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Content

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1 PROPULSION MACHINERY

General

Ambient conditions

The equipment is designed for the following conditions:

Maximum ambient air temperature	45 °C
Maximum LT cooling water temperature before engine	38 °C
Maximum sea water temperature	32 °C

Classification

The equipment meets the requirements of DNV GL for unrestricted service at the date of quotation.

Validity of classification and other rules

The Equipment shall be delivered according to the valid edition of the mentioned rules, regulations and requirements of the Classification Society and Authority or Marine Organization at the date of the quotation. In the event that the rules, regulations and requirements of the Classification Society or Authority or Marine Organization change after the quotation date the Supplier shall have the right to adjust the quotation price and the Delivery date resulting from such changes.

Electric power supply

If not specially mentioned, all electrical equipment delivered with the engine is designed to operate with:

Main voltage	3x440 V
Frequency	60 Hz

Fuel oil quality

The equipment is specified for fuel according to ISO 8217:2017 (E) with a viscosity of max. 380 cSt/50°C.

HFO

The following conditions, not specified in the ISO standard also apply:

Viscosity min., before injection pumps	16 cSt
Viscosity max., before injection pumps	24 cSt
CCAI, max.	870
Water before engine, max	0.3 % volume
Sodium before engine, max	30 mg/kg
Aluminium + Silicon before engine, max	15 mg/kg
Asphaltenes, max	14 % mass

MDF

The following conditions, not specified in the ISO standard also apply:
Viscosity min., before injection pumps ..... 1.8 cSt
Viscosity max., before injection pumps ..... 24 cSt
Flash point (PMCC), min ..... 60 °C
Pour point, max ..... 0-6 °C

Water quality

Fresh cooling water shall be treated with approved products.

Lubricating oil quality

Only approved oils shall be used for the equipment.

1.1 Main Engine(s)

Application

Engine driving a generator at constant speed.

Main particulars

Max continuous rating (MCR) ..... 1110 kW
Speed ..... 900 rpm
Configuration ..... In-line engine
Number of cylinders 6
Cylinder bore ..... 200 mm
Stroke ..... 280 mm
Swept volume per cylinder ..... 8.8 dm^3
Mean piston speed ..... 8.4 m/s
Mean effective pressure ..... 28 bar
Direction of rotation, looking at driving end ..... Clockwise

The max continuous rating (MCR) is valid at ambient conditions mentioned above.

Fuel oil consumption (SFOC)

Fuel consumption at shaft according to ISO 15550 with engine driven pumps using HFO and corrected to a net calorific value of 42,700 kJ/kg:
85 % load ..... 190.3 g/kWh
Tolerance ..... 5 %

Lubricating oil consumption

100 % load ..... 0.5 g/kWh
Tolerance ..... 0.1 g/kWh

Lubricating oil consumption does not include treatment losses or oil changes.

NOx Emissions

The standard engine complies with the maximum permissible NOx emission according to the MARPOL 73/78 ANNEX VI Tier II NOx emission standard.

Testing

The engine will be tested at the max continuous rating (MCR) in our workshop in accordance with the requirements of the classification society and our own standard specification. The fuel oil used during the test run is closest to the actual specification available at supplier factory. The engine power is locked to 110% MCR.

Engine specification

The engine is a four-stroke, turbocharged and intercooled diesel engine. The following equipment is mounted on the engine:

Fuel system
- One injection pump per cylinder
- Adjustable throttle valve in the return pipe

Lubricating oil system
- Engine driven lubricating oil pump with built-in safety valve and pressure regulating valve, Without stand-by connections
- Electric motor driven pre-lubricating oil pump with built-in safety valve
- Automatic lubricating oil filter of back flushing type equipped with a differential pressure sensor
- Centrifugal filter mounted in the by-pass line
- Lubricating oil cooler of plate type
- Lubricating oil thermostatic valve
- Wet oil sump
- Separator connections including shut off valves

Starting air system
- Starting air motor with pressure reducing and safety valve
- Starting air master valve
- Blocking valve for turning gear
- Control air container
- Non-return valve

Cooling water system
- Engine driven HT-cooling water pump Without stand-by connection
- HT thermostatic valve, direct acting type
- Adjustable orifice in HT by-pass line
- Engine driven LT-cooling water pump Without stand-by connection
- LT thermostatic valve, direct acting type
- Adjustable orifice in LT by-pass line

