6RT-flex50-B

9480.0 kW 95.2% R1
124.0 rpm 100.0% R1

IMO Tier I compliant

Project:
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Summary (FW cooled / single-stage SAC / separate HT)

Bore		500	mm
Stroke		2050	mm
MEP		19.0	bar
Piston speed		8.5	m/s
Length		7093	mm
Weight dry		225	t
Weigth water/oil		2.49	t
Lift vertical (standard)		9270	mm
E/R crane capacity		2.5	t
BSFC, tolerance 5 % IMO NOx compl. (ISO Ref. Cond.)		168.6	g/kWh
System oil consumption		5	kg/cyl per day
Cylinder oil consumption (Pulse lubricating system) *1)		0.7	g/kWh guide feed rate
Turbocharger		MHI	1 x MET60MA
Scavenge air cooler			1 x SAC65F
Governor type	KM		DGS C20
(Electronic)	Lyngsoe		EGS2000RTf
	NABCO		MG-800 FLEX
Aux. blower: min. installed electric motor power (shaft)		2 x 27	kW (380/440 V / 50/60 Hz)
Turning gear capacity		2.2	kW (440 V / 60 Hz)
Fuel oil booster P/P		4.3	m3/h
Fuel oil feed P/P		2.4	m3/h
High temperature water circuit P/P		80	m3/h
Low temperature water circuit P/P		297	m3/h
Main lubricating oil P/P		124	m3/h
Sea water P/P		258	m3/h
SAC (LT), heat dissipation		3108	kW
SAC (LT), fresh water flow		227	m3/h
Lub. oil cooler, heat dissipation		810	kW
Lub. oil cooler, oil flow		124	m3/h
Lub. oil cooler, fresh water flow		70	m3/h
Cylinder cooler, heat dissipation		1367	kW
Cylinder cooler, fresh water flow		80	m3/h
Central cooler, heat dissipation		5285	kW
Exhaust gas, mass flow		69.5	t/h
Exhaust gas, temperature		297.2	°C
Air consumption		68.9	t/h
Engine radiation		104	kW
Main lub. oil drain tank		13	m3
Fresh water expansion tank		0.50	m3
Sludge oil tank		2	m3
Air compressor (30 bar)		2 x 59	m3/h
Air receiver (30 bar)		2 x 1.9	m3
HFO separator		1960	l/h
LO separator		1330	l/h
FO endheater		97	kW

*1) Accepted alternative CLU3 with 0.9 - 1.3 g/kWh

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Selection Overview

Engine Data

Power	Rx :	9480.0 kW	=	95.2% R1	Power	R1 :	9960.0 kW
Speed	Rx :	124.0 rpm	=	100.0% R1	Speed	R1 :	124.0 rpm

Turbocharger (MHI type) :	1 x MET60MA	Bore :	500 mm
Scavenge air cooler :	1 x SAC65F	Stroke :	2050 mm

Reference Conditions

Air temperature before blower	25.0	°C
Engine room ambient air temp.	25.0	°C
Coolant temperature before SAC	29.0	°C
Barometric pressure	1000.0	mbar

Design Conditions

Air temperature before blower	45.0	°C
Engine room ambient air temp.	45.0	°C
Coolant temperature before SAC	36.0	°C
Barometric pressure	1000.0	mbar

Ancillary Systems

Cooling system : Fresh water cooled / single-stage SAC /separate HT
Cylinder cooling water inlet temperature : 70.0 °C
Cylinder cooling water outlet temperature : 85.0 °C

Lub. oil system : Lubricating oil system incl. TC
Oil temperature before engine : 45.0 °C
Oil pressure before engine: 5.7 bar
Viscosity: 85.1 mm2/s

Exhaust gas back pressure at rated power (Rx) : 300.0 mm WG

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Engine Performance Data

Reference Conditions			Design Conditions		
Air temperature before blower	25.0	°C	Air temperature before blower	45.0	°C
Engine room ambient air temp.	25.0	°C	Engine room ambient air temp.	45.0	°C
Coolant temperature before SAC	29.0	°C	Coolant temperature before SAC	36.0	°C
Barometric pressure	1000.0	mbar	Barometric pressure	1000.0	mbar
Cylinder water outlet temperature	85.0	°C	Cylinder water outlet temperature	85.0	°C
Oil temperature before engine	45.0	°C	Oil temperature before engine	45.0	°C
Exhaust gas back pressure	300.0	mm WG	Exhaust gas back pressure	300.0	mm WG

