# Efficiency Optimisation

## Brief Summary of the A.P. Møller-Mærsk Energy Efficiency Initiatives

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**Head of Machinery Section**
**Ship Engineering - Maersk Maritime Technology**

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## Who we are

The A.P. Moller - Maersk Group is a diversified conglomerate, founded in 1904 by Mr. A.P. Møller

110,000 employees and operations in over 130 countries

Headquarters in Copenhagen.

Business segments:

- Container shipping
- Tankers
- Offshore supply services, tugs, ferries
- Oil and gas activities
- Retail activities
- Shipyards and other companies

## Container shipping and related activities

A market leader in worldwide container services, agency, logistics and terminal activities etc.

Under the brand names;
Maersk Line,
Safmarine
APM Terminals

We operate:
~500 container vessels; nom ~1.9 MTEU,
hereof ~200 owned vessels
and more than 50 terminals.

## Tankers, offshore and other shipping activities

Brand names
Maersk Tankers, Maersk Supply Service, Maersk Drilling, Maersk FPSO, Svitzer, Norfolkline

## Oil and gas activities

Maersk Oil participates in;
Production activities in 5 countries
Exploration activities in 14 countries

## Retail activity

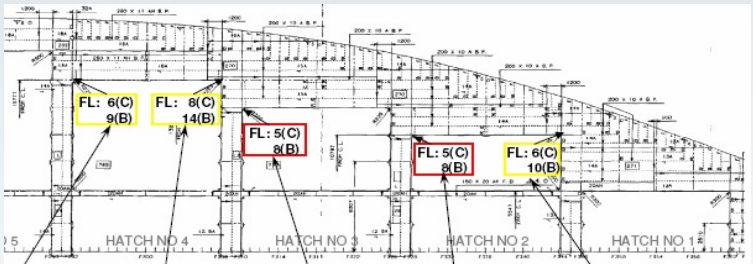
The brand names Bilka, Føtex and Netto operates supermarkets and hypermarkets in 5 countries

## Shipyards, industrial companies and banking

# Maersk Maritime Technology

Corporate function set up to share competencies and services on innovation, vessel performance monitoring, regulatory affairs, technical support, upgrade projects and new-building projects between the shipping related Business Units.

- **Ship Engineering,**
  - Machinery
    - Project management of new building projects
    - Servicing vessels representing more than 300 low speed 2-stroke engines and more than 1800 4-stroke engines




New Container Vessel Design

•

Performance Management

•

WHR systems

•

WHR Performance Benchmarking

•

Optimisation of Turbo Charging

•

Combustion pressure monitoring and control

•

Super Slow Speed Steaming

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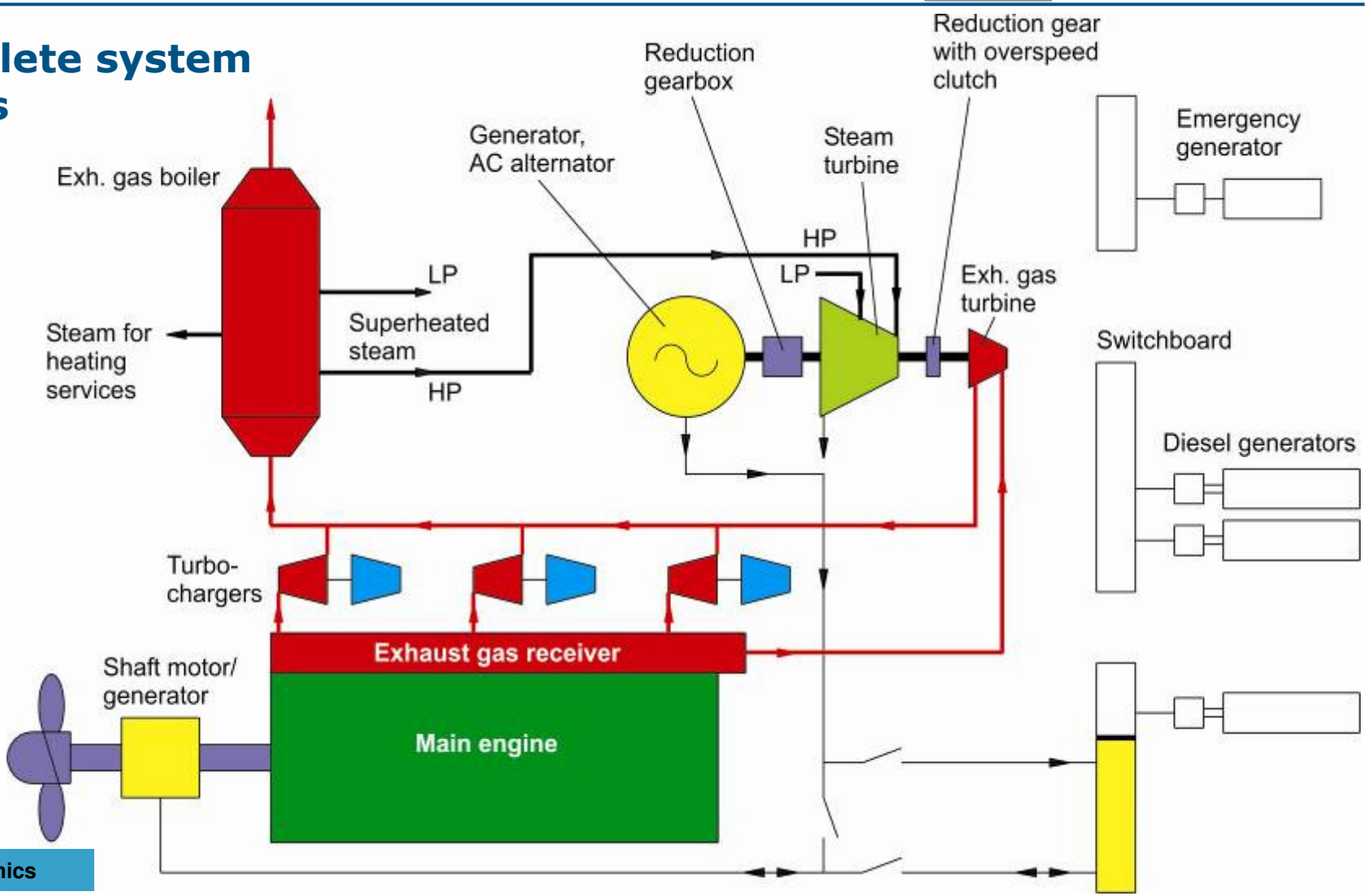
# New Container Vessel design

