Baltic Sea Parliamentary Conference

MARPOL Annex VI

TECHNOLOGY & COMPLIANCE

Ramona Zettelmaier
Lloyd's Register

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Overview

- International Regulations
- SOx reduction
- CO2 reduction
- NOx reduction
- Conclusion and action points for further development

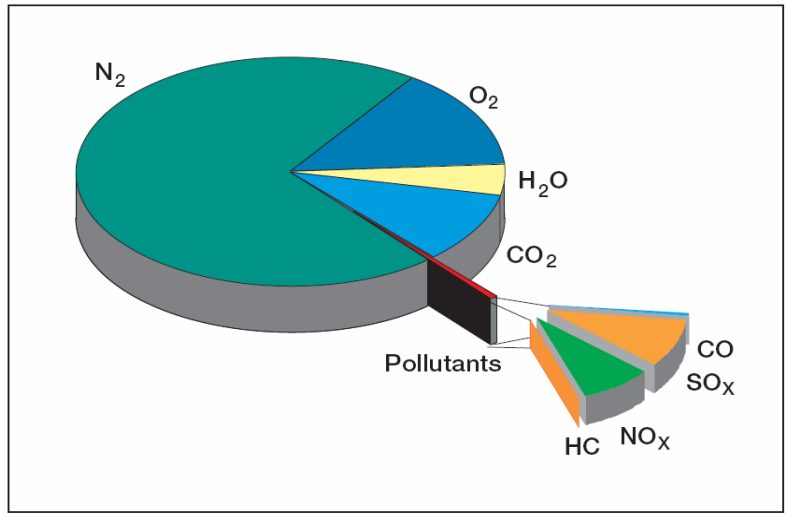
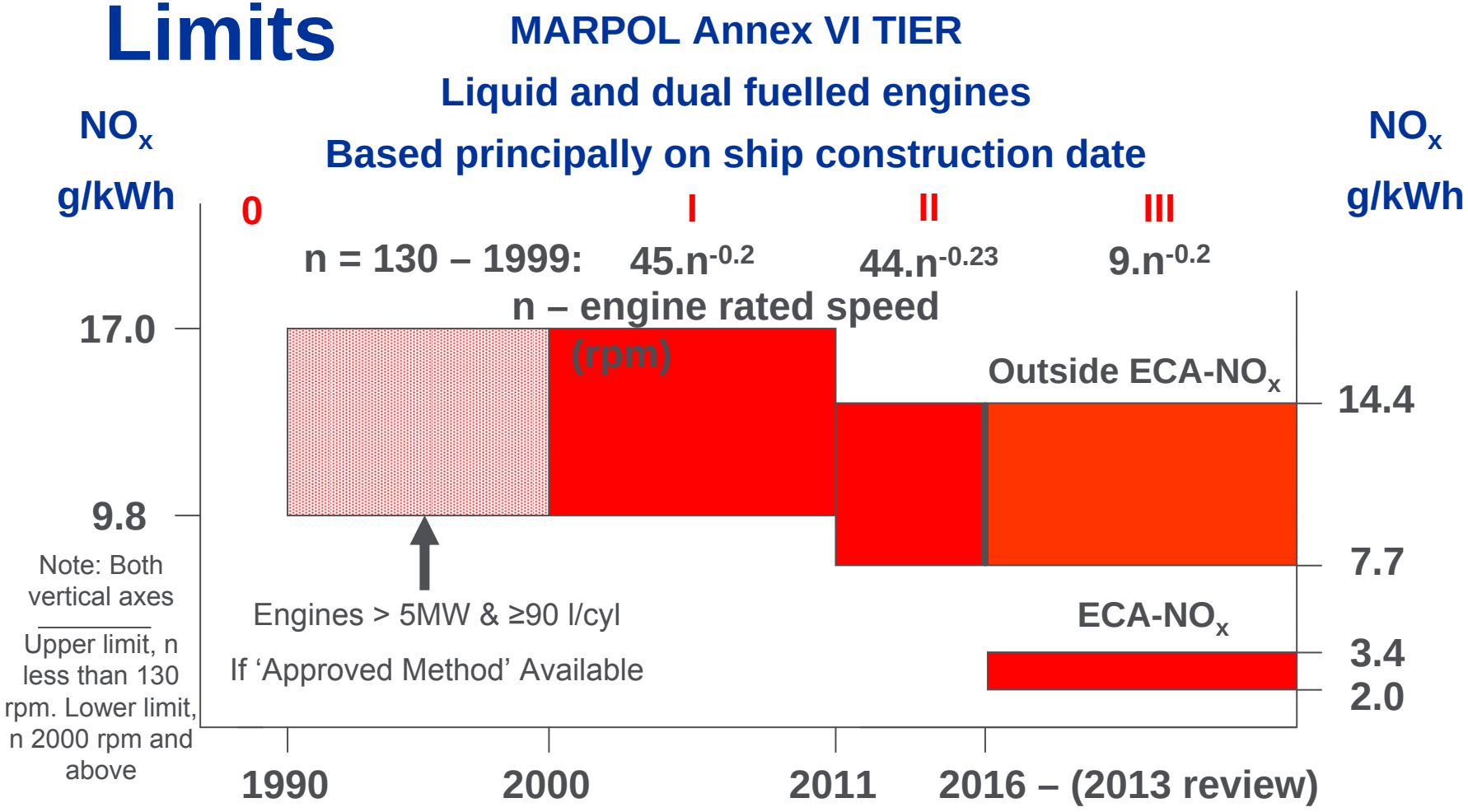