Fresh water cooled / single-stage SAC /separate HT - 1 x MET60MA / 1 x SAC65F

Performance					Reference Conditions			Design Conditions		
Power %CMCR	Power [kW]	Speed rpm	mps m/s	mep bar	BSFC g/kWh	BSEF kg/kWh	tEaT °C	BSFC g/kWh	BSEF kg/kWh	tEaT °C
110.0	10428.0	128.0	8.7	20.2	170.3	7.50	275.9	173.3	7.11	306.0
100.0	9480.0	124.0	8.5	19.0	168.6	7.72	267.2	171.6	7.33	297.2
95.0	9006.0	121.9	8.3	18.4	166.8	7.79	262.9	169.8	7.39	292.9
90.0	8532.0	119.7	8.2	17.7	165.6	7.82	259.0	168.6	7.43	289.0
85.0	8058.0	117.5	8.0	17.0	165.2	7.88	256.4	168.2	7.49	286.4
80.0	7584.0	115.1	7.9	16.4	165.1	7.98	255.3	168.1	7.59	285.3
75.0	7110.0	112.7	7.7	15.7	165.1	8.07	255.8	168.1	7.68	285.9
70.0	6636.0	110.1	7.5	15.0	165.4	8.09	258.3	168.4	7.70	288.4
60.0	5688.0	104.6	7.1	13.5	166.8	8.03	270.4	169.8	7.64	300.4
50.0	4740.0	98.4	6.7	12.0	168.8	7.84	292.7	171.8	7.45	322.8
40.0	3792.0	91.4	6.2	10.3	171.2	7.54	326.2	174.2	7.14	356.2

Abbreviations

BSFC : Brake specific fuel consumption with lower calorific value 42707 kJ/kg
BSEF : Brake specific exhaust gas flow
tEaT : Temperature of exhaust gas after turbine
CMCR: Contract maximum continous rating
mps : Mean piston speed
mep : Mean effective pressure

Tolerances

BSFC : + 5 %
BSEF : ± 5 %
tEaT : ± 15 °C

An increase of BSEF by 5 % corresponds to a decrease of the tEaT by 15 °C

The above performance values correspond to the lower calorific value of 42707 kJ/kg (MDO).
On heavy fuel operation, the resulting values for tEaT could be higher.