Combustion air and exhaust gas system
- Turbocharger(s) with air filter and silencer at Free end of engine
- Exhaust gas outlet(s) orientation, 0° from vertical
- Single-stage charge air cooler(s)
- Connection(s) for cleaning device of turbine
- Cleaning device for compressor(s), manually operated
- Air waste gate
- Variable inlet valve closing system

Control and monitoring equipment on engine
- Hydraulic fuel rack actuator for electronic speed control
- Electro-pneumatic shutdown system independent of the governor
- Microprocessor based distributed real time system for engine control and monitoring

Main components:
- Engine safety module for shutdown of engine acc. to class requirements
- Main control module for internal engine control functions
- Input /output modules for handling of sensor data

Main functions:
- shutdowns (e.g. lubricating oil pressure, overspeed)
- start blockings (e.g. lubricating oil pressure, turning gear)
- measuring of engine and turbocharger speed
- normal start and stop of the engine
- engine speed control
- other internal engine control functions as applicable
- signal processing of engine monitoring and alarm sensors

- hardwired interface with external systems for control functions such as remote start and stop

Operator interface
The operators interface is based on a local control panel (LCP) built on the engine, consisting of a display unit, backup indications and control switches & buttons.

The local display unit shows all engine measurements (e.g. temperatures and pressures) and provides various engine status indications as well as an event history

The following independent backup indications are available:
- Engine rpm
- Turbocharger rpm
- Running hours
- HT water temperature
- Lubricating oil pressure

The LCP is equipped with the following control switches and pushbuttons:
- BLOW/BLOCKED/LOCAL/REMOTE control mode switch
- Local START/STOP pushbuttons
- Trip/Shutdown RESET pushbutton
- Emergency stop pushbutton

Sensors
- Alarm, safety and measuring sensors according to maker and class requirements.
- Connections for testing of pressure sensors
- Sensors are wired to the engine mounted I/O- and control modules

Miscellaneous
- Flywheel with a gear rim for turning
- Manual turning device
- Crankcase explosion valves
- Indicator valve in each cylinder head
- Nameplates in English
- Counter flanges, gaskets, bolts and nuts
- Torsional vibration damper or tuning mass in case needed

Painting
- The generating set will be painted with factory standard colour RAL 5019 Capri Blue

1.2 Fuel oil system

The main components mounted on a steel frame are:
- 2 separator(s) of automatic discharge type
- Suction strainer
- Electrically driven separator feed pump
- Electric heater with safety valve
- Sludge tank with heating coils
- Sludge pump
- Motor starters

Local control panel including temperature control, sequencing, individual alarm indication and group alarm contact

A self-contained skid equipped with a drip-tray comprising the following main components:
- HFO/MDO 3-way changeover valve on fuel oil inlet side, with automatic handling of fuels from the dedicated tanks

- Suction strainer, 2 pcs
- Feed pumps, 2 pcs (duty and stand-by) of screw type with safety valves, shut off valves, non-return valves and mechanical shaft seals
- Pressure control valve for feeder pumps, with air cooler on return line
- An automatic filter with a manual by pass filter installed before the mixing tank with differential pressure indicator and alarm contact.
- Volumetric flow meter with local indication and by-pass line installed before the missing tank
- Insulated mixing tank provided with:
  - Level switch
  - Safety valve
  - Manual drain and deaeration valves
  - Trace heating
- Circulating pumps. 2 pcs (duty and stand-by) of screw type with safety valves, shut off valves, non-return valves and mechanical shaft seals
- Electric heaters (2 pcs) with a capacity of 100% each. Shut-off valves and safety valves
- Plate type MDO Cooler with automatically controlled 3-way valve
- Viscosity control system with shut-off valves and by-pass line
- Feeder and booster pump starters with stand-by automatics
- Local control panels with individual alarm indications and group alarm contacts
- Pressure gauges and thermometers after feeder pumps, booster pumps and heaters

The fuel pipes are equipped with Electric trace heating, insulated and covered with steel plate.

Spring loaded pressure control valve

Duplex filter with differential pressure indicator with alarm contact. The inserts can be exchanged with engine running.

Electric motor driven screw pump with safety valve

1.3 Lubricating oil system

The main components mounted on a steel frame are:
- Separator of automatic discharge type
- Suction strainer
- Electrically driven separator feed pump
- Electric heater with safety valve
- Operating water tank
- Sludge tank with heating coils
- Sludge pump
- Motor starters
- Local control panel including temperature control, sequencing, individual alarm indication and group alarm contact

1.4 Compressed air systems

The total air volume of the starting air vessels are calculated for 12 starts.