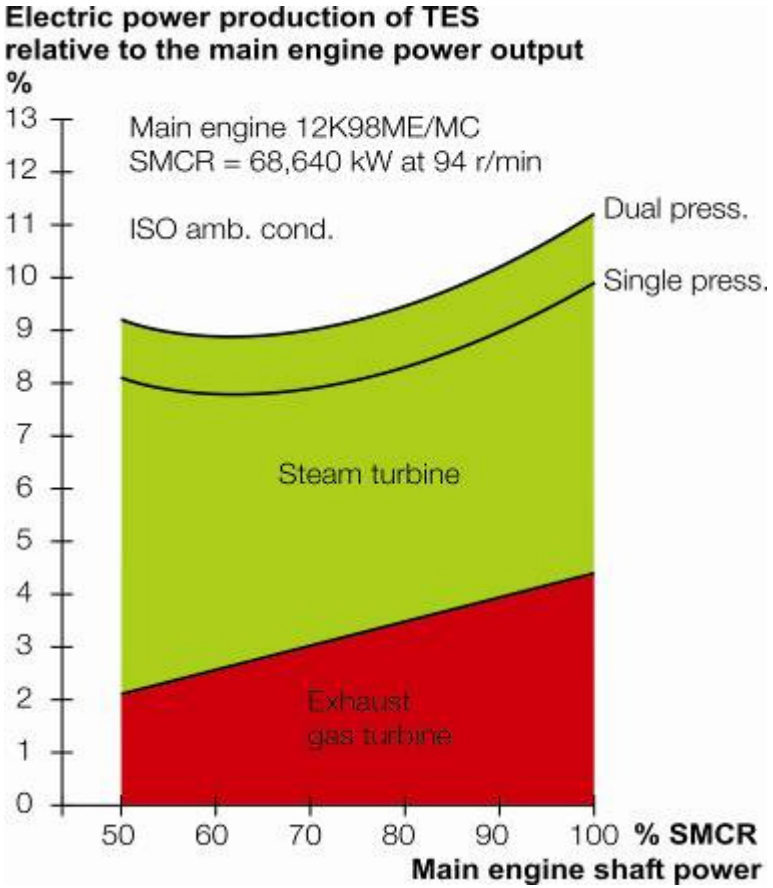
- Slow speed tanker engine
- Hull designed for an operational profile
- Waste Heat Recovery
- In total 22% Efficency improvement

