

Validation of simulated CO₂ emissions with the real-time on board measured CO₂ emissions on the Ro-Pax vessels

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Overview of UniZd activities:

- Measurement of exhaust emissions from ships
- Acquisition of Ro-Pax Engine simulation module
- Measurement of vessel parameters during joint operation of Bridge and Engine simulators for GUTTA – VISIR application
- Validation of CO2 emissions



MV Marko Polo

LOA: 128,13 m

Breadth: 19,62 m

Draft: 5,73 m

Service speed: 19,5 knots



MV Dubrovnik

LOA: 122,06 m

Breadth: 18,82 m

Draft: 4,83 m

Service speed: 20 knots



MV Zadar

LOA: 116 m

Breadth: 18,90 m

Draft: 5,20 m

Service speed: 17,5 knots



Bornholms Trafikken RoPax Ferry (Simulator model)

LOA: 125 m

Breadth: 23,40 m

Draft: 5,30 m

Service speed: 19 knots

- **MV Marko Polo**

- 4 x Stork Werkspoor Diesel 8TM410
- Power per engine: 4 x 3750 kW
- Number of cylinders: 8

- **MV Dubrovnik**

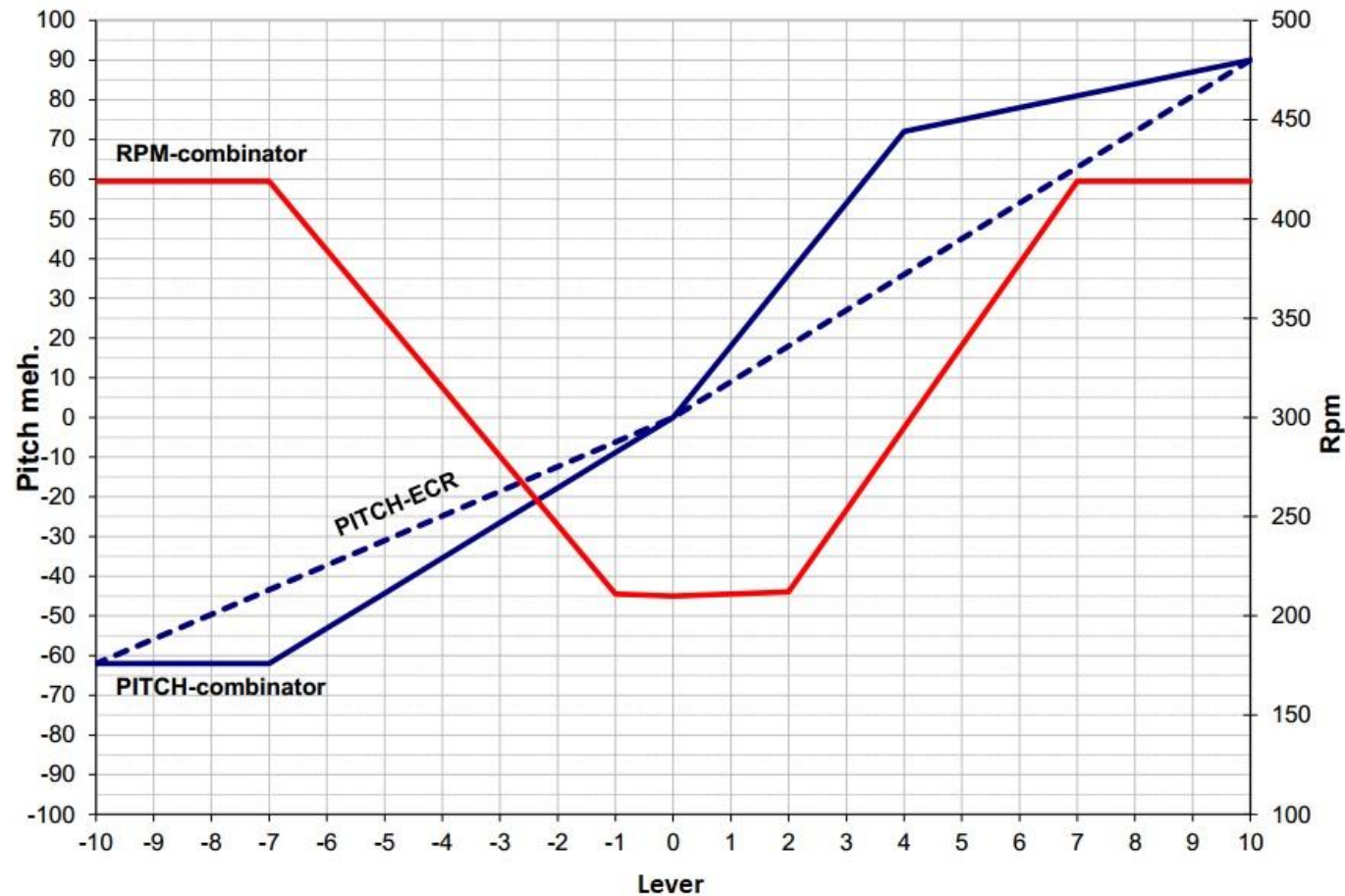
- 4 x MaK Diesel 8 M 551 AK
- Power per engine: 4 x 3310 kW
- Number of cylinders: 8

