

TECHNICAL DATA

Engine Model	16V 396 TE94
Application Group	1DS – Fast vessels with low load factors

Power as per MTU Sales Program

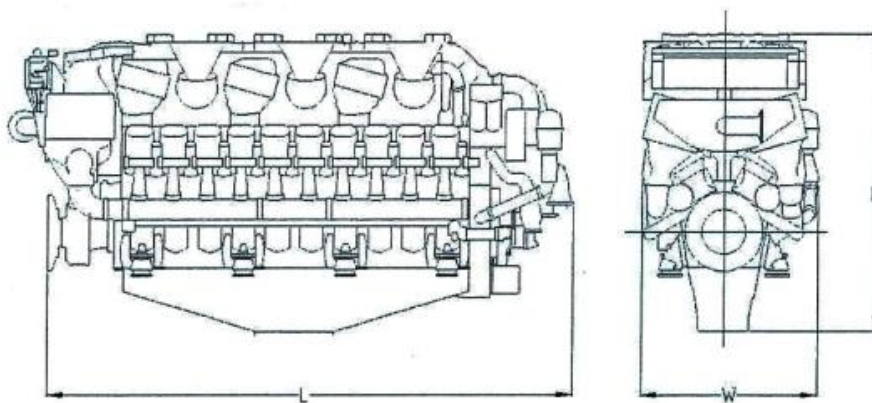
Power per engine (ISO 3046)	2240 (3045)	kW (hp)
Engine speed	2000	rpm
Intake air temperature	25	°C
Coolant temperature	25	°C
Altitude	100	Kpa

On-site Power

Power per engine (ISO 3046)	2180 (2967)	kW (hp)
Engine speed	2000	rpm
Intake air temperature	45	°C
Relative Humidity	95	%
Coolant temperature	32	°C
Altitude	100	Kpa
Power reduction at 45° C/32° C	3.0	%

Technical Data:**DATA-RELEVANT ENGINE DESIGN CONFIGURATION**

* = contract value, L = limit value, G = guaranteed value, R = guideline value

Main dimensions (engine incl. standard accessories):

L (mm)	W (mm)	H (mm)
3995	1525	1850

Quantities

Total of 1 object(s)
4 engine(s) per object

Engine assignment

1	engine 1
2	engine 2
3	engine 3
4	engine 4
1)	item appears only once per object

Selection Criteria for the Scope of Supply

Criteria	Selection	for Engine No.
Engine(s) per Vessel	Two-engine plant	1-4,
Exhaust emissions regulations	IMO	1-4,
Flag State	still unknown	1-4,
Emission certifier	GL (Germanischer Lloyd)	1-4,
Product usage	Commercial	1-4,
Operational area	International waters	1-4,
Application Group	1DS	1-4,
Reference conditions	45 /32	1-4,
Engine rotation device	Engine rotation counterclockwise	1-4,
Engine inclination	Horizontal & driving end down	1-4,
Acceptance Testing	BV (Bureau Veritas)	1-4,
Solas	With solas	1-4,
Gearbox Selection	Gearbox, ZF 12020	1-4,
Plant Automation	TBD (to be discussion)	1-4,
Spare Parts	Unrestricted service	1-4,
Tools	Unrestricted service	1-4,
Painting	Cement gray (RAL 7023)	1-4,
Packing	Extended storage	1-4,
Shipment	TBD	1-4,
Language Displays and Inscription	english	1-4,