Starting air vessel (0.710 m^3) for Vertical mounting with:
- Valve head assembly with inlet, outlet, drain and safety valves
- Counter flanges, gaskets, bolts and nuts

Starting air vessel size to be confirmed by customer, since the approval discussions are carried out between system designer and classification society.

1.4.2 Starting air compressor unit 1

- Two electric motor driven compressors
- Air intake filters
- Air coolers
- Oil and water separator
- Control box for automatic or manual operation
- Pressure switch for starting and stopping the compressor
- Safety valve
- Counter flanges, gaskets, bolts and nuts

1.4.3 Air filter (starting air inlet) 1

- engine built air equipment protection strainer

1.5 Cooling water systems

1.5.1 Central cooler 1

Combined HT/LT fresh water central cooler of plate type.

- Counter flanges, gaskets, bolts and nuts

1.5.2 Preheating unit 1

HT cooling water preheating unit with:

- Electric heater
- Circulating pump
- Non-return valve
- Safety valve
- Control cabinet for heater and pump
- The unit is dimensioned to warm up the engine(s) from 20ºC to 60ºC in 10-15 hours, excluding losses in the external system.
- The unit is dimensioned for 1 engine(s).

1.6 Combustion air and exhaust gas systems

1.6.1 Turbocharger cleaning device 1

Turbocharger water cleaning device for turbocharger turbine side:

- Dosing unit
- 10 meter hose with quick couplings

1.6.2 Connection piece 1

Conical transition piece after the exhaust gas bellows on the turbocharger.

1.6.3 Exhaust gas bellows 1

Flexible expansion bellows after turbocharger.

- Counter flanges, gaskets, bolts and nuts

1.6.4 Exhaust gas silencer with spark arrestor 1

Uninsulated exhaust gas silencer with spark arrestor with approximately 35 dB(A) noise reduction.

- Counter flanges, gaskets, bolts and nuts

1.7 Control and monitoring systems

1.7.1 Power Unit 1

Power unit for supply of isolated and duplicated 24VDC to the engine.

Cabinet for bulkhead mounting, protection degree: IP44

Main components

- 230VAC/24VDC power supply converters

- Miniature Circuit Breakers (MCBs) and terminals

The converters are dimensioned for 100% load and redundant. Failure of one supply will cause automatic takeover by the second supply.

Required power supply from ship's system:
- Supply 1: 230VAC
- Supply 2: 230VAC

At least one of these must be connected to UPS on ship's side.

1.7.2 Speed indicator for engine (ECR) 1

Tachometer for engine speed
- 96 mm x 96 mm, white background, black text

1.7.3 Speed indicator for engine (Bridge) 1

Tachometer for engine speed
- 96 mm x 96 mm, black background, yellow text
- Illuminated

1.8 Electric motor starters

1.8.1 Starter for engine pre lubricating oil pump 1

Starter cabinet for electrical pre lubricating oil pump

Features of the starter:
- Main switch
- Mode selection switch
- Indication lights

1.8.2 Starter for HFO/MDF circulating pump 1

Starter cabinet for electrical HFO/MDF circulating pump

Features of the starter:
- Main switch
- Mode selection switch
- Indication lights

1.9 Foundation

1.9.1 Flexible pipe connections spare set 1

Spare set of flexible hoses including one for each type of pipe connections on engine(s).

1.9.2 Common base frame 1

Foundation for the engine and the alternator:
- Common base frame of welded steel
- Flexible mounts for common base frame
- The generator and engine will be mounted on the common base frame at our factory
- Alternator fittings materials are included.
- Flywheel cover between engine and alternator

1.9.3 Flexible pipe connections 1

Flexible hoses for the pipe connections on engine(s).

1.10 Power transmission

1.10.1 Flexible coupling (flywheel) 1

The final choice of flexible coupling will be based on the torsional vibration calculations (made after the order).

Bolts for connecting the coupling to the flywheel

1.10.2 Flexible coupling fitting materials 1

Bolts for connecting the coupling to the flywheel

1.10.3 Generator 1

Brushless 3-phase synchronous alternator with automatic voltage regulator for marine installation.

Output ..... 1322 kVA
Speed ..... 900 rpm
Frequency ..... 60 Hz
Voltage ..... 450 V
Cos.phi 0.8
Insulation / Temperature rise ..... H/F
Bearings ..... Antirfiction
Enclosure IP44
Mounting IM1101

Construction

The frame and the end shields are of welded or cast construction, treated with primer for protection against corrosion. The outer surfaces are treated at the factory with paint finish. The rotors are designed to withstand the vibration caused by the prime mover and the stresses appearing at 120% rated speed.