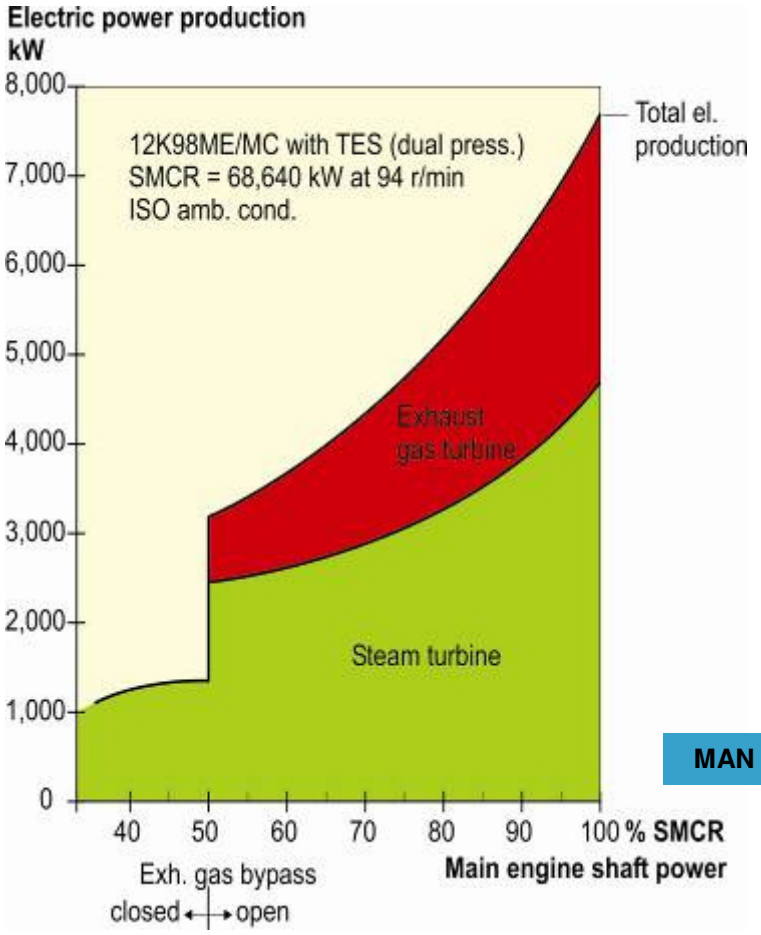
# WHR complete system Schematics




MAN Diesel Graphics

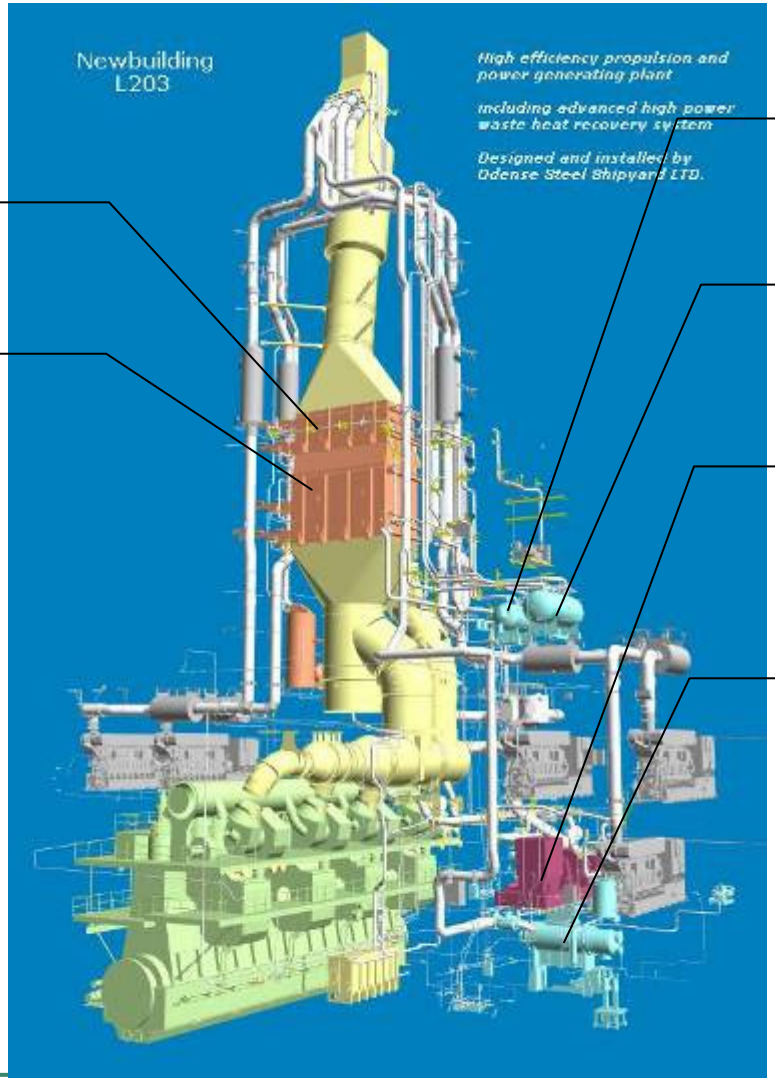
# Theoretical WHR output




MAN Diesel Graphics

# WHR Layout Emma Maersk




LP Boiler

HP Boiler

LP Boiler Drum

HP Boiler Drum

Turbine Unit

Steam Condenser

Odense Steel Shipyard Graphics

# Physical Layout Turbine Unit

Length: 10 meters
Breadth: 3.5 meters
Weight: 58 tons without condenser
Weight: 75 tons with condenser

Peter Brotherhood Graphics

# A.P. Møller-Maersk fleet of WHR vessels in operation



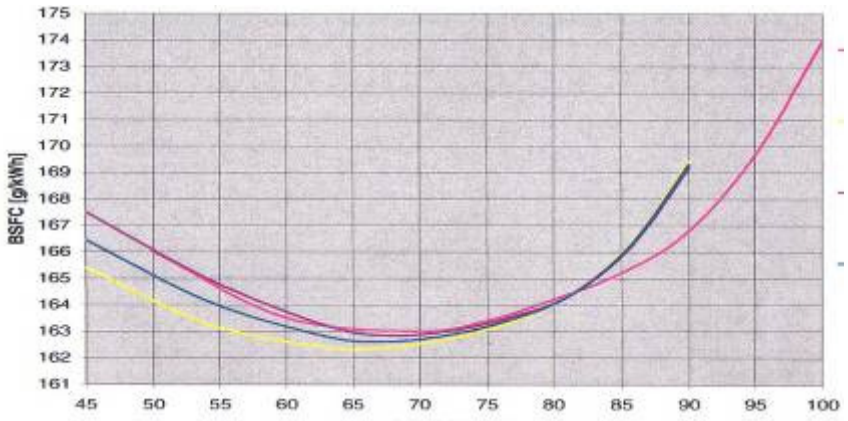
| M-Class, 3 vessels (Original 11) | G/M-Class 12 vessels | E-Class 8 Vessels |
|---|---|---|
| Build 1988 – 1990 at Odense Steel Shipyard Ltd | Build 2005 – 2009 Odense Steel Shipyard Ltd | Build 2006 – 2007 Odense Steel Shipyard Ltd |
| 4300 TEU | 7000 TEU | 11000 TEU |
| MAN B&W 10/12K90MC | Wärtsilä 12RTFlex96C | Wärtsilä 14RTFlex96C |

# A.P. Møller-Maersk WHR vessels in order

| 16 x SAMMAX Container | 22 x WAFMAX Container | 4 x VLCC |
|---|---|---|
| DSME, Korea | Huyndai, Korea | STX, Korea |
| 7450 TEU | 4500 TEU | ~300000 tdw |
| MAN B&W 9S90ME | MAN B&W 6S80ME | MAN B&W 6S90ME |

# TC optimisation, internal parts

## TC matching for low load optimisation

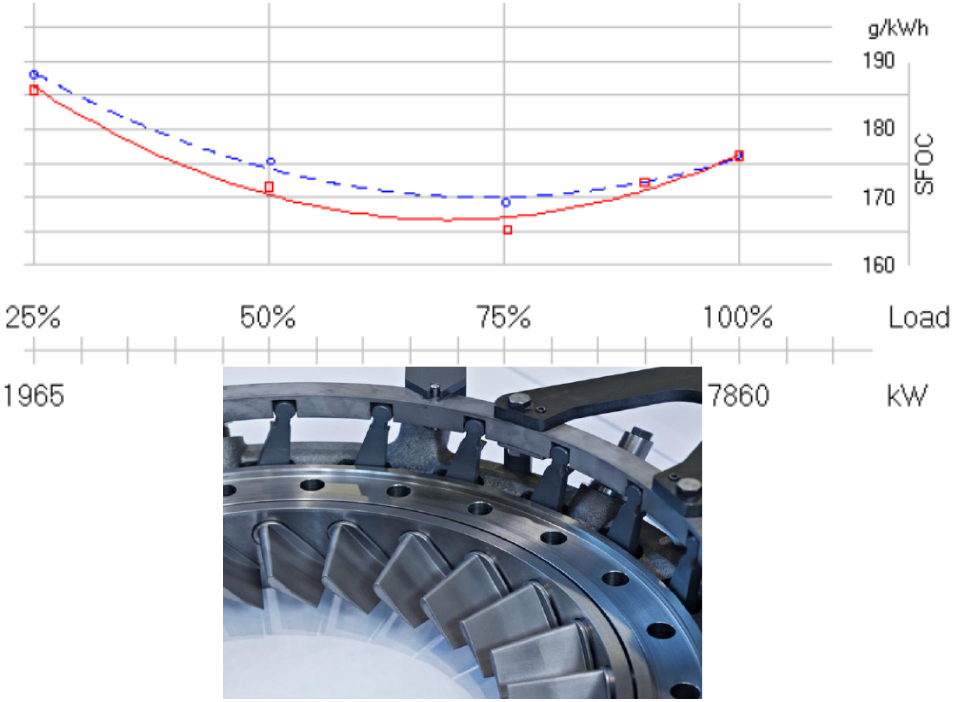



Compromise between optimized low load operation and penalty at high load operation.

One TC matching fits all operational conditions.