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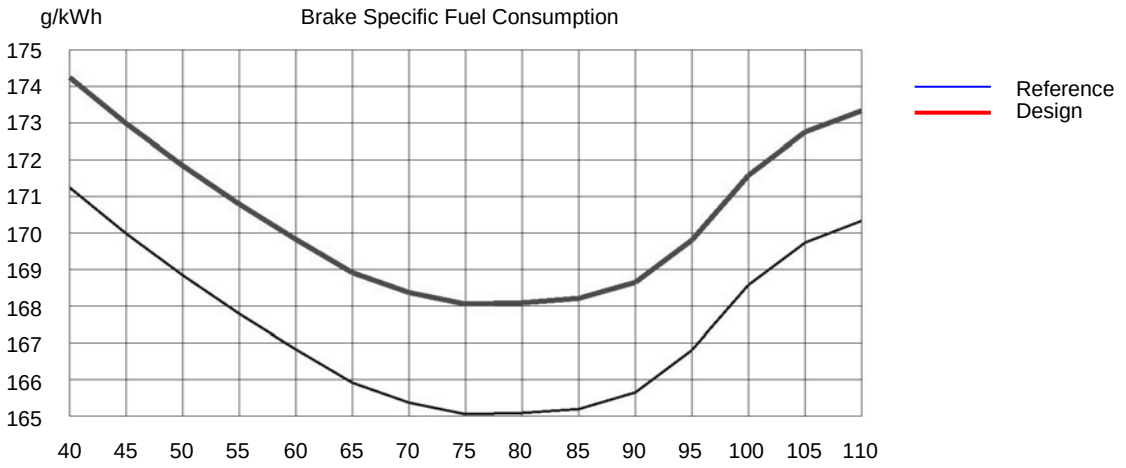
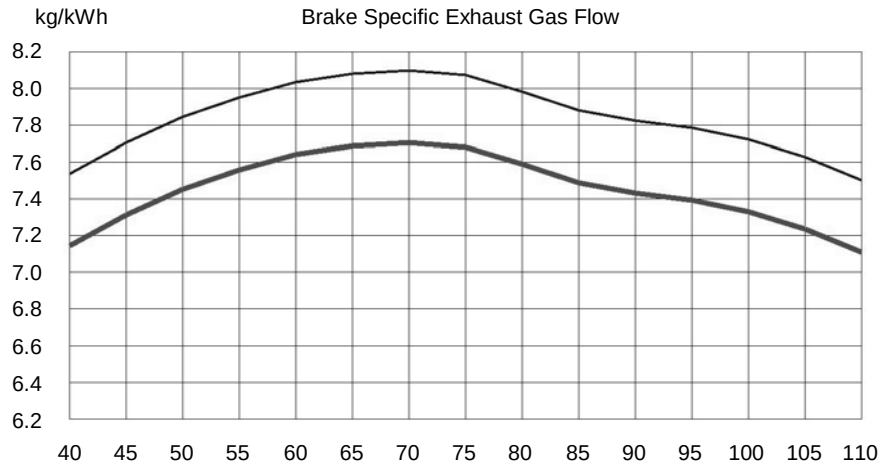
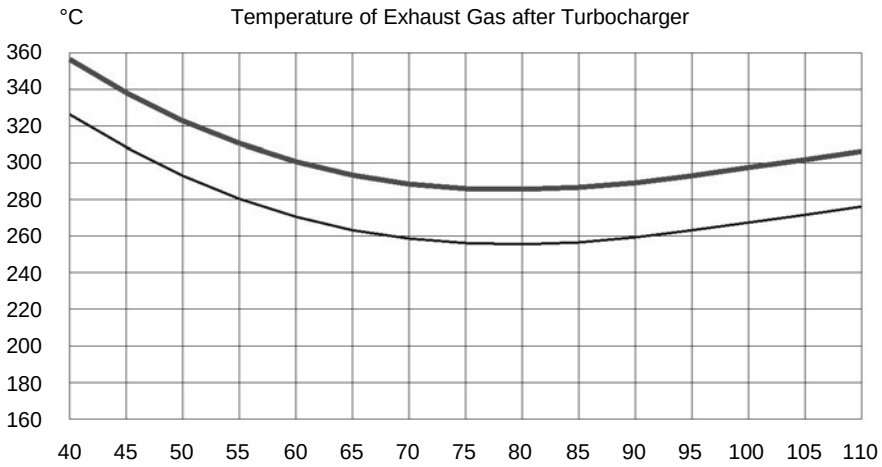
Engine Performance Data - Diagrams







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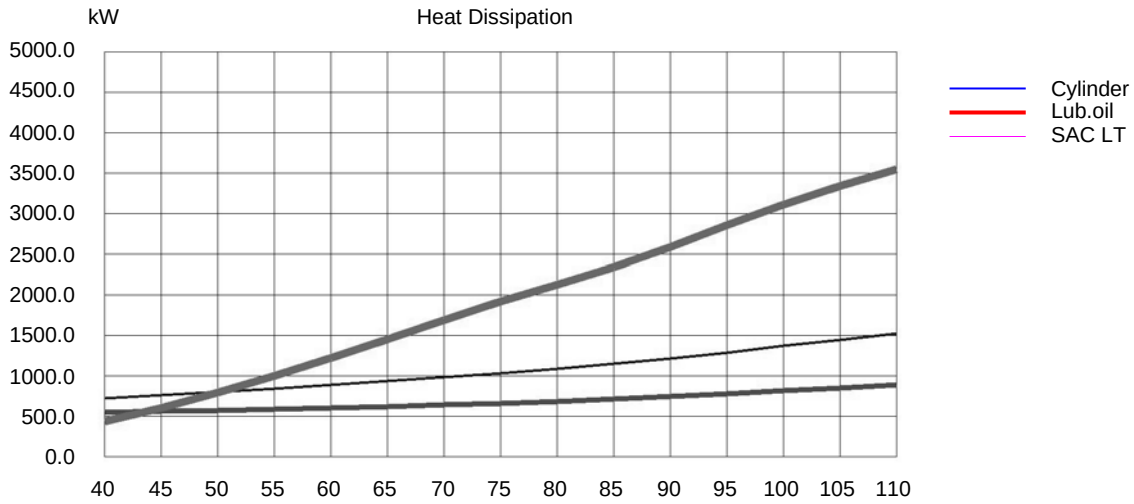
Heat Dissipation

Design Conditions

Air temperature before blower	45.0 °C	Turbocharger (MHI type) :	1 x MET60MA
Engine room ambient air temp.	45.0 °C	Scavenge air cooler :	1 x SAC65F
Coolant temperature before SAC	36.0 °C		
Barometric pressure	1000.0 mbar	Fresh water cooled / single-stage SAC /separate HT	