Fig. 3
The pollutants in the exhaust gases (% vol) of large diesel engines are an extremely small proportion of the whole

Diesel Engine NO_x Emission Limits



ECA-NO_x: Emission Control Area for NO_x control
Currently: North America

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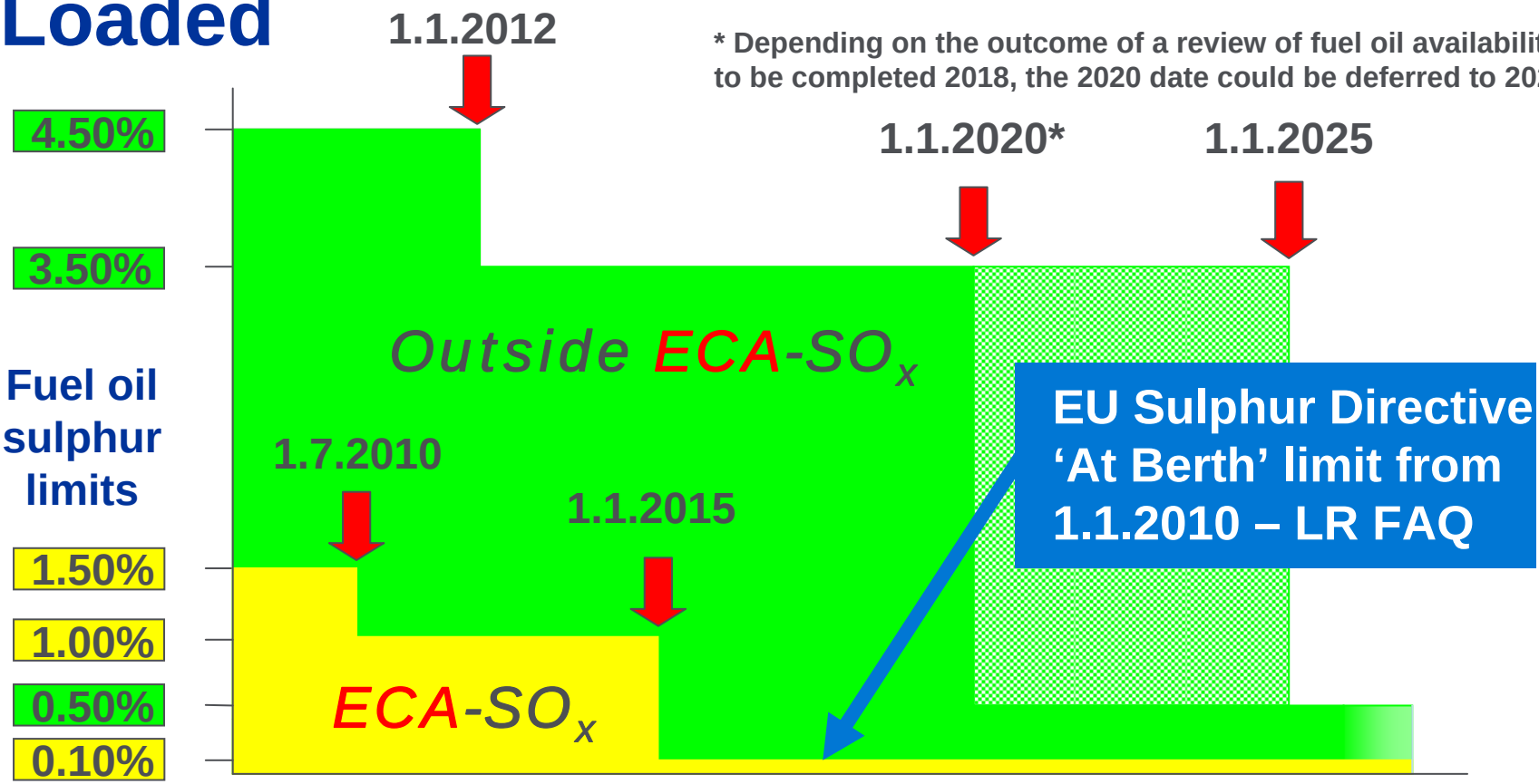
MARPOL Annex VI, SO_x & PM Control Compliance on Basis of Fuel Oils as Loaded



