

1. Engine design parameters (to be completed before measurement)**1.1 Engine**Production year: 2015Location: ☒ Testbed
☐ Ship**1.2 Engine freshly manufactured**☒ Yes ☐ NoIf no: Documentation of relevant maintenance provided ☐ Yes ☐ No**1.3 Engine total running hours**100 [h]**1.4 Regular maintenance interval**- [h]**1.5 Hours since last regular maintenance**- [h]**1.6 Engine category**☐ 4-stroke
☒ 2-stroke**1.7 Engine fuel type**☒ Diesel ☐ Gas ☐ Dual fuel**1.8 Engine max. rated power**11335 [kW]**1.9 Mean effective pressure at rated power**15.47 [bar]**1.10 Engine speed**☒ Less than 130 rpm
☐ 130 or more but less than 2,000 rpm
☐ 2,000 rpm or more**1.11 Method of air aspiration**☐ Naturally aspirated
☒ Pressure-charged single stage
☐ Pressure-charged multi stage**1.12 Injection system**☐ Conventional
☒ Common rail**1.13 Applicable emission limit**☐ IMO Tier I ☒ IMO Tier II ☐ IMO Tier III
☐ Others: _____**1.14 Applicable test cycle**☐ C1 ☐ D2 ☐ E2 ☒ E3
☐ Others: _____

1.15.1 Specific lubrication oil consumption

SLOC: - _____ [g/kWh]

Breaking-in period: ☐ Finished
☐ Not finished
☐ Not applicable

1.15.2 Cylinder liner lubrication☐ None☒ Yes, active at

<input checked="" type="checkbox"/> 100%	Feed rate:	15869 [g/h]
<input checked="" type="checkbox"/> 75%	Feed rate:	12219 [g/h]
<input checked="" type="checkbox"/> 50%	Feed rate:	8553 [g/h]
<input checked="" type="checkbox"/> 25%	Feed rate:	4961 [g/h]
<input checked="" type="checkbox"/> 10%	Feed rate:	2580 [g/h]

Breaking-in period: ☒ Finished
☐ Not finished
☐ Not applicable

1.15.3 Inlet valve seat lubrication☒ None☐ Yes, active at

<input type="checkbox"/> 100%	Feed rate:	_____ [g/h]
<input type="checkbox"/> 75%	Feed rate:	_____ [g/h]
<input type="checkbox"/> 50%	Feed rate:	_____ [g/h]
<input type="checkbox"/> 25%	Feed rate:	_____ [g/h]
<input type="checkbox"/> 10%	Feed rate:	_____ [g/h]

1.16 Exhaust gas treatment device☐ None☐ Yes

☐ SCR
☐ Scrubber
☐ EGR
☐ Water injection
☐ Others: _____

2. Fuel**2.1 Fuel in use**

<input type="checkbox"/> ULSD	<input type="checkbox"/> DMX	<input type="checkbox"/> DMA	<input type="checkbox"/> DMZ	<input checked="" type="checkbox"/> DMB	
<input type="checkbox"/> RMA	<input type="checkbox"/> RMB	<input type="checkbox"/> RMD	<input type="checkbox"/> RME	<input type="checkbox"/> RMG	<input type="checkbox"/> RMK
<input type="checkbox"/> Other: _____			acc. standard: _____		
<input type="checkbox"/> Natural Gas					
<input type="checkbox"/> Other gases acc. IGF: _____					

☐ Liquid to gas fuel ratio as certified at mode point:

100%	_____
75%	_____
50%	_____
25%	_____
10%	_____

Fuel properties and composition (in use during testing)

2.2 Gas

Please fill in as far as possible
most important marked with *)

Property	Unit / Standard	Actual value	Remark
Methane number*)	[-] / DIN EN 16726		
Lower calorific value*)	[MJ/kg] / ISO 6976		
Higher calorific value	[MJ/kg] / ISO 6976		
Wobbe Indices Ws / Wi	[MJ/m ³] / ISO 6976		
Density*)	[kg/m ³] / ISO 6976		
Methane*)	wt.-% [kg/kg] / ISO 6974 or DIN 51894		
Ethane*)	wt.-% [kg/kg] / ISO 6974 or DIN 51894		
Propane*)	wt.-% [kg/kg] / DIN 51894		
Isobutane*)	wt.-% [kg/kg] / DIN 51894		
N-Butane*)	wt.-% [kg/kg] / DIN 51894		
Pentane	wt.-% [kg/kg] / DIN 51894		
Hexane	wt.-% [kg/kg] / DIN 51894		
Heptane	wt.-% [kg/kg] / DIN 51894		
Nitrogen	wt.-% [kg/kg] / ISO 6974		
Sulphur*)	wt.-% [kg/kg] / ISO 6326-5		
Hydrogen sulfide	wt.-% [kg/kg] / ISO 8819		
Carbon dioxide	wt.-% [kg/kg] / ISO 6974		
Hydrogen	wt.-% [kg/kg] / DIN 51894		
Others			