Most larger container vessels have been de-rated as retrofit to low load tuning as from 2008

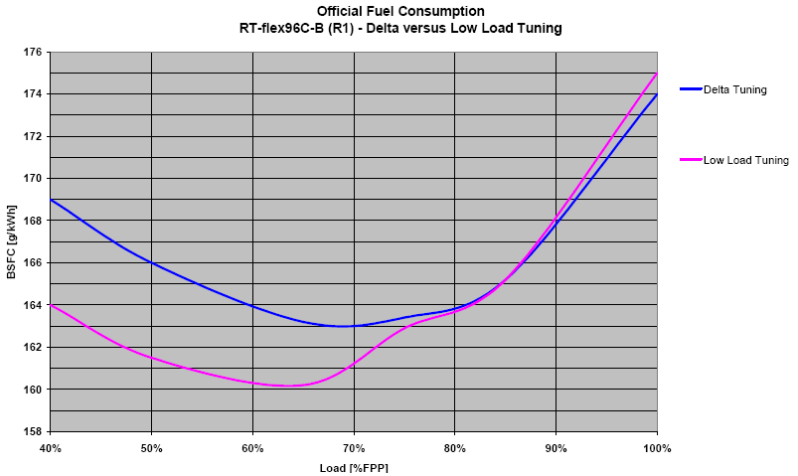
## Variable Turbine Technology

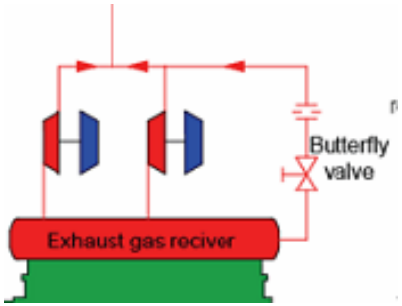



Field test on Maersk Kalea with ABB A175, VTG from April 2009

# TC optimisation, external parts

## Exhaust gas waste gate



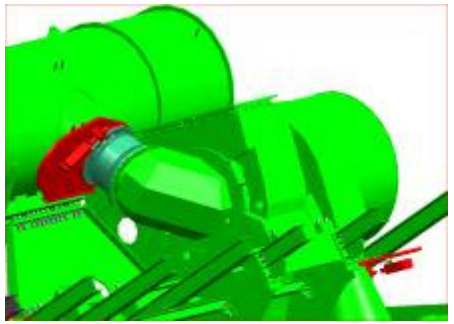

TC able only to absorb full exhaust gas amount at low load.

Not suitable for retrofit as all internal TC parts to be exchanged.

Comes naturally with WHR installations

## TC cut out

| | | 25% ME | 50% ME |
|---|---|---|---|
| Pscav | Bar | +0.25 | +0.52 |
| SFOC | g/kWh | -5.6 | -3.3 |
| NOx | g/kWh | +4.3 | +0.3 |
| Turbine Out | K | +4 | +1 |
| Piston | K | +18 | +34 |
| Exh. Valve | K | +16 | -8 |
| Liner | K | +4 | +4 |
| Pmax-Pcomp | Bar | +10 | +3 |
| | | | |

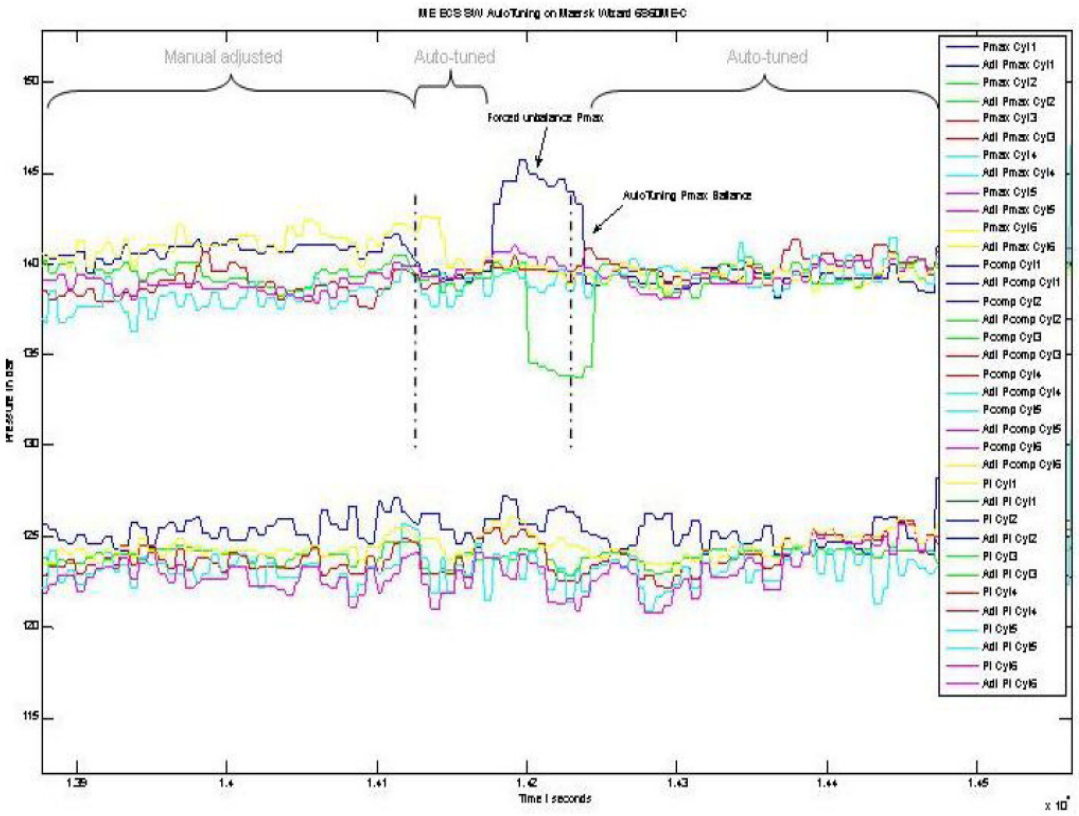


Suitable for 3 or more TC's. Field test on first vessel initiated May 2009

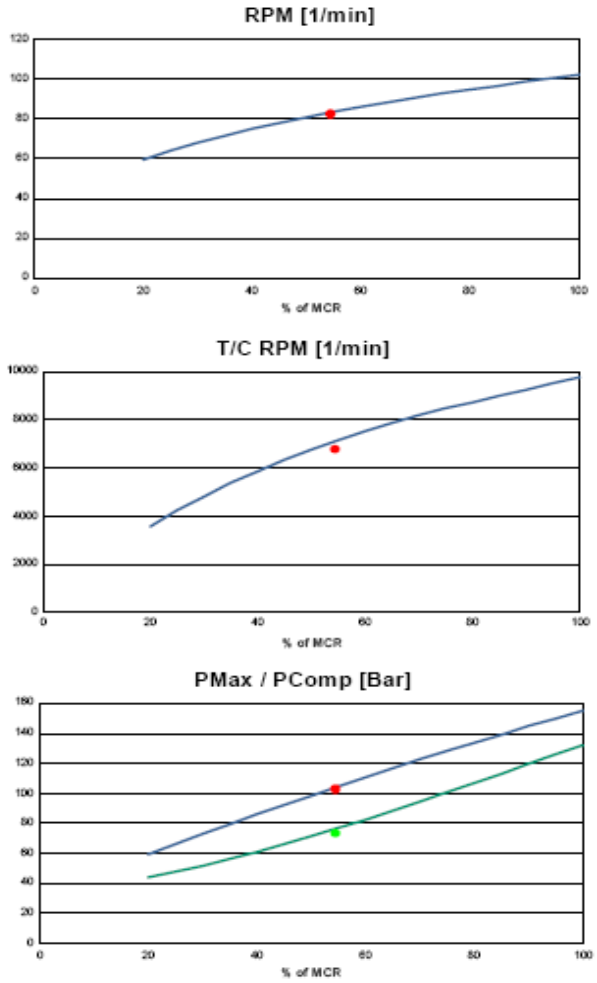
Business cases under development for all larger container vessels