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ECA-SO_x: Emission Control Area for SO_x & PM control – Currently: Baltic, North Sea and, from Aug 2012 North America

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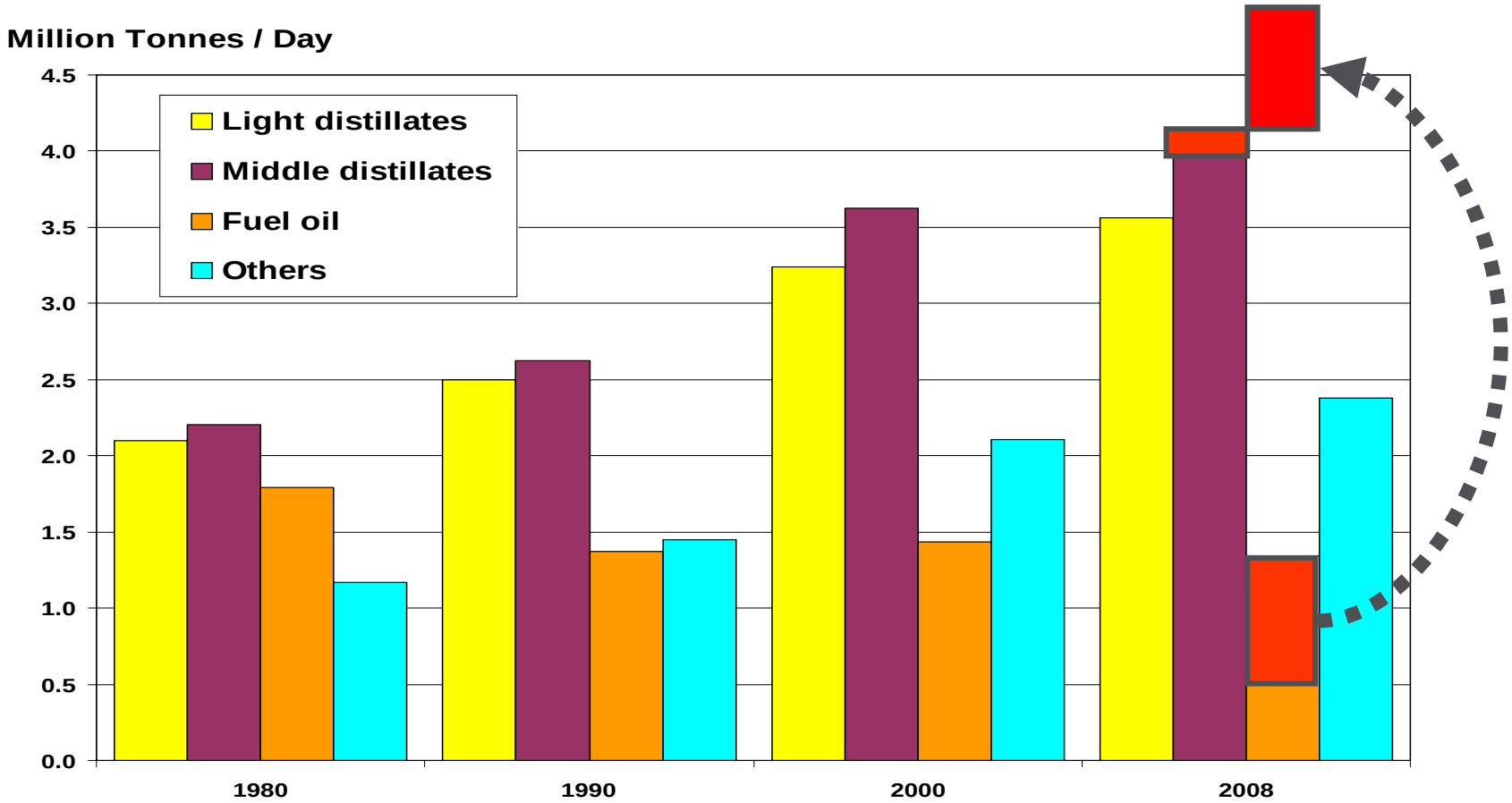
Petroleum Products