A. Engine with Standard Equipment:

- A.1 Liquid-cooled, four-stroke diesel engine, anticlockwise direction rotation(viewed on flywheel end), with direct fuel injection, exhaust gas turbo charging , charge air cooling, Crankcase with oil pan and bolted-on flywheel housing (SAE 0), four-valve, individual cylinder heads with valve seat inserts Rotocap valve rotators, gear train for valve gear auxiliary PTO , forged crankshaft, machined all over with bolted-on counterweights, metal skirt and bolted –on steel crown , piston cooling via oil spray nozzles , triple- walled , liquid-cooled exhaust manifolds, auxiliary PTO possibility at timing end , vibration damper (subject to torsional vibration calculation), all necessary on engine air , exhaust ,coolant, fuel and oil pipe work.
Electronic engine control and monitoring unit ECS (see Item A.11)
- A.2 AC battery charging generator (28 VDC, 85 A, 2 Pole)
- A.3 Fuel delivery pump with fuel priming pump, fuel duplex prefilter with diverter valve block type, with water separator, pressure gauge and water level monitor, hose lines to and from engine, fuel safety equipment (jacketed HP lines incl. leak-off fuel tank with level monitor, flameproof hose line), fuel injection pump with emergency shutdown level and cylinder cutout system with 24 VDC solenoid control valve, injection timer.
- A.4 Oil change equipment with semi rotary hand pump. Lube oil priming system incl. electrical pump control (400 VAC, 3-ph, 50 HZ, 0.75 kw)
- A.5 Set of air intake adaptors on turbocharger intake elbows (for vertical Hose connection from above), Set of intake air filters (plastic filter element. Seawater – resistant filter housing), Brackets for filters installation and hose connection, Set of hose lines including hose clamps for engine –to- air filter connection.
- A.6 Exhaust junction (insulated Y-pipe) for both turbochargers including bellows after turbochargers including bellows with companion flange. for resilient connection of ship's exhaust system to the junction (Exhaust Pipe work along engine centerline towards flywheel end inclined 30 upwards form the horizontal), Connecting elbow, Insulated elbow for exhaust junction changes exhaust outlet from 30 Upwards form the horizontal to Vertical upwards or 30 downwards from the horizontal.
- A.7 Cooling-to-row water plate–core heat exchanger including coolant expansion tank with breather valve, swivel-type raw outlet with threaded flange. Engine driven, self- priming raw water pump, raw water inlet with Threaded flange. Flameproof raw water inlet/ outlet including engine side connection. Flameproof hose lines for row water system venting and rubber sleeve for engine coolant venting /overflow.
- A.8 Coolant preheating system including on-engine connecting hardware and flameproof hose lines (400 VAC, 3 ph, 50 Hz, 4.5 kw)
- A.9 Resilient engine mounts, (For free-standing gearbox arrangement), Resilient engine mount,

timing end, Resilient engine mount, flywheel end.

- A.10 Engine control and monitoring system (ECS) with Integrated load –profile recorder, installed in sheet metal housing (for Separate installation in engine room), with plug connectors and the Following function /subassemblies.
- Engine speed control in response to speed setting signal with fuel Injection and speed limitation as a function of engine status and operating condition.
 - MTU sequential - turocharging control (for engines with sequential turbocharging) and cylinder-cutout control.
 - Automatic start / stop /emergency stop sequence system. Engine emergency stop system with manual operation capability and automatic shutdown in response to following criteria:
 - Engine over speed, Low engine oil pressure, ECS failure (governor defective), Low gearbox lubes oil pressure, Low gearbox clutch oil pressure (If transmitter available)
 - Data processing logic for serial data transfer (RS 422) to Local Operating panel (LOP) and instrumentation in main control stand.
 - Processing logic for gearbox control during 'local 'operation, Connection for gearbox transmitters /monitors (oil pressure before filter or oil differential pressure, oil temperature. oil level shaft speed).
 - Data modules, programmed with engine and plant –related data.
 - Electric governor actuator (24 VDC).
- A.11 Monitoring in engine room:
(standard version acc, to customer's specification)
Monitoring system, consisting of:
Set of on-engine sensors and wiring incl. terminal box with plug connector.
Connecting Interface (CCS), in sheet –metal housing with plug -in connecting cable to ECS and terminals for ship's cable, for external signal adoption and remote –control signal conversion and amplification.
- Local Operation Panel (LOP)
 - Local operation plant (LOP) in sheet housing .completely with plug connector and the following equipment:
 - 2 LCD display unit for incremental analog and digital display with selector buttons for all measured parameters:
 - Speeds
 - Fuel injection
 - Temperatures
 - Pressures
 - Alarm unit with visual individual alarm and output for audio common alarm for all measured parameters and internal malfunction
 - Operational status signal unit for activated turbocharger (for engines with sequential turbo charging) and cylinder cutout.
 - Combined control and display elements for:
 - Local control