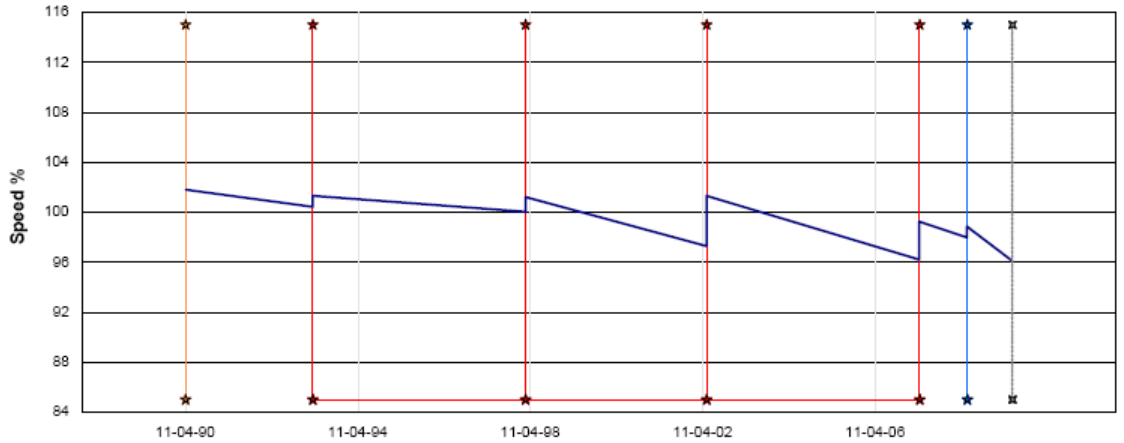
# Cylinder pressure monitoring & Auto tuning

- All larger engines are equipped with online pressure monitoring systems.
- Used for optimising the ME tuning.
- Especially for electronically controlled engines this enables always optimal tuned engine at the whole load range.
- Business cases are under development for all larger MAN B&W ME engines for upgrading to Auto Tuning.
  Field test proved concept on former Maersk Wizard (now Maersk Kobe).



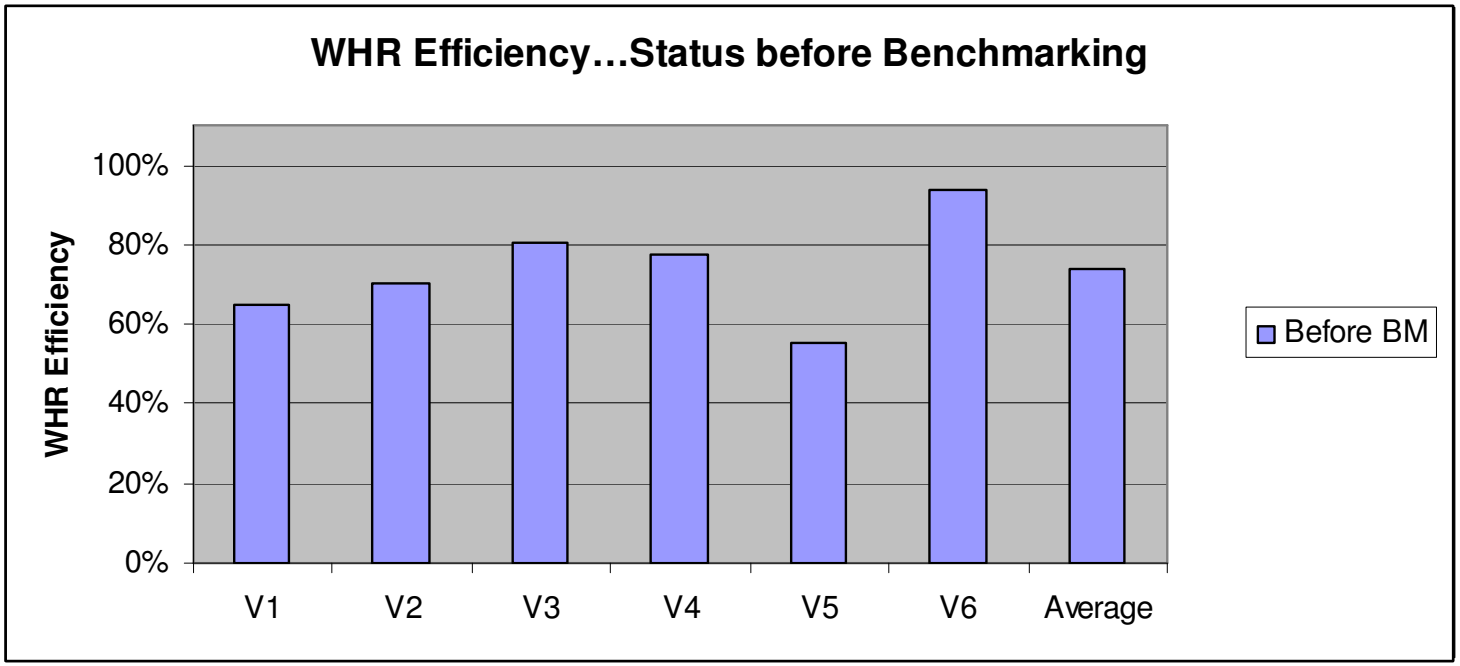
# Hull and prime mover performance monitoring




- All vessels are reporting all key operational data back to the office every day.
- Data enters automatically into a database from which data can be extracted into reports via a web interface.
- Once a month a complete performance test of the Main Engine is performed and data is reported into the database

# WHR Benchmarking,




**WHR Benchmarking**

- **Performance Sharing**
- **Knowledge Sharing**
- **Seminars**
- **Stimulating Constant Care (Rettidig omhu)**
- **Acknowledgement of top performance**