- **MV Zadar**

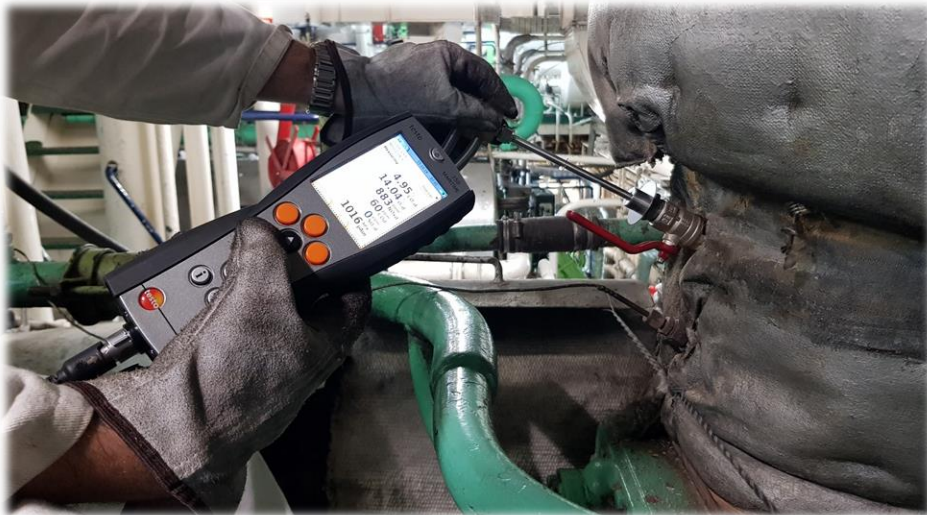
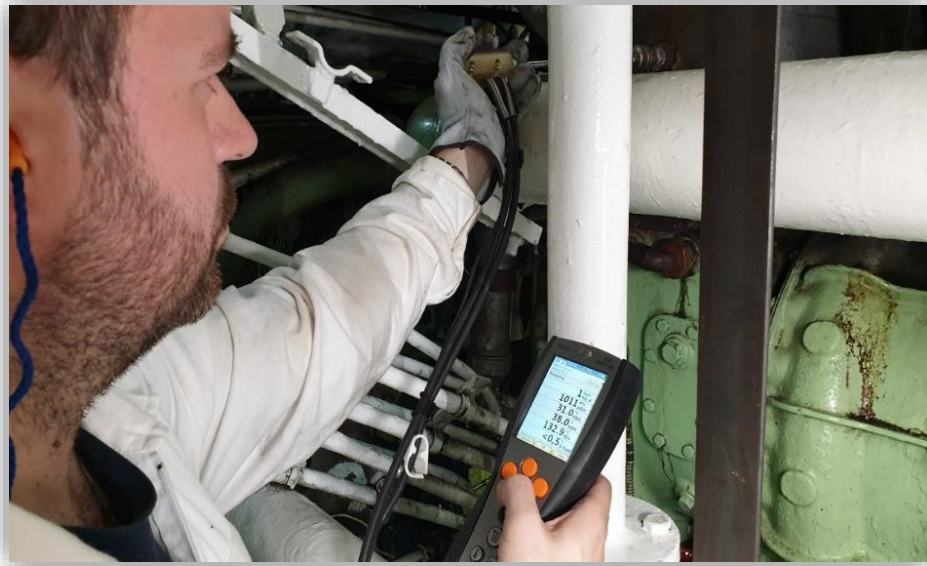
- 2 x Bazan MAN B&W 8L 40/54 A
- Power per engine: 2 x 3500 kW
- Number of cylinders: 8