- Ready for operation
- Engine start / stop / emergency stop
- Gearbox engaged / disengaged
- Over speed test
- Engine speed increase / decrease
- Lamp test
- Common alarm acknowledgement
- Flashing light and for horn visual and acoustic and common alarm in engine room.
- Set of connecting cables, with plug connectors at both ends for ECS/ ETB connection, Connecting cable with ETB-side plug connector for ETB/CCS connection, Connecting cable with plug connector at both ends for ECS/LOP Connection.

A.12 Engine factory acceptance testing.

A.13 Standard installation, Operation and maintenance manual, Workshop manual for W1 to W6 maintenances level, torsional vibration calculation.

B. ENGINE ACCESSORISE

- B.1 Air –in cylinder starting system (max .40 bar) with solenoid starting valve (24VCD) and hose line.
- B.2 Coolant preheating system including on -engine connecting hardware and flameproof hose lines (440 VAC; 3 PH; 60 Hz: 4,5 Kw)
- B.3 Centrifugal oil filter (for extension of oil change intervals)
Alternative to let A. 6b
- B.4 Lube oil priming system incl. electro. Pump control (440 VAC; 3 PH;60 HZ;0.9 KW)
- B.5 Set of sensors for individual –cylinder exhaust temperature measurement.
(Mandatory with free –standing direct drive gearbox)
- B.6 Torsinally resilient and off –set compensating Coupling.
- B.7 Bilge pump (1x per ship)
- B.8 Free auxiliary PTO with flange (max, torque 1470 Nm)
- B.9 Compressed air tank, 180 Liter
REMOTE CONTROL (for FPP plants)
(in compliance with manufacturer's specification)
- B.10 SHIP' S-SIDE-MONITORING SYSTEM
(incompliance with Classification Society Regulations)
Monitoring System (MCS-5, type 2) with graphic control station (active process visualization via color monitors) for monitoring of propulsion plants and additional measuring points and control functions in general ship's area – upon request.
- B.11 Paintwork
Paint finishes "cement grey" single –component paint, single color (RAL 7023).
- B.12 Spare parts
shipboard spare parts kit to manufacture's recommendation
- small kit – (1x per ship)
a - for engine
e - for monitoring system and remote control
- B.13 TOOLS
Shipboard tool kit to manufacturer's recommendation
- small kit – (1x per ship)
a - for engine
e - for monitoring system and remote control

- C ENGINE MONITORING & MANAGEMENT SYSTEM
FOR ENGINE ROOM /VERSION II**
- C.1 Sensors**
Per engine 1 set of sensors comprising:
2 electric engine speed transmitters
· Electric flue rack travel transmitters limit switch for emergency air shut –off flap position display
· Temperature transmitters PT1000 double system for engine- lube oil engine coolant, charge air.
· Pressure transmitter (4-20 m A) for engine lube oil , engine , coolant raw water , charge air and fuel monitor for lube oil differential pressure .
· 2NiCrNi thermocouples for exhaust temperature before turbocharger
· Level monitor for low engine coolant level.
- C.2 Cylinder Exhaust Temperature**
- Cylinder head each with 1 thermocouple wired to terminal box, for measurement of individual cylinder exhaust gas temperatures.
- C.3 Pressure Measuring Block**
- Measuring block for combination of pressure measuring points including connecting lines.
- C.4 Wiring With Engine Terminal Box**
On – engine wiring, including resiliently mounted engine terminal box with plug connector.
- C.5 Engine Control and Monitoring System**
- see basic engine configuration
- C.6 Safety System DSS 01 B**
Safety system DSS 01 B for installation in main control stand console, completely wired with terminal strip for ship – side wiring and comprising the following equipment:
1-Visual individual display / alarm for engine in operation, gearbox disengaged mode, sensor malfunction, and broken wire, Speed sensor malfunction, low engine lube oil pressure, engine over speed.
2-Emergency shutdown in case of low engine lube oil pressure engine speed.
3-Push buttons for lamp test, alarm acknowledgement, alarm memory test
4-Output for common alarm for further processing in other monitoring units;
acoustic alarm.
- C.7 Connecting Interface**
- CCS connecting interface in sheet metal housing with plug in connecting cable to ECS, for external signal adapting and connecting to ECS, and remote control signal conversion and amplification, including terminal for ships conversion and Amplification, including terminal for ships cables.