# Super Slow Speed Steaming

Optimal Speed

Optimal Load

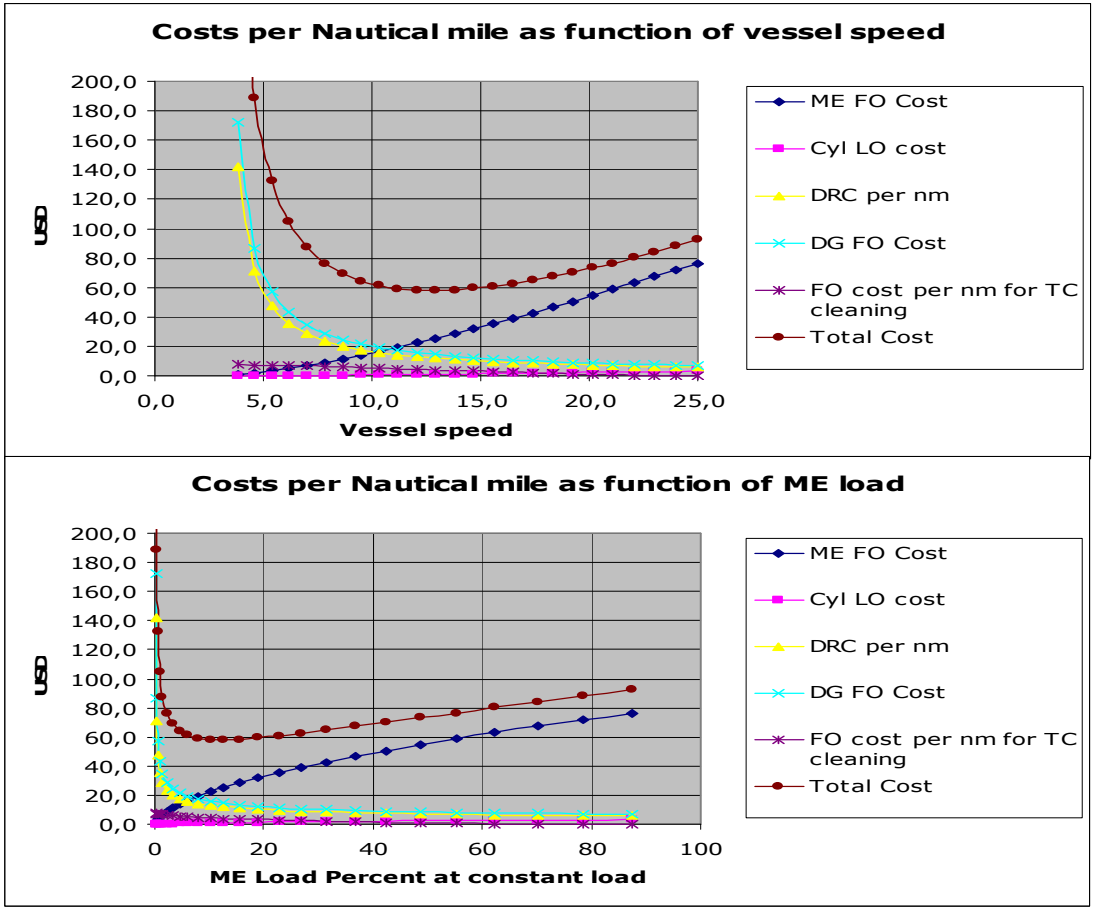
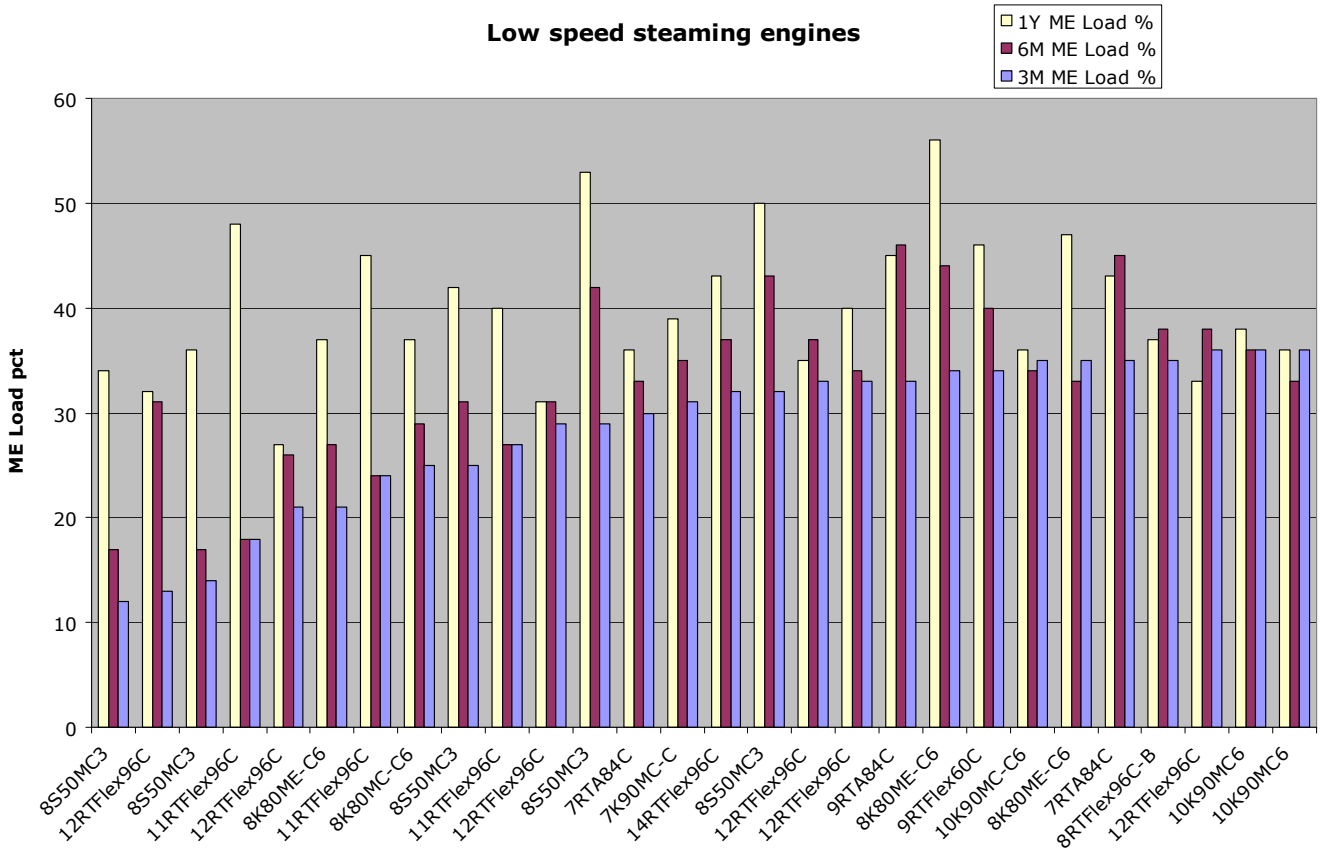