2.3 Liquid fuel

Please fill in as far as possible
most important marked with *)
essential **)

Property	Unit / Standard	Actual value	Remark
Type of fuel	Grade / ISO 8217	DMB	
Flash point*)	[°C] / ISO 2719		
Viscosity @ 40/50°C **)	[mm ² /s] / ISO 3104	9.18	ISO 3104
Density @ 15°C *)	[kg/m ³] / ISO 3675 or 12185	902.8	ISO 3675
Net calorific value (Hu) *)	[J/g] / DIN 51900	43140	ASTM D4868
Sulphur content*)	ppm [mg/kg] / ISO 8754 or 14596	2610	ISO 8754
Ash content*)	ppm [mg/kg] / ISO 6245	-	
Water content*)	ppm [mg/kg] / ISO 3733	500	ISO 3733
Carbon content*)	wt.-% [kg/kg] / ASTM D5291	87.16	ASTM D5291
Hydrogen content*)	wt.-% [kg/kg] / ASTM D5291	11.91	ASTM D5291
Nitrogen content*)	wt.-% [kg/kg] / DIN 51444	0.09	ASTM D5762
Oxygen content*)	wt.-% [kg/kg] / DIN 51732	0.58	Calculation
Cetane index*)	ISO 4264		
CCAI*)			
FAME content*)	wt.-% [kg/kg] / EN 14078		
Mono aromatic compounds*)	wt.-% [kg/kg] / EN 12916		
Poly aromatic compounds*)	wt.-% [kg/kg] / EN 12916		
Di aromatic compounds	wt.-% [kg/kg] / EN 12916		
Tri aromatic compounds	wt.-% [kg/kg] / EN 12916		
Inorganic constituents (V)	ppm [mg/kg] / ISO 14597 or 8691		
Inorganic constituents (Ni)	ICP		
Carbon residues*)	wt.-% [kg/kg] / ASTM D4530	2.56	ISO 10370
Others			

3. Lube oil properties and composition (in use during testing; Producers specification can be used)

3.1 Circulation lubrication oil

Please fill in as far as possible

Property	Unit / Standard	Actual value	Remark
Lube oil	Brand / Type	-	
Grade	Multi / Mono	-	
BN	mg KOH/g / ISO 3771	-	
Ash content	wt.-% [kg/kg] / ISO 6245	-	
Viscosity	[mm ² /s] / ASTM D7042	-	
Sulphur content	wt.-% [kg/kg] / ISO 20884	-	

3.2 Cylinder oil

Please fill in as far as possible

Please fill in if applicable

Property	Unit / Standard	Actual value	Remark
Lube oil	Brand / Type	-	
Grade	Multi / Mono	-	
BN	mg KOH/g / ISO 3771	-	
Ash content	wt.-% [kg/kg] / ISO 6245	-	
Viscosity	[mm ² /s] / ASTM D7042	-	
Sulphur content	wt.-% [kg/kg] / ISO 20884	-	

3.3 Valve seat lubrication oil

Please fill in as far as possible

Please fill in if applicable

Property	Unit / Standard	Actual value	Remark
Lube oil	Brand / Type		
Grade	multi / mono		
BN	mg KOH/g / ISO 3771		
Ash content	wt.-% [kg/kg] / ISO 6245		
Viscosity	[mm ² /s] / ASTM D7042		
Sulphur content	wt.-% [kg/kg] / ISO 20884		

4. Measurement equipment information (to be completed before measurement) and parameters

Measurement instrument

4.1 BC measurement instrument information Make: AVL Model: 415S (SE)

4.2 Measurement principle ☐ LII ☒ FSN ☐ PAS ☐ MAAP
☐ Others: _____

4.3 Values reported as ☐ EC (thermal) Protocol acc.: _____
☐ rBC
☐ eBC
☒ FSN
☐ Others: _____

4.4 Values reported in unit ☐ mg/m_n^3 (wet basis; act. O_2 -concentration) H_2O -conc.: _____ [Vol.-%] (wet)
☐ mg/m_n^3 (dry basis; act. O_2 -concentration)
☐ mg/m_n^3 (dry basis; Ref. O_2 -concentration) O_2 -conc.: _____ [Vol.-%] (dry)
☐ mg/kWh refer to 5.
☒ FSN
☐ mg/kg fuel refer to 5.
☐ Others: _____