Power %CMCR	Power [kW]	SAC LT kW	Cylinder kW	Lub. oil kW	Radiation kW	Exh. heat recov. kW
110.0	10428.0	3542	1519	885	104	2882
100.0	9480.0	3108	1367	810	104	2513
95.0	9006.0	2853	1284	776	104	2326
90.0	8532.0	2584	1208	744	104	2143
85.0	8058.0	2336	1144	711	104	1994
80.0	7584.0	2125	1086	681	104	1884
75.0	7110.0	1914	1028	657	104	1797
70.0	6636.0	1684	980	636	104	1719
60.0	5688.0	1221	886	598	104	1612
50.0	4740.0	789	794	569	104	1538
40.0	3792.0	433	717	542	104	1442



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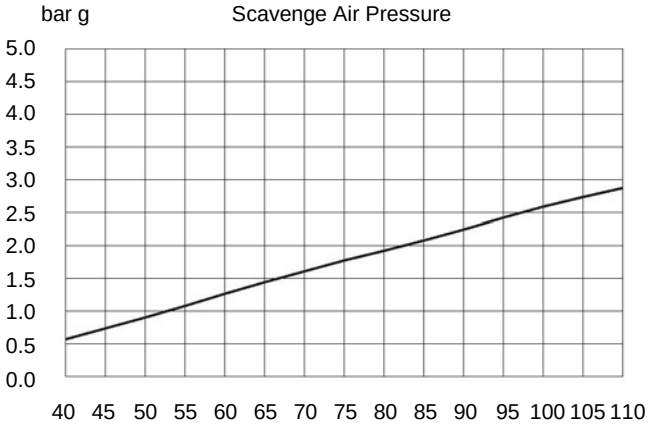
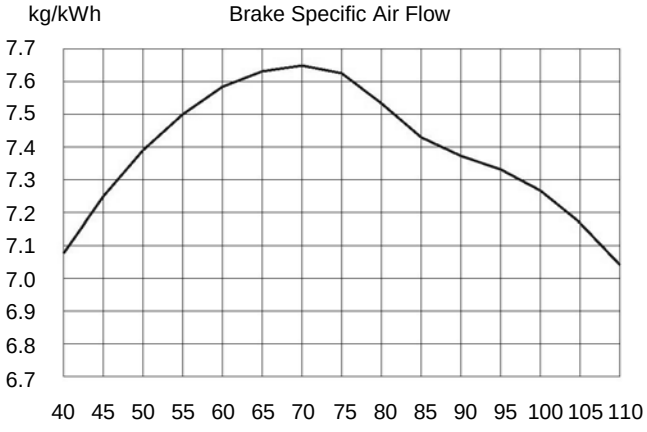
Scavenge Air System

Design Conditions

Air temperature before blower	45.0	°C	Turbocharger (MHI type) :	1 x MET60MA
Engine room ambient air temp.	45.0	°C	Scavenge air cooler :	1 x SAC65F
Coolant temperature before SAC	36.0	°C		
Barometric pressure	1000.0	mbar	Fresh water cooled / single-stage SAC /separate HT	

Power %CMCR	Power [kW]	after TC °C	after SAC °C	Mass flow kg/h	Pressure bar g
110.0	10428.0	224.7	48.4	73411	2.87
100.0	9480.0	211.7	46.8	68877	2.59
95.0	9006.0	203.8	45.9	66020	2.42
90.0	8532.0	195.1	44.9	62887	2.24
85.0	8058.0	186.7	44.0	59859	2.07
80.0	7584.0	179.2	43.3	57120	1.92
75.0	7110.0	171.6	42.6	54212	1.77
70.0	6636.0	163.0	41.8	50751	1.61
60.0	5688.0	143.6	40.1	43137	1.26
50.0	4740.0	120.9	38.7	35029	0.90
40.0	3792.0	96.4	37.4	26831	0.56





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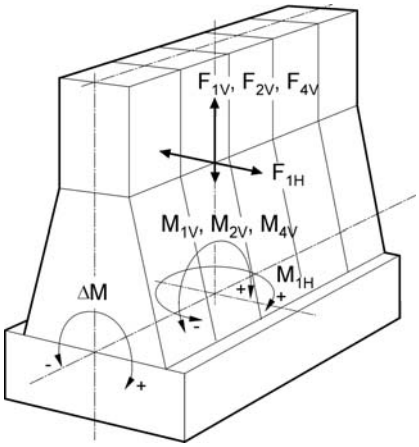
Dynamic Characteristics