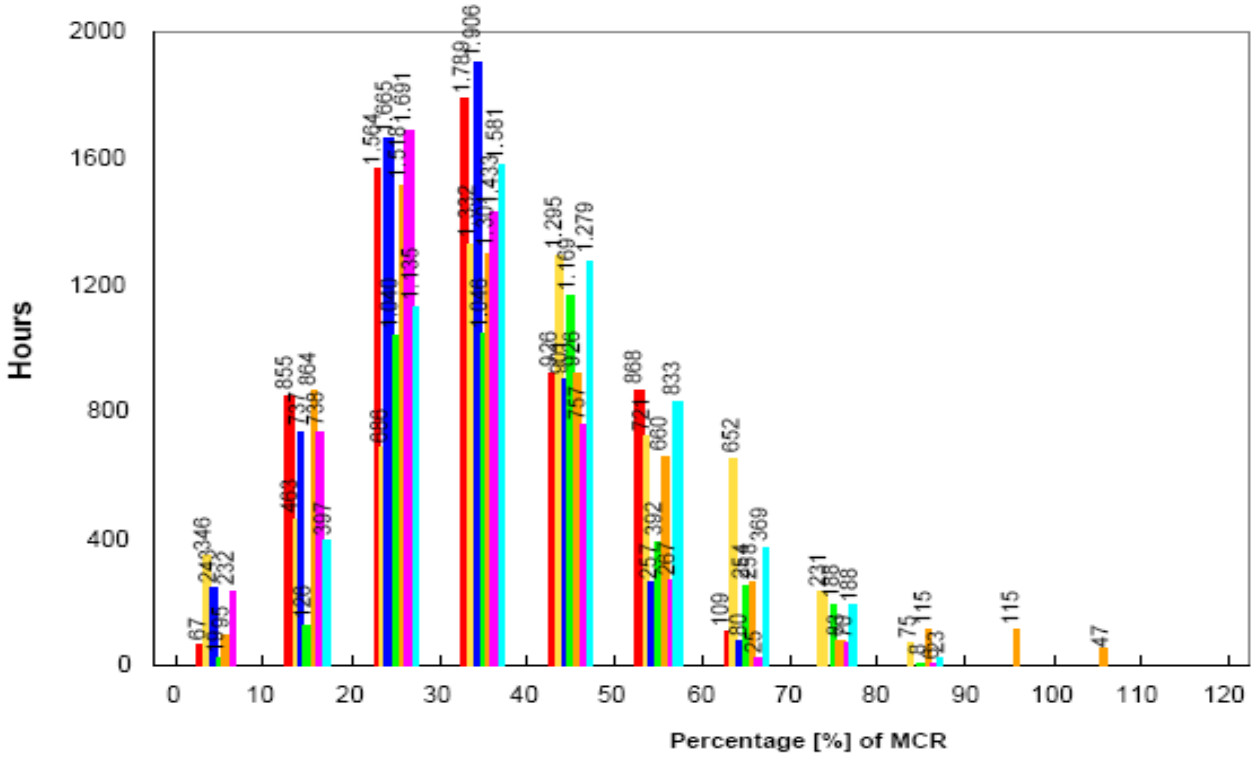

Figure 1; Cost per Nautical mile
Vessel: 3030TEU, ME: 7RTA96C, 200 Reefers; FO Cost 300$/mt

# APMM low load experience




- Container vessels operated from Copenhagen has since 2007 been operated without lower limit (110 vsl)
- The most common used 2-stroke engines have been performing slow speed steaming, electronically controlled engines as well as mechanically controlled.

# APMM low load experience



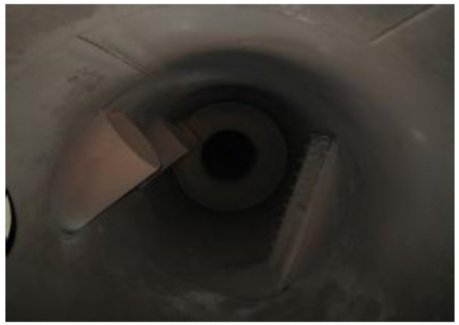

- The operational profiles shows that even though the average load is 40% at least half of the running hours are performed below 40% load .

# APMM unified low load policy

- The low load operation has been monitored using the performance system and by using structured means for collecting information on the ME condition.
- The vessels have on regular basis returned a slow steaming inspection report, including a questionnaire and systematic reporting of visual inspections.
- Based on the operational experience a unified low load policy has been defined for all vessels owned and operated by APMM having 2-stroke engine propulsion.
- This policy allows continuous operation down to 10% engine load given the engine operational conditions are kept within well defined limits.
- The engine designers have issued service letters based on this low load policy, and the policy has been rolled out to all APMM owned and operated vessels effective from January 2009

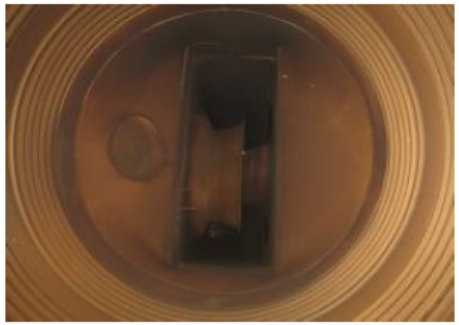
**Inspection area #4:** The piston ring lands and the top land, here from #13. (Representative unit!)

**Inspection area #5:** The piston crown and ports were found without any deposit.



**Inspection area #6:** The exh. receiver was found clean and no signs of unburned fuel / deposits.

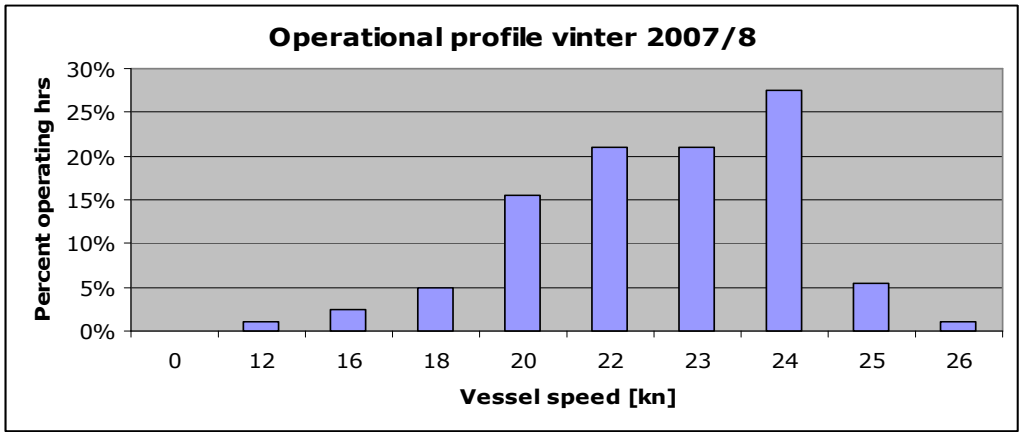
**Inspection area #7:** The exh. valves were found in good condition. During previous dismantling of exh. valves, some major deposits has been found in the seat area.