- C.8 Local Operating Panel /LOP
Local operating panel / LOP in sheet metal hosing, completely wired, with connector and following equipment:
1- 2LCD Display units for incremental analog and digital displays with selector buttons for all measured parameters such as speeds, fuel injection, temperatures and pressures.
2- Alarm unit with visual individual alarm and output for audio common alarm for all measured parameters and system internal malfunctions.
3- Operational status signal unit for activated turbo charger and cylinder cutout
4- Combined control and display elements for local control, ready for operation, engine start and stop, emergency stop, gearbox engaged, gearbox disengaged, over speed test, engine speed increase, engine speed decrease, lamp test common alarm acknowledgement.
- Flashing light and horn for visual and acoustic common alarm in engine room.
- C.9 Connecting Cables
Set of connecting cables, comprising:
1- 2 Connecting cable 12m each with plug connectors at both ends for ECS / ETB connection.
2- 1 Connecting cable 15 m with ETB side connection for ETB/ CCS connection.
3- 1Connecting cable 2 m with plug connectors at both ends for ECS / LOP connection.
- C.10 Labeling of LOP in English
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- C.11 REMOTE CONTROLS / ELECTRONIC REMOTE CONTROL SYSTEM FOR FPP APPLICATION
Microprocessor controlled, fully redundant, with can data bus technology.
- C.11.1 Electronic Engine and Gearbox Remote Control System for the Main Control Stand
Remote control unit MTU RCS – 5 FPP Fully redundant system unit, ready for installation in housing with dimmer, with integrated control logic and the following equipment:
1- Propulsion control lever for control of engine speed and gear box coupling status.
2- Operating display tableau for control stands selection and single lever control for multi engine plants.
3- Integrated monochrome LCD display with selection keys for operating mode display and program information.
4- Optical alarm with alarm acknowledgement.
Connection of remote control unit to ECS / LOP via CAN Interface coupling.
Version for closed control stand with protection class IP66 front panel and IP65 for real panel.
- C.11.2 Electronic engine and Gearbox Remote Control System for the Slave Control Stand.
Scope of function as for main control stand / closed version
- C.11.3 CAN interface Coupling
CAN interface coupling in terminal box for connection - RC55 and ship side MC55.
Monitoring unit together with standard ECS with back up
- C.11.4 Directional Exhaust flow Control

Control system UGS-PN for ship –side exhaust flaps (surface /underwater discharge) , installed in sheet metal housing for wall mounting, comprising the following equipment :

- 1- Control logic
- 2- 5/2 Way solenoid for pneumatic exhaust flat control.
- 3- Illuminated push buttons for selection and display operating mode (manual or automatic).
- 4- Illuminated push buttons for manual operation and exhaust flat status display

C.12 SHIP SIDE MONITORING SYSTEM

Modular, expandable VDU system with active process visualization via color monitors and data transfer via data bus.

C.12.1 Monitoring and Control System MC55 Type 2 for the Control Stand /1 per Ship

The basic system installed in the main control stand consist of two control stations operating independently from each other in compliance with classification society rules and regulations with active process visualization via color monitors.

By means of graphic display each MC55 type 2 workstation shows on several screen pages all ship sections monitored by the system the date it acquires is integrated in the graphic display according to its allocations. Inadmissible operating data results in visual and acoustic alarms .the screens ball can be comfortably selected from tool bars via track ball required voltage supply is 24 VCD.

Basic Configuration Two Control Stations for Installation in Consoles Consisting of:

- 1- 2 TET color monitors (15"screen size) with cable, chassis.
- 2- 2 Track balls
- 3- 1 Key switches
- 4- 1 Alarm buzzer
- 5- 2 Management computer units 19" slide- in chassis including operating software.