International Shipping ~ 1.0 Mt/d



Source : Production - BP Statistical Review of World Energy 2009
Shipping – IMO BLG12

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SO_x Control Compliance

Compliance on basis of fuel oil as used dependent on:

- **Sulphur content of the fuel oil as loaded**
- **Inside ECA-SO_x - Avoiding significant admixture with fuel oils with sulphur content above ECA-SO_x limit**

Port State Control – Guidelines MEPC.181(59)

Bunker Supplier Registration Scheme – regulation 18.9

- **Ensuring that Bunker Delivery Notes (BDN) are compliant**
- **Ensuring that MARPOL Samples are compliant – MEPC.182(59)**
- **Approval of equivalent alternatives to BDN & MARPOL Samples**
- **Taking action in cases of non-compliance: procedures / quality**

Alternative SO_x Control Options

Residual Fuel Oil + Secondary control technologies

Exhaust Gas Cleaning Systems (SO_x Scrubbers)

- Open or closed loop water wash out of SO_x
- Dry chemical reaction – solid residue
- Possibility of other systems being developed

Issues:

- Approval: MARPOL – Flag State, EU – Member State
- Functionality, reliability and durability
- Installation restrictions / operational complexity / consumables
- Open loop wet systems, wash-water discharge restrictions
- Wet systems, cool exhaust gas exit temperatures
- Capital costs / Long term payback / Running costs

Natural Gas as a Marine Fuel

SO_x None
PM None
NO_x Reduction ~ 90%
CO_2 Reduction ~20%

Useable in Combustion Engines, Gas Turbines, Boilers, Fuel Cells, …

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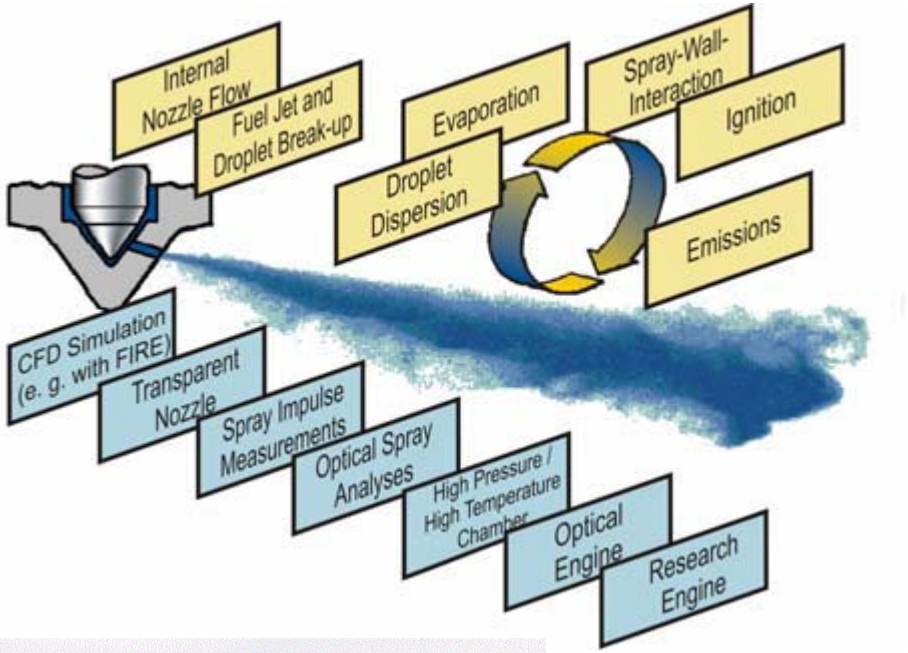
CO2 reduction / GHG emission