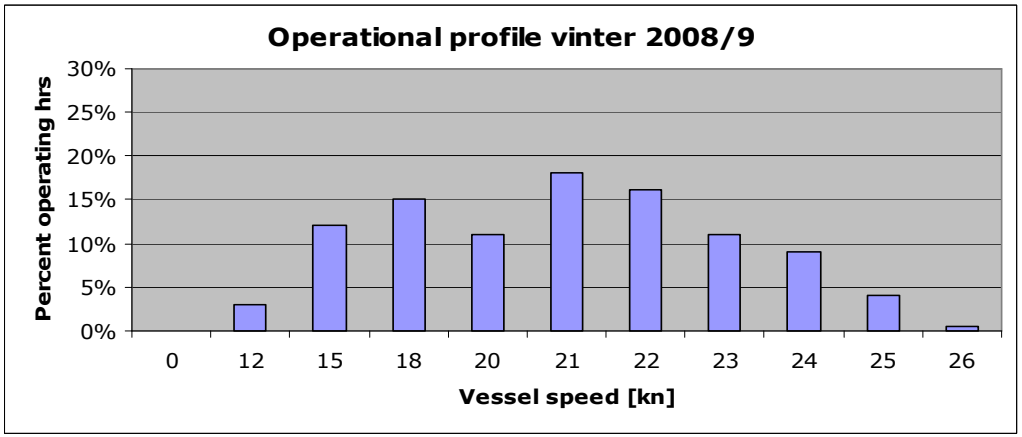


**Inspection area #8:** The outlet from the turbines were found without deposits, although the receiver was found with some "sticky" surface.

**Inspection area #9:** The turbine blades were found without major deposits.

# Flexible Slow Speed Steaming



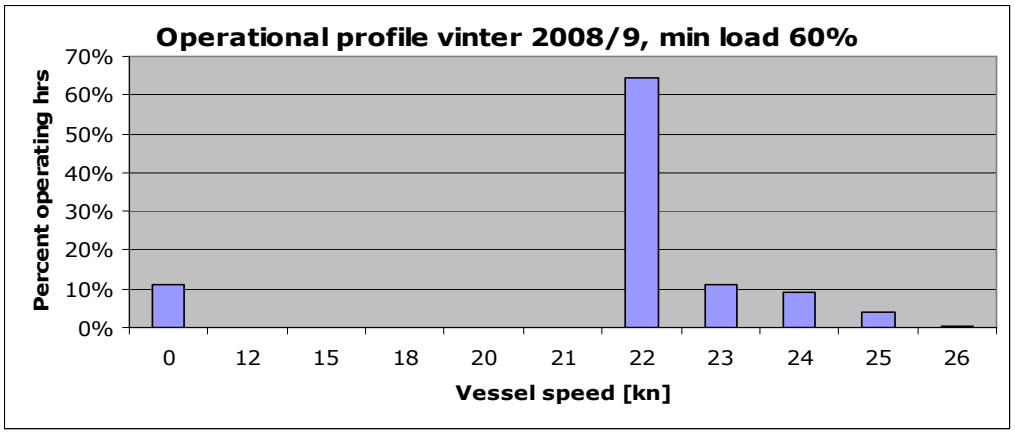

**Ex 1:** Actual operational data winter 2007/8 average of 8 vessels over 6 month.
Average speed 22.1kn

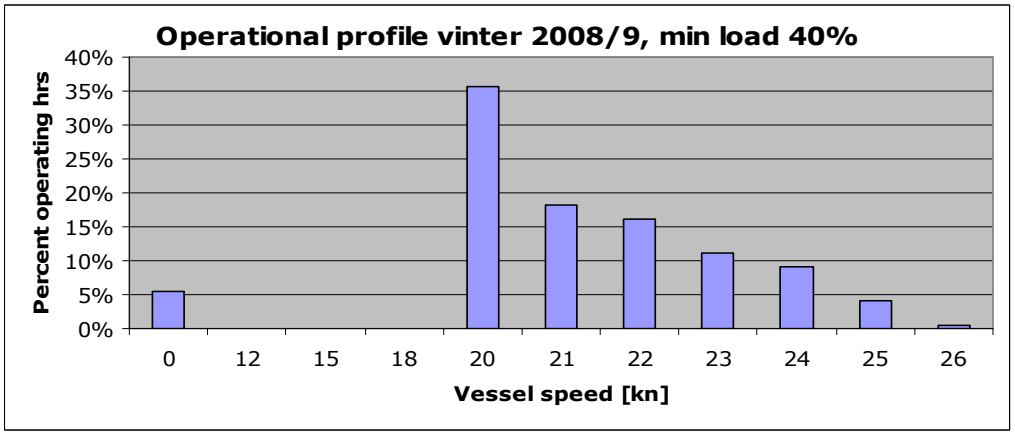
| | Index |
|---|---|
| Capacity per vessel, TEU*km | 100 |
| Yearly FOC per vessel | 100 |
| $No_x$ emission g/[TEU*km] | 100 |

**Ex 2:** Actual operational data winter 2008/9 averaged over 6 month.
Average speed 20.2kn

| | Index |
|---|---|
| Capacity per vessel, TEU*km | 91,4 |
| Yearly FOC per vessel | 80,7 |
| $No_x$ emission g/[TEU*km] | 87,5 |

# Non-flexible Slow Speed Steaming




**Ex 3:** Case study ME Minimum load 60%, same schedule as previous Ex 2.
Average speed 20.2kn

| | Index |
|---|---|
| Capacity per vessel, TEU*km | 91,4 |
| Yearly FOC per vessel | 93,3 |
| $No_x$ emission g/[TEU*km] | 94,8 |

**Ex. 4** Case Study
ME Minimum load 40%,
same schedule as above Ex 2.
Average speed 20.2kn

| | index |
|---|---|
| Capacity per vessel, TEU*km | 91,4 |
| Yearly FOC per vessel | 85,0 |
| $No_x$ emission g/[TEU*km] | 91,2 |


Thank you for your attention