C.12.3 Printer /1 per Ship

1 Ink jet printer (black & white, 24 VCD) for automatic printout of alarm reports and journals, incl. 5m connecting cable.

C.12.4 Programmable Process Station / 1 per Ship

programmable process station PPS to process data from operating panels and indicators and to serve as receiving terminal for the CAN process bus for data conversion to field bus level for bus interface modules (PIM); for installation in console.

C.12.5 Operating panel / 1 per ship

Operating panel for the following functions and illuminated display in console a four – engine plant:

- 1- Engine start, stop emergency stop
- 2- Local operation
- 3- Ready- for - operation

C.12.6 Engine Speed Indicator Mane Control stand / 1 per Ship

Illuminated indicator 96 * 96mm incl. Bus interface module PIM for installation in console for four engine plant

- C.12.7 Shaft Speed Indicator Main Control Stand /1 per ship
Illuminated indicator 96 * 96mm incl. Bus interface module PIM for installation in console for four engine plant.
- C.12.8 Programmable process Station / 1 per Ship
Programmable process station PPS and interface module PIM for processing data form all engine and gearbox mounted housing for a four –engine plant.
- C.12.9 Operating Panel for Second Control Stand // 1 per Ship
Operating panel for the following functions and illuminated display in consol for a four-engine plant.
1- Engine start, stop emergency stop
2- Local operation
3- Ready- for – operation
- C.12.10 Engine Speed indicator Second Control Stand / 1 per Ship
Illuminated indicator 96 × 96mm incl. Bus interface module PIM for installation in console for four engines - plant.
- C.12.11 Shaft Speed Indicator Second Control Stand/ 1 per Ship
One graphic control station for installation in consol comprising:
1- 1 TFT color monitor (15"screen size) with cable, chassis
2- 1 Track balls
3- 1 Management computer unit's 19" slide- in chassis including operating software.
4- 1 Alarm buzzer

D POWER TRANSMISSION

- D.1 Resilient Coupling
(For free- standing gearbox)
-Heat-resistant. Non –aging resilient coupling integrated and aligned in a bell housing including offset compensating coupling (short version) with engine connecting hardware.
(Subject to torsional vibration calculation)
- D.2 Gearbox connecting hardware
(For free- standing gearbox)
- for ZF, 12020
- D.3 Gearbox
ZF 12020, Vertical offset remote mount marine transmission.
Maximum rated input: 3602KW (4826hp)
Scope of Supply:
- ZF 12020, Reduction Ratio #2.263:1 (Special Ratio)
 - Gearbox actuation – Electrical
 - Oil pump for transmission hydraulics lubrication – Gear mounted
 - Oil cooler salt- water resistant, max permissible inlet temp 40 Deg. C
 - Integral thrust bearing for taking the propeller thrust.
 - Rigid Mounting brackets –cast on
 - Special Monitoring for MTU Engines with following Devices
 - 1 No. Pressure sensor for clutch actuation oil pressure
 - 1 No. Pressure sensor for lubrication oil pressure
 - 1 No. Pressure switch for warning filter contamination
 - 2 Nos. Temperature sensor
 - Connection point with Isolating valves for pressure indicators
 - Electrical connection via 2 canon plugs
 - Other attachments:
 - Trailing pump
 - Electrical trolling (auto troll)
 - Manually operated hand lever in case of power failure
 - Special input flange to suit MTU engine
 - Propeller shaft counter flange
 - Shaft speed sensor (digital speed sensor drive connection for speed sensor)
 - Special painting (RAL 7023 concrete grey)
 - Two units CCW & Two units CW
 - Packing

E Documentation

The following documentation and drawings will be supplied upon receipt of order:

- E.1 Standard Publication engine & Gearbox
10 sets per vessel (5 sets of manual and 5 sets of CDs. For all items).
1- Description / operation Manual in English
2- Spare parts catalogue in English
3- Tools catalogue in English
4- Fluid & Lubrication in English
5- Maintenance manual
6- Tolerance and wear list
- E.2 Standard drawings Engine & Gearbox / 10 sets per vessel:
7- MTU Engine installation drawing 16V 396 TB 94
8- MTU Engine / Gearbox arrangement drawing
9- Diagrams for all system such as coolant, lube oil, controls, electrical wiring, monitoring system.
10- Installation Publication Electronics supplied loose.
- E.3 Standard Publication Electronics / 10 sets per vessel:
11- Part1 /layout and operation
12- Part2 / Control
13- Part3 / Maintenance
14- Part4 / illustrated parts catalogue
15- Part 5 / Contract related documentation
16- Standard drawings Electronics /10 sets per vessel:
17- Installation drawings of all items supplied loose
18- Wiring diagrams and lists
19- Master wiring diagrams
20- Workshop manual for engine & gearbox to be included from W2 to W6
21- Documentation / Drawings for populum system
22- Maintenance manual and installation manual for shaft and propeller rackets
23- Maintenance planning
24- Maintenance documentation
25- Manual for special tools engine and gearbox
- E.4 Technical documents for compressors
26- Work shop manual
27- Operational manual
28- Part list
29- Drawings for compressors

F. Compressor Unit WP 32:**F.1 Technical Specification Compressor Unit WP3232**

- Manufacturer JP. Sauer & Sohn Germany
- As per drawing B3232- D5918
- 2units WP3232 per ship
- Built in accordance ti LRS

F.2 Technical Data

· Filling –up capacity	11.2	m3/h
· Working pressure	230	bar
· Speed	1150	rpm
· Power required	5.3	kW
· No of cylinders	3	
· Stages	3	
· Heat dissipation	5.8	kJ/sec
· Cooling		air- cooled
· Driving system		direct drive
· Max ambient temp	50	deg. C.
· Unit weight	approx.	245 kg

All capacity data with 5 % tolerance and based on 20 deg. C. ambient temp And 1013 m bar.

F.3 Motor design

· Type	three phase motor 132 m
· ISO- Rating	6.6kw
· Speed	1150 rpm
· Voltage	440 volt
· Frequency	60 Hz
· Model	B3/B5
· System of protection	IP55
· Insulation Class	F

F.4 Regular equipment

- Air intake/ silencing filter system
- Re- cooler after each stage
- Axial fan
- Flywheel
- Oil and water separator of the 2 n d and 3 rd stage
- Automatic condensate drain from drainage of the 2 n d and 3 rd stage, 220 V, 60HZ
- Standard relief, integrated in the condensate drain automatic system
- Pressure oil lubrication
- Oil pressure switch

- Oil pressure gauge
- High pressure gauge for each stage
- Safety valve for each stage
- Flexible coupling
- Basic plant
- Resilient mounting system
- High pressure hoses for air – outlet and drainage

G. Training

G.1 Engine training for Customer's Personal

- Course Objective Capability of diagnosing and rectification faults and Execution of maintenance takes as per MTU instructions.
- Target Trainees Operator field Service training
- Curriculum Introduction to the company
Handing of documentation
Design and function of the engine
Explanation of oil, flue, etc. systems
Explanation of the fluids and lubrication specification
Execution of maintenance up to W5

G.2 ELECTRONICAL TRAINING

Electronic Training for Customer's personal:

- Course objective Capability of plant operating and care without measuring technical requirement
- Target trainees Operator + field service training
- Curriculum Presentation of the scope of electronic equipment
Design of system
Function description
Operation of electronic systems
Fault recognition based on fault codes / display

G.3 Fault finding (MCS 5)

- Target MCS5- Type 2

G.4 Gear box

- Target work shop training

H. Supervision**H.1 Supervision of Installation**

- Upon award of contract and request by the buyer the Seller will make available trained personal to supervise the installation of supplied engines, gearbox as well as monitoring and control system.
- Upon award of contract and request by the Buyer the Seller will make available trained personnel to attend HAT and SAT.
- During HAT and SAT our personnel will record all relevant reading and parameters concerning the supply MTU engines.

Seller is responsible to obtain required entry permits as convening all local cost for the buyer's team

The buyer send a technical team for inspection in during assembly and FAT test of engines to MTU factories.