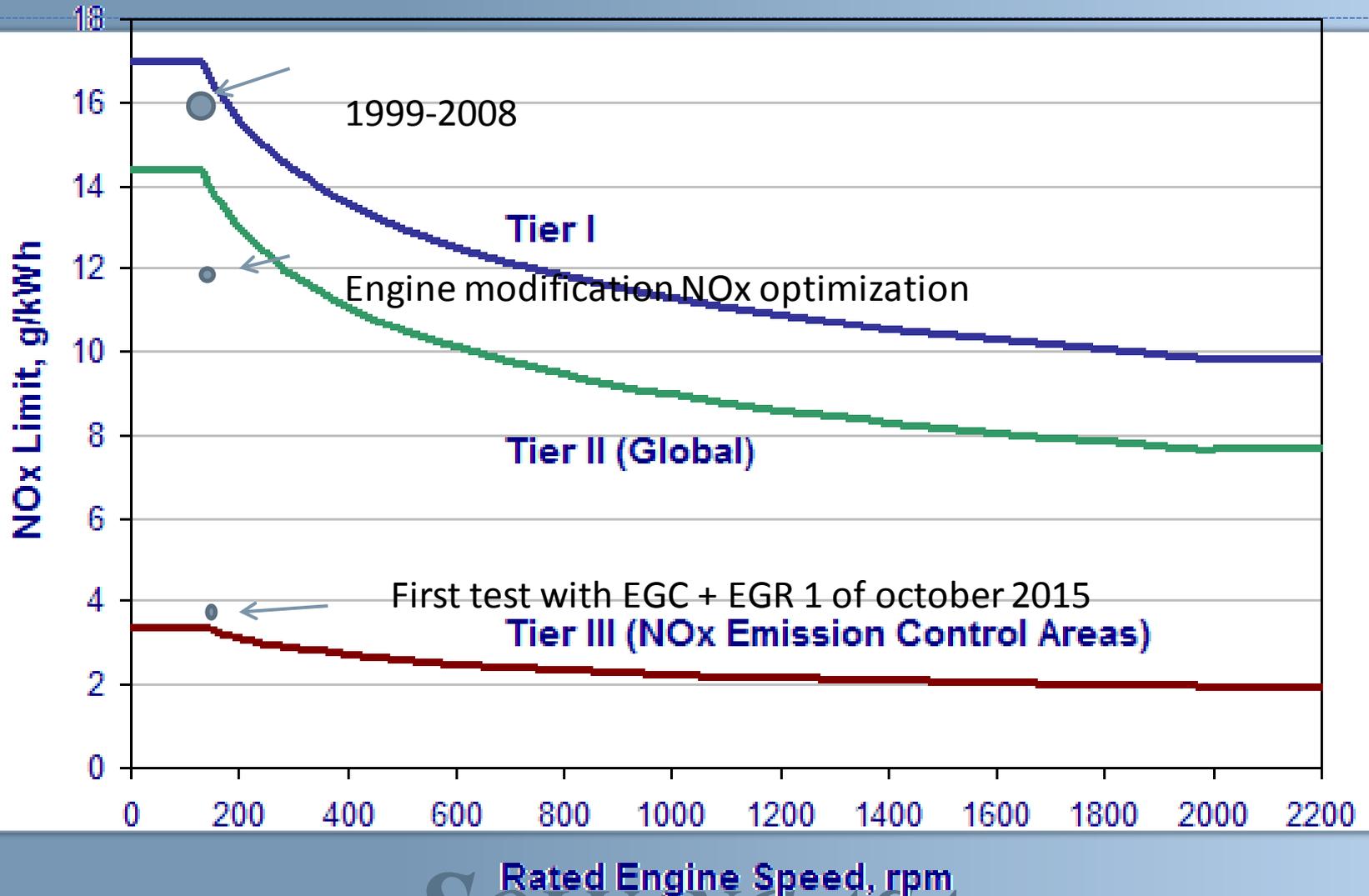
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Turbocharger EGR inlet + EGR outlet



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Clipper Harald



Summary-Conclusion



- Results Mai 2017
 - System designed to run 20 % EGR (need apr 35% too reach TIR III)
 - Technically the systems works very well
 - Need modification to reach TIR III
 - More frequent cleaning of turbocharger and air cooler to ensure good operation
 - Improved partikel removal in EGC will decrease need of cleaning