External couples and forces



Massmoments and Forces

External moments		[±kNm]	Free forces	[±kN]
M_{1V}	standard counterweights	0	F_{1V}	0
M_{1H}	standard counterweights	0	F_{1H}	0
M_{2V}		938	F_{2V}	0
M_{4V}		65	F_{4V}	0

Countermeasures for Dynamic Effects

External couples (2nd order balancer) :	Balancing countermeasure is unlikely needed*1)
Torsional vibration :	Detailed calculations have to be carried out for every installation
Axial vibration :	An integrated axial damper is fitted as standard
Lateral rocking (side-stays) :	The countermeasure indicated may be needed
Lateral rocking (longitudinal-stays) :	The countermeasure indicated is not needed

*1) No engine-fitted 2nd order balancer available. If reduction of M2v is needed, an external compensator has to be applied.

Rating R1 : 1660 kW/Cyl. / 124 rpm

Lateral H-Moments

Orders	[±kNm]	Orders	[±kNm]
Ord. 1	0	Ord. 7	0
Ord. 2	0	Ord. 8	0
Ord. 3	0	Ord. 9	0
Ord. 4	0	Ord. 10	0
Ord. 5	0	Ord. 11	0
Ord. 6	551	Ord. 12	13

Lateral X-Moments

Orders	[±kNm]	Orders	[±kNm]
Ord. 1	0	Ord. 7	0
Ord. 2	82	Ord. 8	33
Ord. 3	149	Ord. 9	46
Ord. 4	221	Ord. 10	11
Ord. 5	0	Ord. 11	0
Ord. 6	0	Ord. 12	0

Torque variation ΔM 561 [±kNm]

The value of lateral forces and moments of other engine ratings and orders are available on request.

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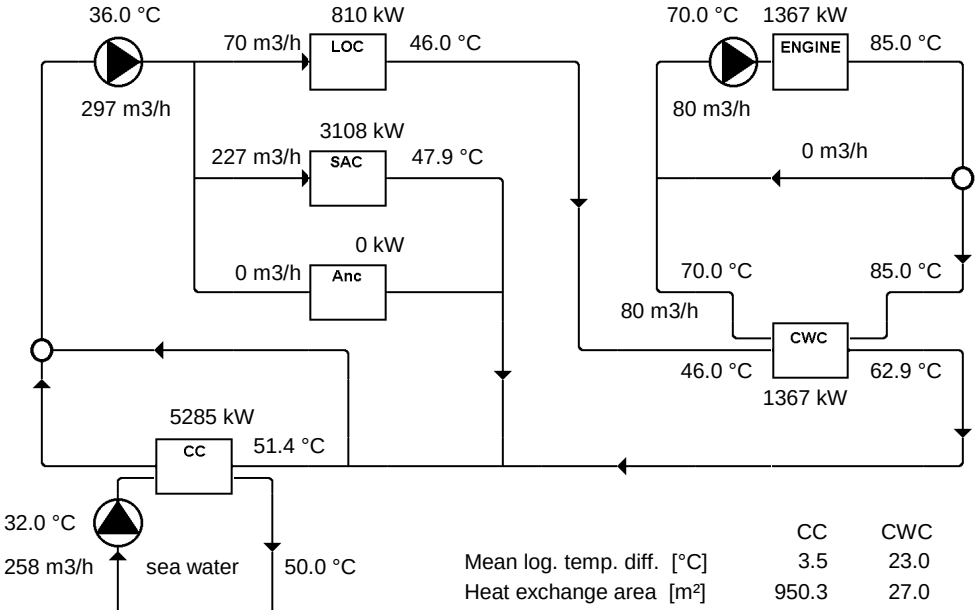
Cooling System

Design Conditions

Air temperature before blower	45.0 °C	Turbocharger (MHI type) :	1 x MET60MA
Engine room ambient air temp.	45.0 °C	Scavenge air cooler :	1 x SAC65F
Coolant temperature before SAC	36.0 °C		
Barometric pressure	1000.0 mbar	Fresh water cooled / single-stage SAC /separate HT	

FW Cooled / Single-Stage SAC / Sep. HT



	CC	CWC
Mean log. temp. diff. [°C]	3.5	23.0
Heat exchange area [m²]	950.3	27.0

System data at 100 %Rx (9480.0 kW)