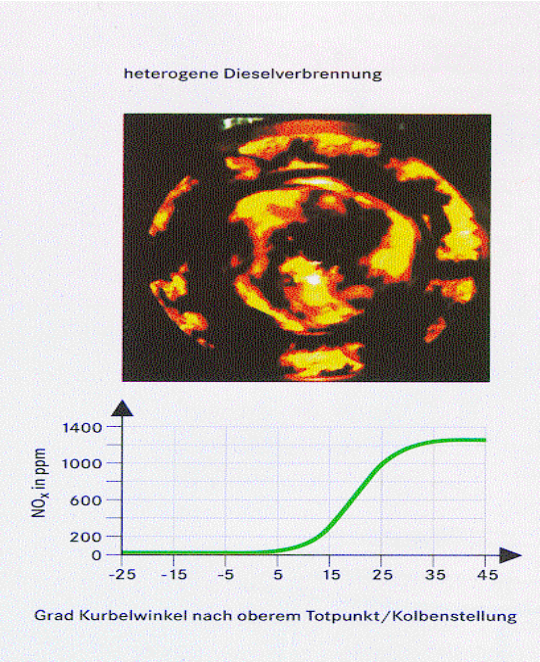
- **Ratio of Hydrocarbon optimisation**
  - **Fuel oil quality**

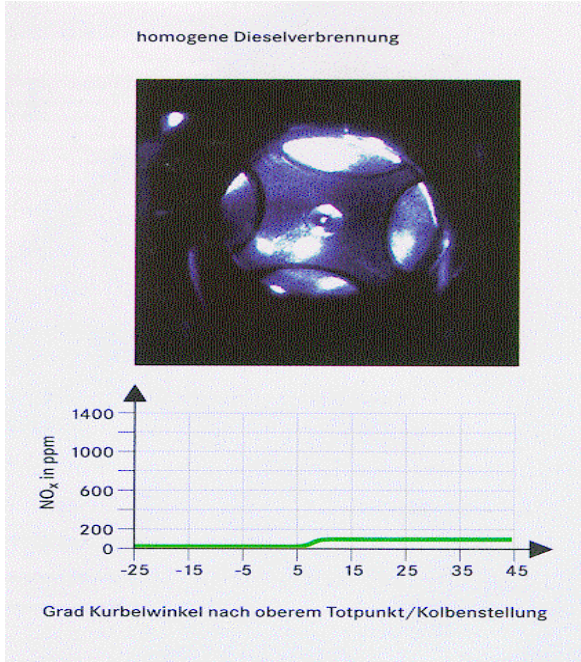
- **Overall energy consumption reduction / minimisation**
  - **Vessel design**
  - **Vessel speed**
  - **Heat recovery systems (ORC process)**