4.5 Reference conditions Norm temperature: _____ [°C]
(only if 4.4 is referred to Norm-cubic meters [m_n^3]) Norm pressure: _____ [mbar]

4.6 Sampling time / -number Sampling time of each measurement: 18 [s]
If mean values are reported: Number of consecutive measurements at each mode point: 3 [-]
Acc. manufacturer specification: ☒ Yes ☐ No

4.7 BC instrument parameter Temperature inside measuring cell: 70 [°C]
Pressure inside measuring cell: Ambient [mbar]
Wavelength(s) used: 550 [nm]
Mass absorption cross section(s) used: 2 [m^2/g]
Conversion equation(s) used: -
Repeatability of the instrument used: $\leq 0.005 \text{ FSN} + 3\%$ of measured value
Reproducibility of the instrument used: $\leq 0.005 \text{ FSN} + 6\%$ of measured value
Acc. manufacturer specification: ☒ Yes ☐ No

Other parameters which could influence the measured values:

Parameter / Correction	Unit

4.8 BC Instrument Calibration

Date of last calibration: - _____ (dd.mm.yyyy)

Calibration procedure according manufacturer specification:

☐ Yes ☐ No ☐ Others: _____

Calibration including zero point: ☐ Yes ☐ No

Used medium for zero point calibration: _____

Used calibration standard: ☐ Synthetic flame soot
☐ Printex-U
☐ Graphite spark aerosol generator GfG soot
☐ Soot with inorganic coatings
☐ Soot without inorganic coatings
☐ Reflectance standards
☐ Others: _____

Remark: _____

Leakage test performed before or after calibration: ☐ Yes ☐ No ☐ Not applicable

4.9 Sample gas pre-treatment

Please fill in if applicable

Exhaust gas dilution: ☐ Yes ☒ No

If yes, dilution ratio (1:x) _____ at mode point: _____ [%]

Dilution medium: ☐ Ambient air ☐ Exhaust gas
☐ Others: _____

Filtration of the dilution medium before dilution: ☐ Yes ☐ No

Temperature of the dilution medium: _____ [°C]

Temperature of the diluted exhaust gas: _____ [°C]

Evaporation tube ☐ Yes ☒ No
Temperature _____ [°C] acc. manufacturer spec. ☐ Yes ☐ No

Catalytic stripper ☐ Yes ☒ No
Temperature _____ [°C] acc. manufacturer spec. ☐ Yes ☐ No

Thermo-denuder ☐ Yes ☒ No
Temperature _____ [°C] acc. manufacturer spec. ☐ Yes ☐ No

Others: _____

4.10 Sample flow rate/volume

Acc. manufacturer specification: ☒ Yes ☐ No

Sample flow rate of the raw exhaust gas: _____ 10 [l/min]

Sample flow rate of the diluted exhaust gas: _____ [l/min]

Sample volume of the raw exhaust gas: _____ [l]

Sample volume of the diluted exhaust gas: _____ [l]

☐ Subkinetic ☐ Isokinetic ☐ Superkinetic ☐ Not applicable

Sample line and probe

4.11 Sample/transfer line

Please fill in if applicable

Use of a sample line: ☒ Yes ☐ No (in situ,...)

Acc. manufacturer specification: ☒ Yes ☐ No

Length of the sample line: _____ [m]

Heated sample line: ☒ Yes ☐ No Temperature: 70 [°C]

Sample line material: Viton

Inner diameter of the sample line: 4 [mm]

Isolated or heated connections between sample line, measurement instrument and probe: ☒ Yes ☐ No

Electrical conductive (sample line material): ☐ Yes ☐ No

Grounded: ☐ Yes ☒ No

Grounding method: _____

Backflushing sample line between measurements: ☒ Yes ☐ No

4.12 Sample probe

Please fill in if applicable

Use of sample probe: ☒ Yes ☐ No (in situ,...)