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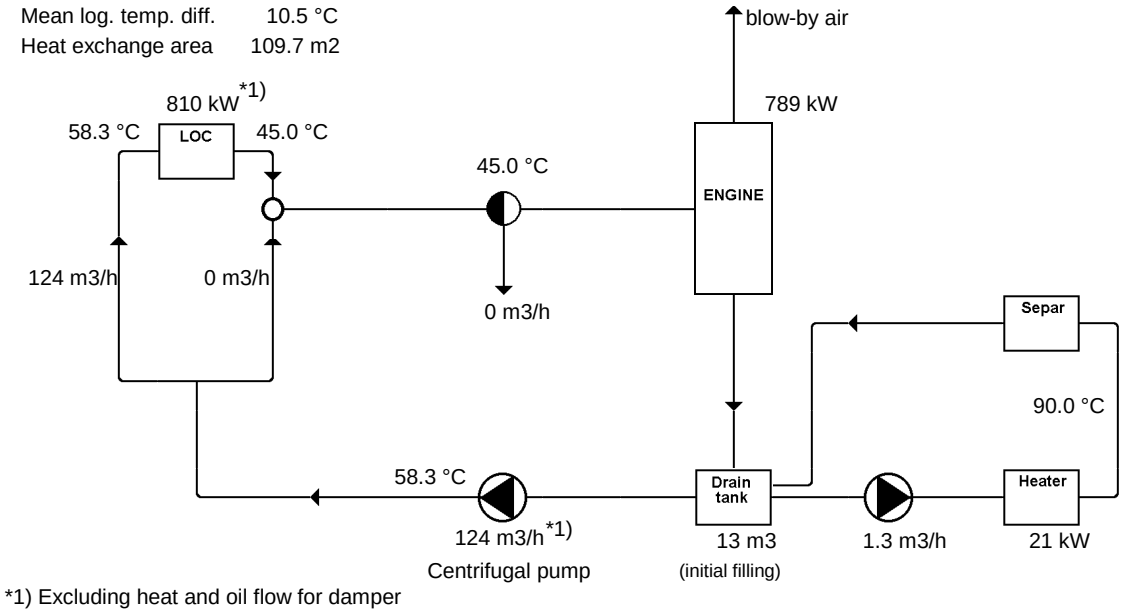
Lubricating Oil System

Design Conditions

Air temperature before blower	45.0 °C	Turbocharger (MHI type) :	1 x MET60MA
Engine room ambient air temp.	45.0 °C	Scavenge air cooler :	1 x SAC65F
Coolant temperature before SAC	36.0 °C		
Barometric pressure	1000.0 mbar	Fresh water cooled / single-stage SAC /separate HT	

Main Lub. Oil System incl. TC



*1) Excluding heat and oil flow for damper

System data at 100 %Rx (9480.0 kW)

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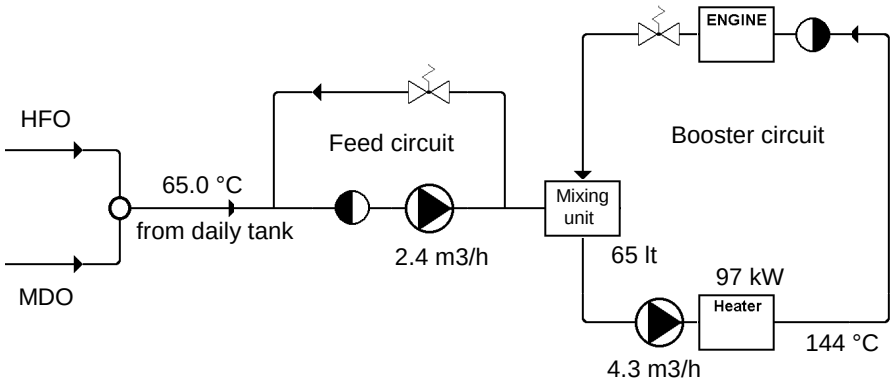
Fuel Oil System

Tank System Data and HFO Treatment

Feed circuit	HFO setting tank	15	m3	8 h operation at MCR
	HFO daily tank	15	m3	8 h operation at MCR
	MDO daily tank	15	m3	8 h operation at MCR
	Feed pump	2.4	m3/h	
Booster circuit	Booster pump	4.3	m3/h	
	HFO endheater	97	kW	
	Mixing unit	65	lt	
Treatment	Separator throughput	2.0	m3/h	
	HFO preheater	39	kW	