NOx reduction

Combustion Refinement
Injection Pressure
rate shaping







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NOx reduction

Humid Engine (HAM)
Water Injection / Emulsion
Intensified Charge Cooling

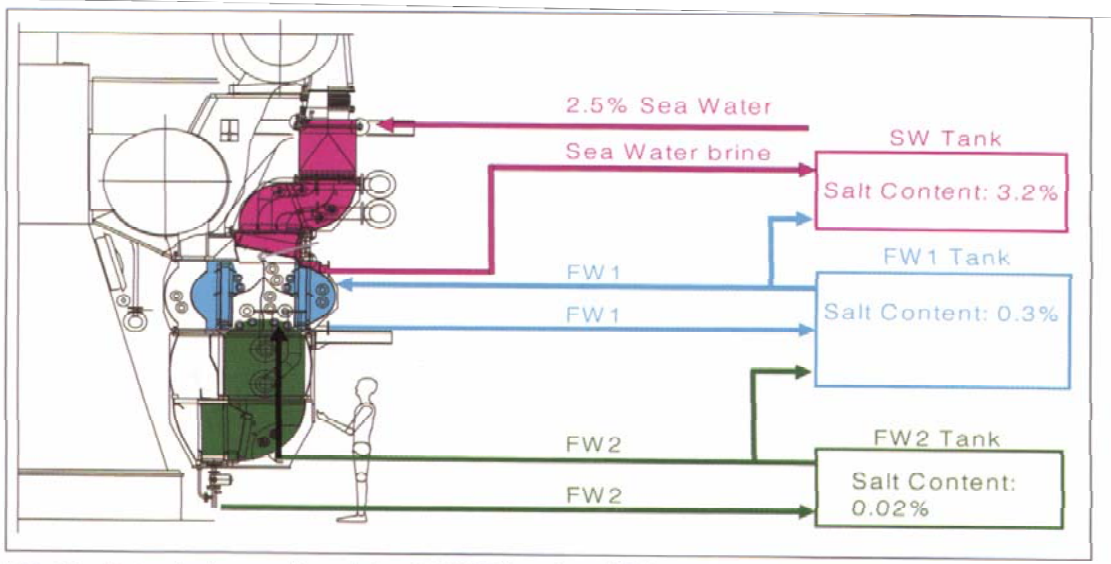
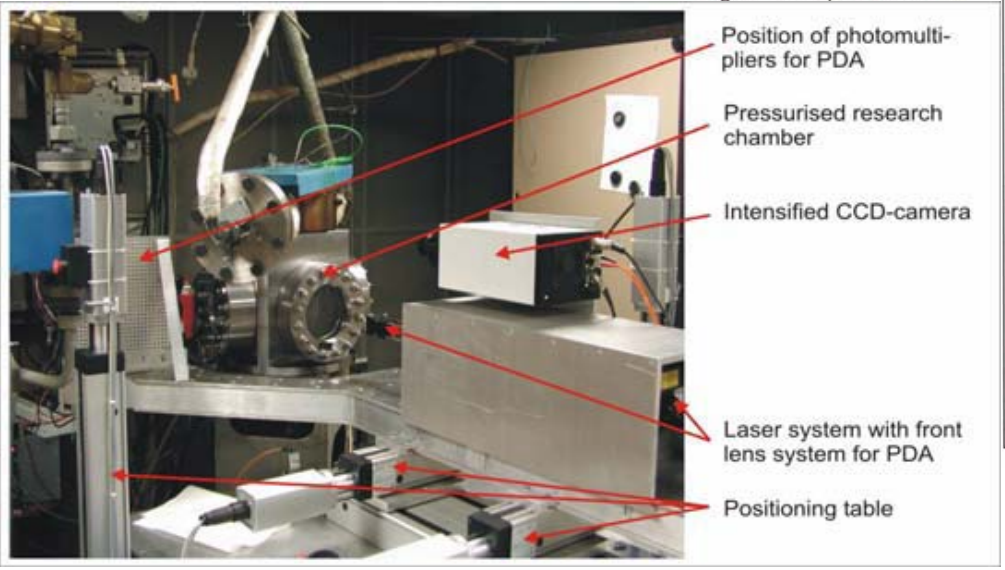
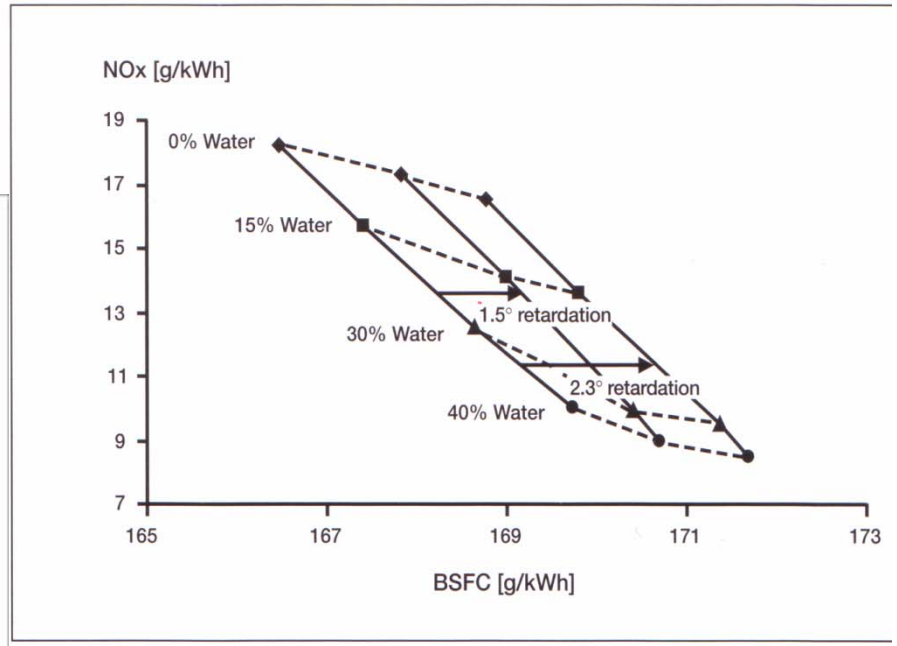