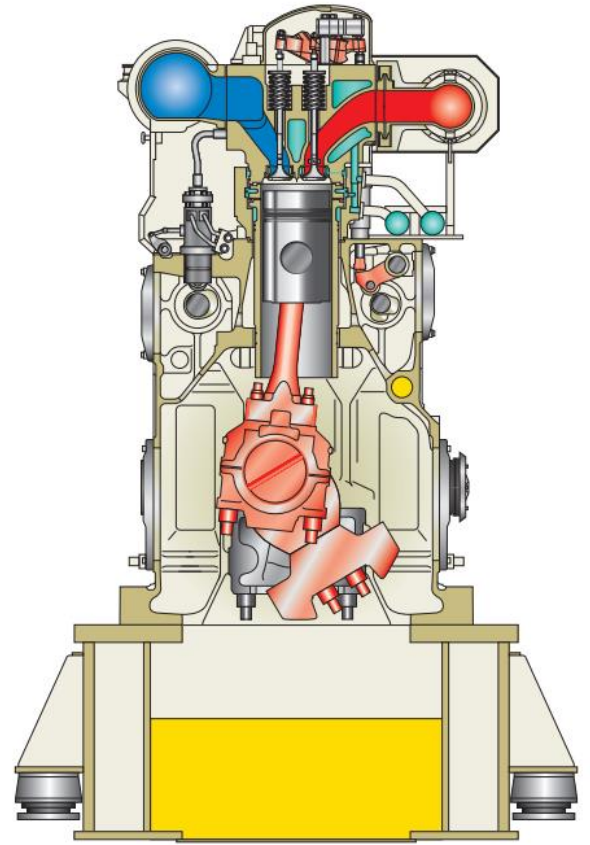
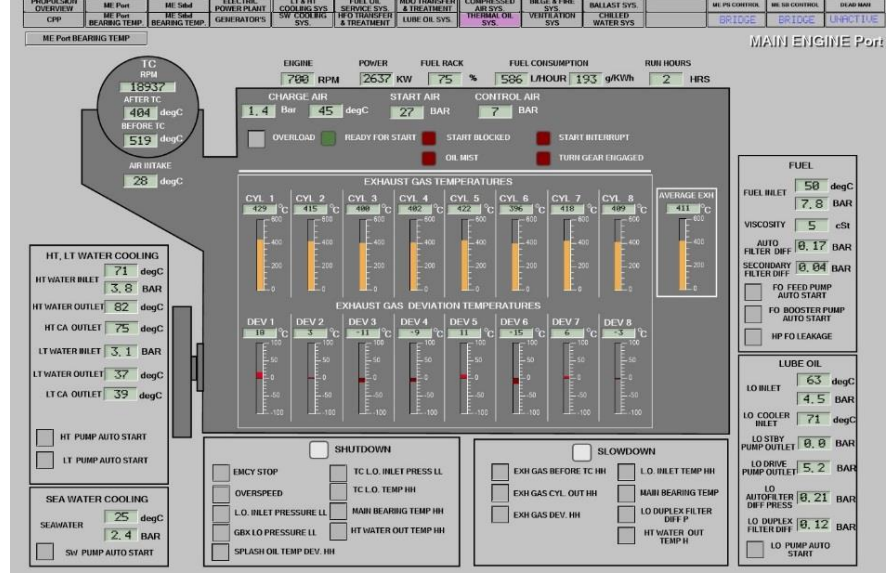
- **RoPax Ferry - Engine Simulator model**