Furter work

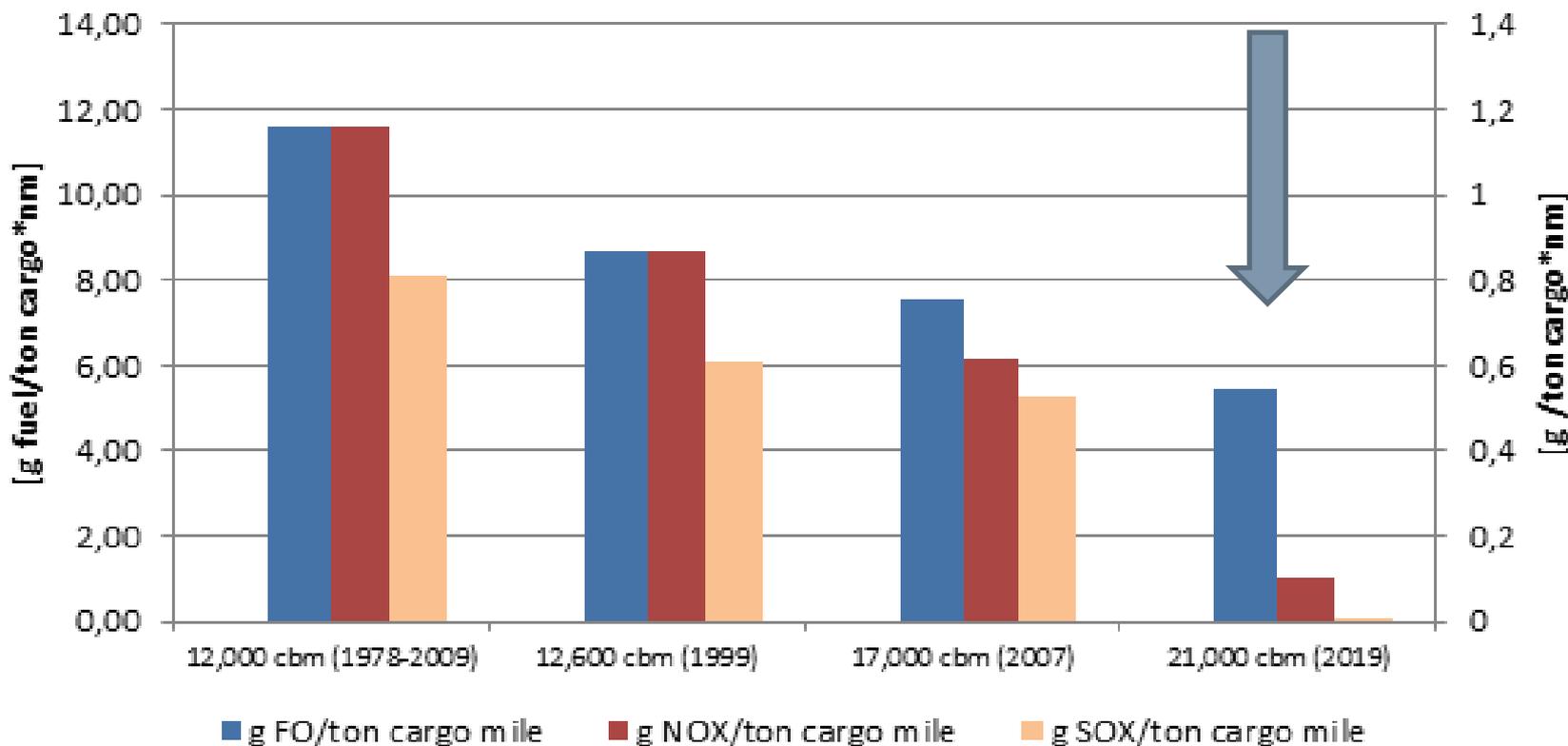


- Continous running to gain long term experience (TIR III Sept 2017)
 - Critical components
 - Compressor wheel (may need another material)
 - Air cooler (need another material)
- Improve EGC soot and SO₃ removal (?)
- Automatisatation of cleaning
 - Compressor and air cooler

4 New Etylen carriers ordered with LP EGR 2019.



**Historical Transport efficiency/emissions - Solvang Ethylene carriers
(Main Engine figures operation on 3,5 % S)**



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Thank you for listening