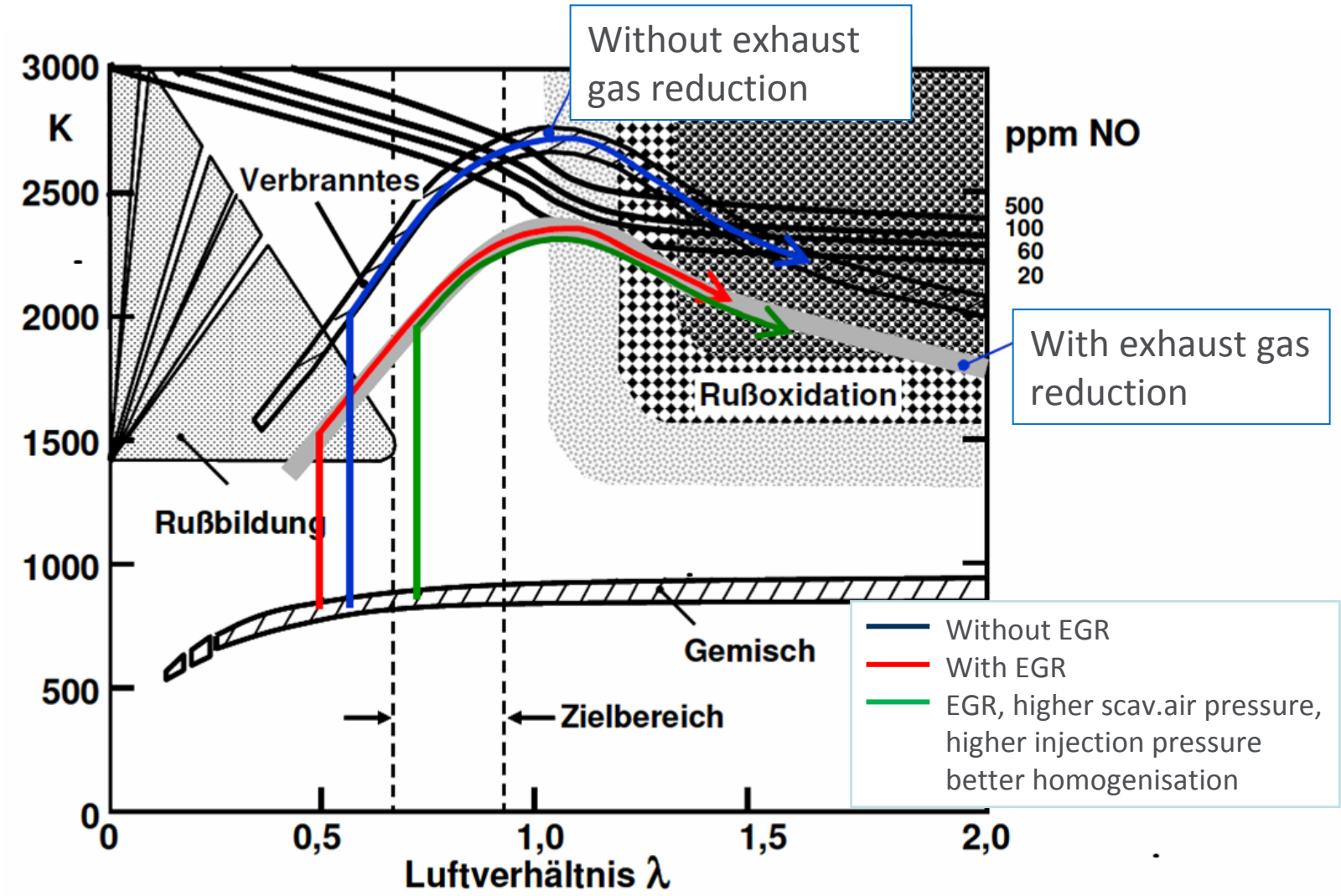
Fig. 11: Expected operation data at 100% load and ISO ambient conditions