- 2 x MAN 8L32/40 Four stroke non-reversible diesel engine
- Power per engine: 2 x 4000 kW (MCR 3800 kW)
- Number of cylinders: 8

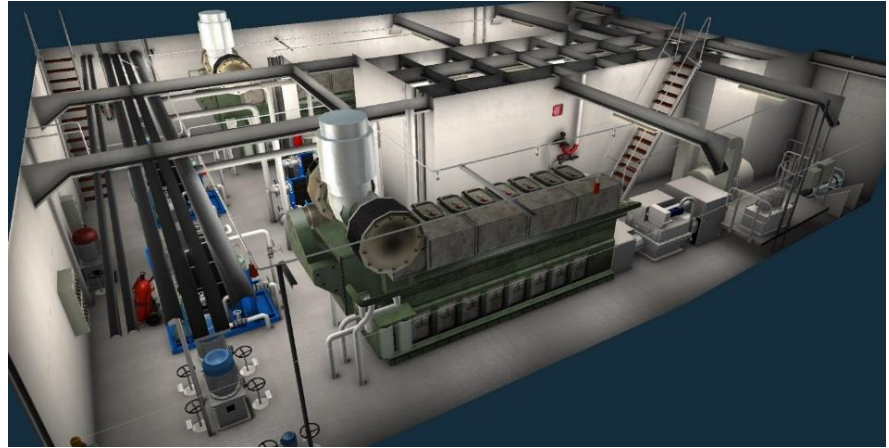


testo 350-MARITIME





Ro-Pax ferry general view



Air

8.5 kgr/KWh

79% N₂

21% O₂



Fuel Oil

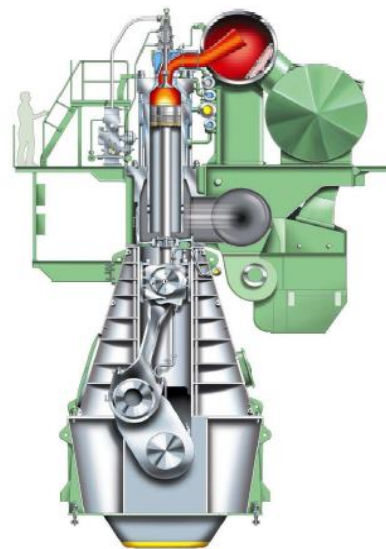
c, h, s

>183 gr/KWh

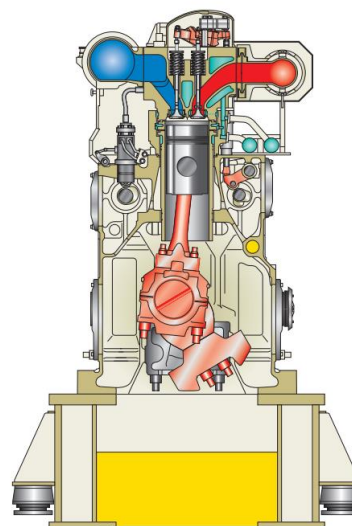
for L32/40



Lube Oil



L32/40



Exhaust gases

75,8% N₂

13,0% O₂

5,2% CO₂

5,3% H₂O



Air pollutants

(< 0,3%)