Water cooling

The generator is cooled with a shaft mounted fan. The cooling air is circulated inside the generator through a double tube air-to-water heat exchanger.

Antifriction bearings

Antifriction bearings are standard grease lubricated bearings.

Brushless excitation

The excitation system comprises an electronic voltage regulator, an exciter and a rotating diode bridge. The voltage regulator controls the generator output voltage, supplying the excitation current to the exciter. The exciter and the diode bridge operate as an amplifier and supply the excitation current to the generator main poles.

Voltage control

The generator can be operated in parallel. The static accuracy of the generator voltage is better then ±1% at all symmetrical loads from no-load to rated load. The voltage can be set within ±10% of the rated voltage.

Overcurrent capability

The stator winding withstands a current, which can be over 3 times the rated current for the class specified amount of time.

Accessories

- Anti-condensation heater 230 VAC
- 6 pieces of PT 100 in stator windings, (3 in use and 3 as spare)
- One PT 100 in each bearing
- Air filter

One set of spare parts according to the recommendation of the classification society is included.

1.11 Tools and spare parts

Tools for the engine according to enclosed tools list

Spare parts according to the recommendations of the IACS, unrestricted service, for the engine(s) according to enclosed spare parts list

1.12 Packing and transportation

The engine is protected during transportation by a plastic VCI-film (Volatile Corrosion Inhibitor).

The engine is protected during transportation by a tarpaulin.

The engine is provided with a temporary wooden or steel foundation during transportation.

1.13 Technical documentation

Installation Planning Instructions
Delivery includes, in English, Installation Planning Instructions (IPI) necessary for Buyer's installation work of equipment in Wärtsilä scope of supply.

Any delivery schedule of the IPI is subject to timely supply of necessary, complete and correct technical data and drawings by Buyer. A document delivery schedule (DDS) is part of the Contract.

InfoBoard
InfoBoard enables online access to project specific documentation (IPIs) and product related documentation (Product Guides). InfoBoard can be accessed via any internet service provider with one or several personal login names and passwords free of charge.

Access to the project specific documentation will expire in February in the year after the warranty for the project has expired.

Operating & maintenance manuals, spare parts catalogues, certificates and the record book of engine parameters are also published through InfoBoard.

Type	Media	Language	Qty
Installation planning instructions (Wärtsilä 6L20)	InfoBoard + A4 binder	English	3

Classification drawings
Buyer shall prepare and submit to the relevant Classification Society and Authorities (class) all drawings necessary for certification and approval of the vessel unless otherwise specifically stated.

Torsional Vibration Calculation

Torsional Vibration Calculations (TVC) of systems mechanically driven by Wärtsilä engine(s) will be made and submitted for class approval Inertia and axial force requirement of the system (e.g. generator) not included in scope of supply shall be provided before contract signing.

Data and drawings of equipment NOT included in scope of supply, which are required for preparation of TVC, shall be supplied not later than four (4) weeks after Contract, unless otherwise agreed.

1.13.1 Engine manuals **1**

Set of engine Operating & Maintenance manuals (O & M manuals) and spare parts catalogues per ship set for the equipment included in scope of supply.

Operating & Maintenance manuals

Operating & Maintenance manuals cover instructions and descriptions by text and pictures of the main actions and cautions needed when operating the delivered equipment. The engine Operating & Maintenance manual are made specific for the delivered engine(s).

Spare Parts Catalogues

Spare Parts Catalogues contain the needed pictures for identification of spare parts to be ordered, stored or installed. The Spare Parts Catalogue

Type	Media	Language	Qty
O & M manual (Wärtsilä 6L20)	A4 binder	English	3
Spare parts catalogue (Wärtsilä 6L20)	A4 binder	English	3

Record Book of Engine Parameters

The Record Book of engine Parameters lists all the parts being under the emission regulations with pictures and codes and also contains original certificates.

Delivery1 pcs Book of Engine Parameters as A4 binder.

1.13.2 ELDOC **1**

ELDOC2i, electronic documentation on CD (1 pcs)

ELDOC2i software provides an Interactive Electronic Technical Manual (IETM) designed to give rapid access to extensive technical documentation through an interactive and easy-to-use interface. ELDOC2i contains in English an engine specific instruction manual, engine specific spare part catalogue with technical illustrations, drawings and step-by-step instructions supported by digital video and photo sequences (digital media availability depending on engine type).