Fig. 18
Influence of percentage water content in fuel/water emulsions and fuel injection timing on NO_X emissions for a Sulzer 7RTA84T two-stroke engine at 75 per cent load





NOx reduction - Variable EGR (cooled / uncooled)



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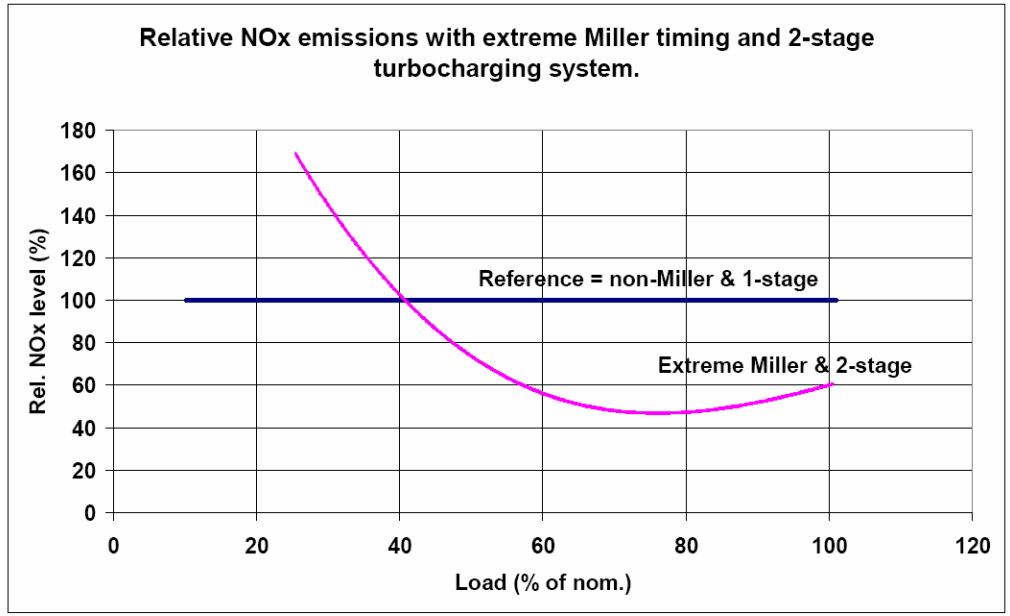

Research engine

	WTZ Roßlau	TU HH
Bore	250 – 350 mm	265 mm
Stroke	320 – 450 mm	400 mm
P_{eff}	< 30 bar	40 bar
P_{max}	< 400 bar	365 bar
P_{sc}	< 8 bar	10 bar
Compr. ratio	< 20	14 … 19

2 stage turbocharging $\pi_{sC} > 6{,}5$

NOx reduction

Increased Boosting

Miller Cycle

Peak Pressure

Specific Power

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Recommendations to BSPC

- Consistent and proportionate application of Port State Control
- Bunker Supplier Registration Schemes that fulfil the obligations given in MARPOL Annex VI regulation 18
- Alignment of MARPOL Annex VI and EU Sulphur Directive requirements, approval processes
- Ship Energy Efficiency Index optimisation
- Proactive approach to Exhaust Gas Cleaning Systems – certification, wash water criteria and application
- Facilitation of alternative marine fuel oil options: Research, development, implementation

Recommendations to BSPC / research and development

- Development of Standard Training Courses for PSC
- Development of regulations for Bunker Supplier according of MARPOL Annex VI regulation 18
- Development of control mechanismen for SOx compliance, (measurements and PSC)
- Research in new technologies to improve Ship Energy Efficiency (heat recovery systems / etc..)
- Development of receiption facilities for consumabels, i.e. waste wash water of scrubber

Thank you

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