Acc. manufacturer specification: ☒ Yes ☐ No

Material: ☒ Stainless steel ☐ Others: _____

Type/design:

☐ Probe with single hole at the end (pipe)

☒ Probe with single hole at the end (45° beveled)

☐ Multi-hole

☐ L-shaped pipe with single hole, opening shielded with preclassifier (e.g. hat)

☐ Others: _____

Direction of the probe opening relative to the exhaust gas flow:

☐ With flow ☒ Against flow

☐ Others: _____

Effective cross section of sample hole opening(s) 17.8 [mm²]

Backflushing sample probe between measurements: ☒ Yes ☐ No

Sampling point and probe location

4.13 Sample point and probe location ■ Engine Outlet

☐ Downstream heat exchanger

☐ Downstream exhaust gas treatment device

Treatment device active during measurement ☐ Yes ☐ No

☐ Others: _____

Distance between engine outlet and sampling point: - _____ [m]

Diameter of the exhaust gas pipe: - _____ [m]

Type of exhaust gas pipe where the sample probe is located:

☐ Straight part of the exhaust gas pipe

☐ Bent part of the exhaust gas pipe

Immersion depth of the sample probe: - _____ [m]

Orientation of the exhaust gas pipe where the sample probe is located:

☐ Horizontal ☐ Vertical ☐ Others: _____

Length of straight part of the exhaust gas pipe,

if sample probe is located at straight part of the exhaust gas pipe:

Upstream sample probe: _____ [m]

Downstream sample probe: _____ [m]

Exhaust gas pulsation at the sampling point during measurement:

■ No ☐ Yes _____ [mbar]

5. Determination of engine load, exhaust gas flow, exhaust water content, fuel mass flow, O₂ and CO₂ (if applicable)

5.1 Determination of values, instrument performance and calibration shall be in accordance with the requirements of NOx Technical Code 2008 (NTC 2008) and its applicable appendices

5.2.1 Method of load determination

Waterbreak 4-20mA

5.2.2 Estimated accuracy of engine load determination

+/- 1 [%] of reading

5.3.1 Method of exhaust gas flow determination

Calculation

5.3.2 Estimated accuracy of exhaust gas flow determination

+/- 1 [%] of reading

5.4.1 Method of exhaust water content determination

Calculation

5.4.2 Estimated accuracy of exhaust water content determination

+/- 1 [%] of reading

5.5.1 Method of fuel mass flow determination

Flowmeter ProMass F

5.5.2 Estimated accuracy of fuel mass flow determination

+/- <1 [%] of reading

5.6.1 Method of O₂ and CO₂ determination

Horiba PG250/PG350

5.6.2 Estimated accuracy of O₂ and CO₂ determination

+/- 2 [%] of reading

6. Measured values for BC determination (to be completed during measurement; measured values)

Date of measurement (dd.mm.yyyy)

19.06.2015	19.06.2015	19.06.2015	19.06.2015	19.06.2015
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Engine parameters

Measurement at mode points:

100	85	75	50	25
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 [%]

	↓	↓	↓	↓	↓	
6.1 Stabilized mode point						
Actual Speed	70	66.3	63.6	55.6	44.1	[rpm]
Speed variation during measuring	1	1	1	1	1	+/- [%]
Actual Load	11335	9635	8501	5668	2834	[kW]
Load variation during measuring	1	1	1	1	1	+/- [%]
6.2 Charge air temperature	37.2	35.8	34.9	33.9	38.8	[°C]
6.3 Charge air pressure	33370.000	2970.000	2640.000	1580.000	630.000	[mbar]
6.4 Exhaust gas temp. at engine outlet	425	373	355	308	248	[°C]
6.5 Exh. gas temp. at sampling point	242	211	205	200	195	[°C]
(only if there is a significant difference to the exhaust gas temperature at the engine outlet)						
6.6 Exhaust gas back pressure	27	22.9	20.2	12.6	65	[mbar]
6.7 Exhaust gas mass flow	74520.000	70200.000	65520.000	47880.000	28800.000	[kg/h]
Ambient conditions						
6.8 Ambient temp. at engine inlet	25.2	25.5	25.6	25.8	26.2	[°C]
6.9 Ambient pressure at engine inlet	1009	1009	1009	1009	1009	[mbar]
6.10 Absolute humidity of ambient air	10.6	10.3	11	11.3	11.5	[g/kg]
7. Black Carbon						
	Reported as (see 4.3):		FSN		Unit (see 4.4): FSN	
7.1 Estimated accuracy of measured value	-	-	-	-	-	+/- [%]
7.2 Black Carbon emission	0.025	0.023	0.02	0.017	0.015	
Remark: _____						
8. Measurement repeatability Indicators						
8.1 95% confidence interval (+/- unit measured)	-	-	-	-	-	
8.2 Variance	-	-	-	-	-	
8.3 Sample size (number of measurements taken)	3	3	3	3	3	