NO

SO_x

HC

CO

Vessel 1

Engine	% CO ₂ d	% O ₂ d	ppm NO _x d	ppm CO _d	ppm SO ₂ d	°C tEx	Load %
1L	5.45	13.09	856	205	0	386.5	83%
1D	5.43	13.14	1051	139	0	386.0	78%
2L	5.47	13.10	1039	179	0	392.5	70%
2D	5.76	12.70	837	188	0	411.5	75%
Average	5.53	13.01	946	178	0	394.1	76%

% CO ₂ d	% O ₂ d	λ
5.11	13.64	2.93

% CO ₂ d	% O ₂ d	λ
5.88	12.6	2.41

214 g/kWh

Vessel 2

Engine	% CO ₂ d	% O ₂ d	ppm NO _x d	ppm CO _d	ppm SO ₂ d	°C tEx	Load %
L	5.60	13.09	1184	150	0	331.7	66%
D	5.89	12.59	1299	161	0	354.7	77%
Average	5.74	12.84	1241	155	0	343.2	72%

% CO ₂ d	% O ₂ d	λ
5.5	13.1	2.73

% CO ₂ d	% O ₂ d	λ
6.11	12.28	2.32

203 g/kWh

λ
2.55

Vessel 3

Engine	% CO ₂ d	% O ₂ d	ppm NO _x d	ppm CO _d	ppm SO ₂ d	°C tEx	Load %
1L	4.58	14.54	879	56	0	361.6	48%
2L	4.93	14.05	878	68	0	378.0	52%
3D	5.19	13.64	943	50	0	401.6	54%
4D	4.84	14.18	736	53	0	383.9	49%
Average	4.88	14.10	859	57	0	381.3	51%