1.13.3 Inventory of Hazardous Materials (IHM) **1**

The Inventory of Hazardous Materials documentation is made in accordance with the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009 and the 2015 Guidelines for the development of the Inventory of Hazardous Materials, IMO RESOLUTION MEPC 269(68).

Wärtsilä Online Services is aimed for ship owners and operators, Online Services provides the possibility to manage installations and equipment efficiently by accessing information whenever, wherever. Wärtsilä Online Services, CORE level includes the following:

- Technical Knowledge
- Parts Online
- TechRequest
- Warranty Online

Technical knowledge

The Online services provides a 24/7 access to technical information on installations and equipment such as service bulletins, interactive manuals and frequently asked questions

Parts Online

With Parts Online Services users can identify spare parts through catalogues and illustrations. Check spare part prices and availability, create spare part quotations or orders and track and trace deliveries. Your order history is automatically archived in the Online Services.

TechRequest

By creating a TechRequest you can ask technical questions directly from Wärtsilä Technical Services. With a direct contact and dialogue with Wärtsilä´s technical experts you prevent losing time and any crucial information during the discussion as your questions are automatically sent to the correct team. You can see full history of all Technical questions and related answers for your company and installations.

Warranty Online

In Warranty Online services you can easily and efficiently register all your warranty claims online and track and trace the resolution progress i.e. claim status and history. The Warranty Online provides you efficient and fast service along with full history of the warranty claim activities.

More information can be found on www.wartsila.com/online-services

1.14 Commissioning

Conditions related to commissioning

A commissioning kick-off meeting shall be held prior to starting commissioning activities to agree on a commissioning plan for the Wärtsilä scope of supply.

The entire commissioning work shall be done in accordance with the enclosed Commissioning Responsibility Matrix doc. C11388301A-01 which is also available in project specific Installation Planning Instruction (IPI) manual. Commissioning Manual is included in scope of supply defining acceptance criteria to be met by all involved and responsible parties in achieving Mechanical Completion / Pre Commissioning completion satisfactorily prior to commencement of final Commissioning.

Wärtsilä personnel shall only be employed based on mutual agreed scope of supply for commissioning work.

Technical documentation in form of drawings, specification etc. which might be necessary for the successful completion of commissioning work shall be supplied by Buyer.

Time required for checking the installation prior to start of engine(s) shall be reserved by Buyer. During this installation check, no other major jobs are allowed in the engine room. No welding or spray painting may be done above or next to the engine(s), unless agreed in writing with Wärtsilä representative. Any risk of work interference should be avoided in order to prevent injuries and damages.

If Commissioning has not been started within eighteen (18) months after Delivery due to reasons attributable to the Buyer, any claims of the Buyer against the Supplier in this respect, will be deemed to be waived and absolutely time barred upon the expiry of nineteen (19) months from the date of Delivery.

For this purpose a qualified chief engineer and relative crew members responsible for the vessel shall be present at the expense and initiative of the Buyer.

Commissioning Services Summary:

Wärtsilä Scope of supply	
Commissioning planning and verification	Included
Engine first start-up support	Included
Engine performance and sea trial participation	Included
On-Site Management	Excluded

Commissioning support or sea trial participation exceeding the contracted
If required commissioning support, due to reasons attributable to Buyer, exceeds the contractual amount based on a normal working week of sixty (60) hours and a normal working week of six (6) days, not exceeding ten (10) hours per day,

1.14.1 Commissioning planning and verification 1

Support for pre-commissioning and commissioning of the installation including travelling and lodging costs. Commissioning support included for maximum:

- Total 13 man-days at yard during 2 visit(s)

Buyer shall notify Wärtsilä at least two (2) weeks before mobilization of personnel is required.

Installation Planning Instructions (IPI) including commissioning responsibility matrix is included in scope of supply.

Mechanical completion verifying the equipment delivered by Wärtsilä are installed according to specifications and final drawings. Mechanical completion checklist is included in the Commissioning manual delivered I

1.14.2 Engine first start-up support 1

Participation supporting at first engine start including travelling and lodging costs. Engine first start support included in maximum:

- Total 2 man-days at yard

Buyer shall notify at least two (2) weeks before mobilization of personnel is required.

1.14.3 Engine performance and sea trial participation 1

Main engine performance verification test is included in sea trial procedure as well as travelling and lodging costs. Sea trial participation included in maximum:

- Total 2 man-days at yard during 2 visit(s)

Buyer shall notify at least two (2) weeks before mobilization of personnel is required.