Pressurized Fuel Oil System



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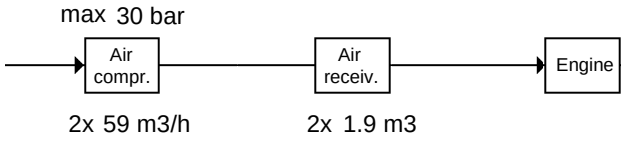
Starting Air System

Design Conditions

Air temperature before blower	45.0 °C	Turbocharger (MHI type) :	1 x MET60MA
Engine room ambient air temp.	45.0 °C	Scavenge air cooler :	1 x SAC65F
Coolant temperature before SAC	36.0 °C		
Barometric pressure	1000.0 mbar	Fresh water cooled / single-stage SAC /separate HT	

Number of starts : 12 *2)
Propeller pitch control : FPP

Relative shaft inertia J_{Tot} / J_{Eng} : 2.0
Engine inertia J_{Eng} : 33000 kgm2 *3)



For 30 bar design

Air receiver : 2 x 1.9 m3
Air compressor : 2 x 59 m3/h

The above capacities are for the engine only. If additional consumers for board purposes must be supplied with air, then additional capacity must be provided.

*2) 12 consecutive starts of the main engine, alternating between ahead and astern
*3) Data given for engine without damper and front disc on crankshaft but included smallest flywheel

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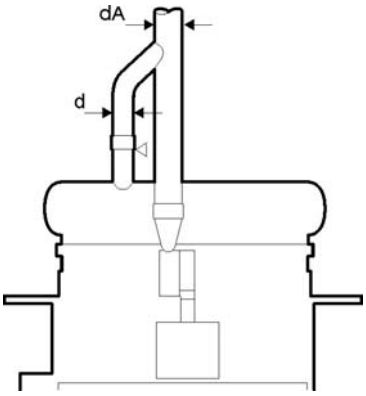
Exhaust Gas System

Design Conditions

1 x MET60MA



Exhaust gas

Mass flow	69480	kg/h
Temperature after TC	297.2	°C
Density	0.628	kg/m3
Backpressure	300	mmWG

*1) The reason for this bypass pipe is to allow engine operation after turbocharger failure, during normal operation it is blinded off.

Pipes	Gas velocity m/s	Volume flow m3/h	Diameter mm
Pipe A	40	110529	dA 1000

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Pumps

Design Conditions

Air temperature before blower	45.0	°C	Turbocharger (MHI type) :	1 x MET60MA
Engine room ambient air temp.	45.0	°C	Scavenge air cooler :	1 x SAC65F
Coolant temperature before SAC	36.0	°C		
Barometric pressure	1000.0	mbar	Fresh water cooled / single-stage SAC /separate HT	

Pumps	Minimum capacities m3/h	Delivery head *2) bar
Lubricating oil *3)	124	7.6
High temperature water circuit	80	2.5
Low temperature water circuit	297	2.0
Fuel oil booster	4.3	7.0
Fuel oil feed	2.4	4.0
Sea-water	258	2.2

*2) Pressure difference across pump (final delivery head) must be according to the actual piping layout