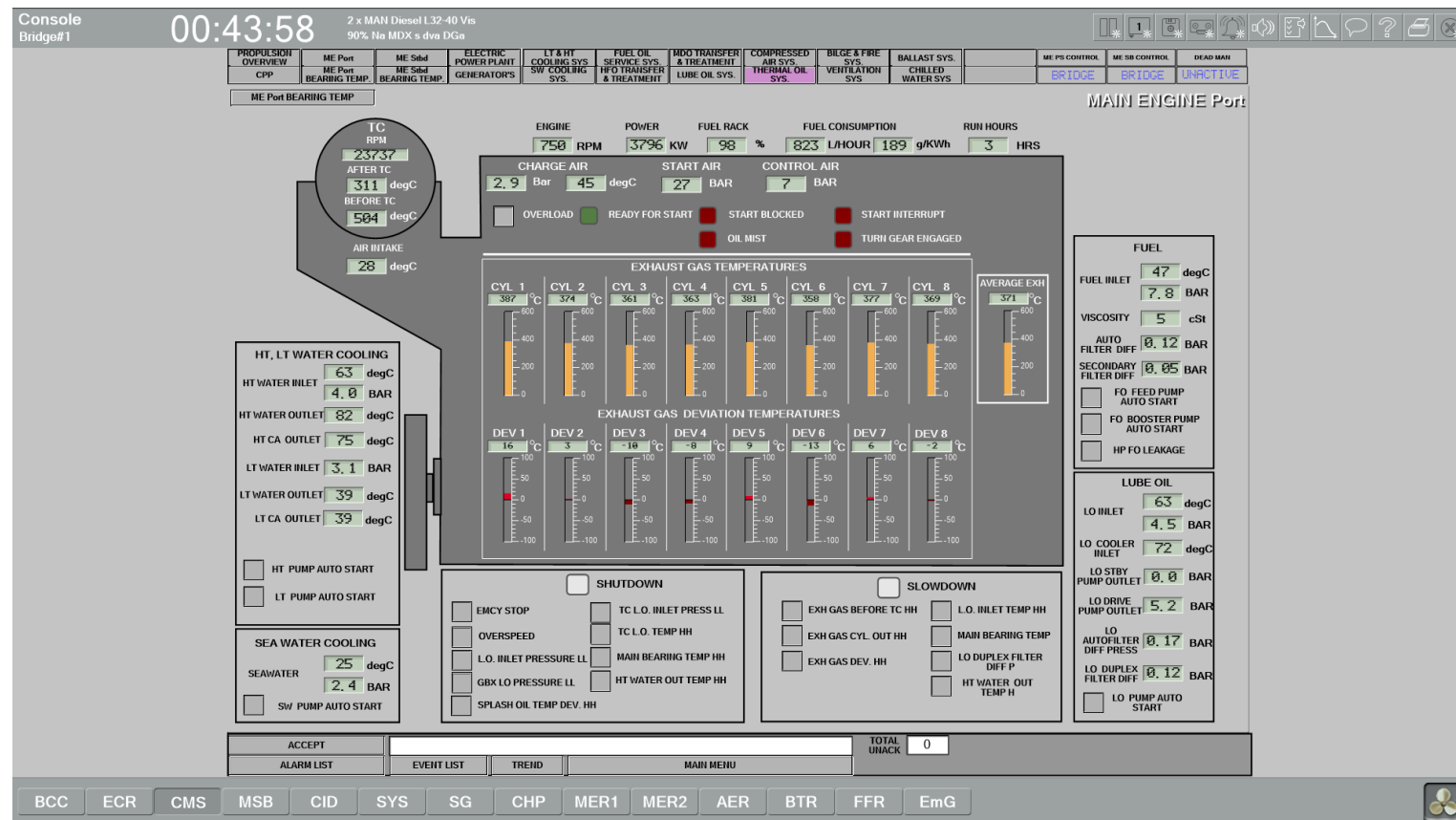
% CO ₂ d	% O ₂ d	λ
4.49	14.54	3.34

% CO ₂ d	% O ₂ d	λ
5.28	13.59	2.72

216 g/kWh

Simulated vessel

Load %	SFC g/kWh	CO2 %	NOx ppm	CO ppm	λ
85%	190	6.09	1025	94	2.477
83%	191	6.00	992	94	2.513
72%	191	5.88	954	99	2.564
70%	193	6.70	884	99	2.258
68%	193	6.64	860	99	2.277
60%	194	6.75	816	104	2.241
55%	195	6.60	747	104	2.291
50%	195	6.60	740	109	2.291



Example:

Vessel 2

Engine	% CO ₂ d	% O ₂ d	ppm NO _x d	ppm COd	ppm SO ₂ d	°C tEx	Load %
L	5.60	13.09	1184	150	0	331.7	66%
D	5.89	12.59	1299	161	0	354.7	77%
Average	5.74	12.84	1241	155	0	343.2	72%

% CO ₂ d	% O ₂ d	λ
5.5	13.1	2.73

203 g/kWh

% CO ₂ d	% O ₂ d	λ
6.11	12.28	2.32

λ
2.55

Simulated vessel

Load %	SFC g/kWh	CO ₂ %	NO _x ppm	CO ppm	λ
85%	190	6.09	1025	94	2.477
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60%	194	6.75	816	104	2.241
55%	195	6.60	747	104	2.291
50%	195	6.60	740	109	2.291

Voyage duration 8 h

Vessel 2:

8 h x (2 x 72% x 3500 kW) = 29030 kWh
 kWh x SFC = 5.893 t of fuel

Simulated vessel:

8 h x (2 x 72% x 3800 kW) = 43776 kWh

- Reduced voyage duration ~5.3 h;
- Reduce energy ~33.7% to have same fuel oil consumption
- Reduce power/load to ~ 2 x 50% and consume approx. same amount of fuel
- Only one engine at 95.5%~5.52 t

Thank you for your attention!



Initial meeting in Zadar, April 2017

Questions?



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