*3) Excluding oil flow for damper

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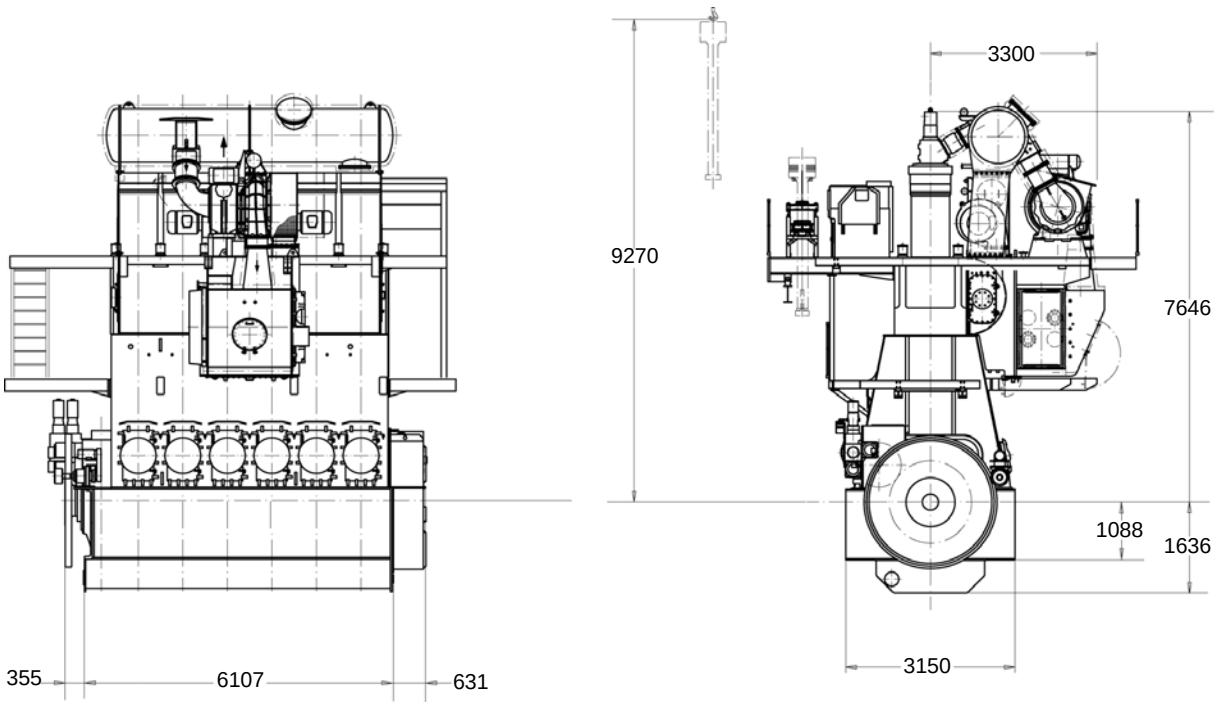
Installation Data



Net engine mass: 225 t
Minimum crane capacity: 2.5 t

Engine mass is calculated according to nominal dimensions of drawings, incl. turbochargers and scavenge air coolers (specified for R1), piping and platforms but without oil / water. The dimensions are in mm across R1-rated engines without Efiiciency-Booster System with a tolerance of approx. +/- 10 mm.

The standard piston dismantling height as shown in the sketch can be reduced by using special tools and / or tilted lift of the piston.

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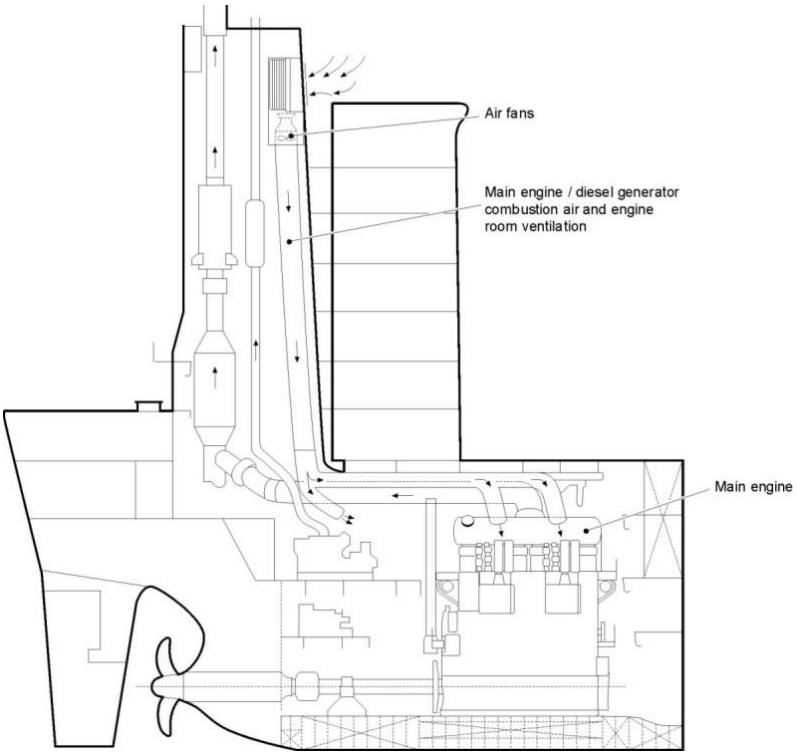
Engine Room Ventilation



Combustion air required	Power / Heat kW	Air flow m3/h
Main engine	9480	60952
Auxiliary engines	1672	10653
Boiler	5000	7654
Ventilation air required		
Radiated heat	555	
Ventilator	308	188881

Based on : air outdoor temperature : 35°C
delivery head of the ventilation air blower : 30 mbar