

22,32 MW Gas Power Plant

Technical Specification

3 MAN Gensets 12V35/44GTS plus basic equipment supply

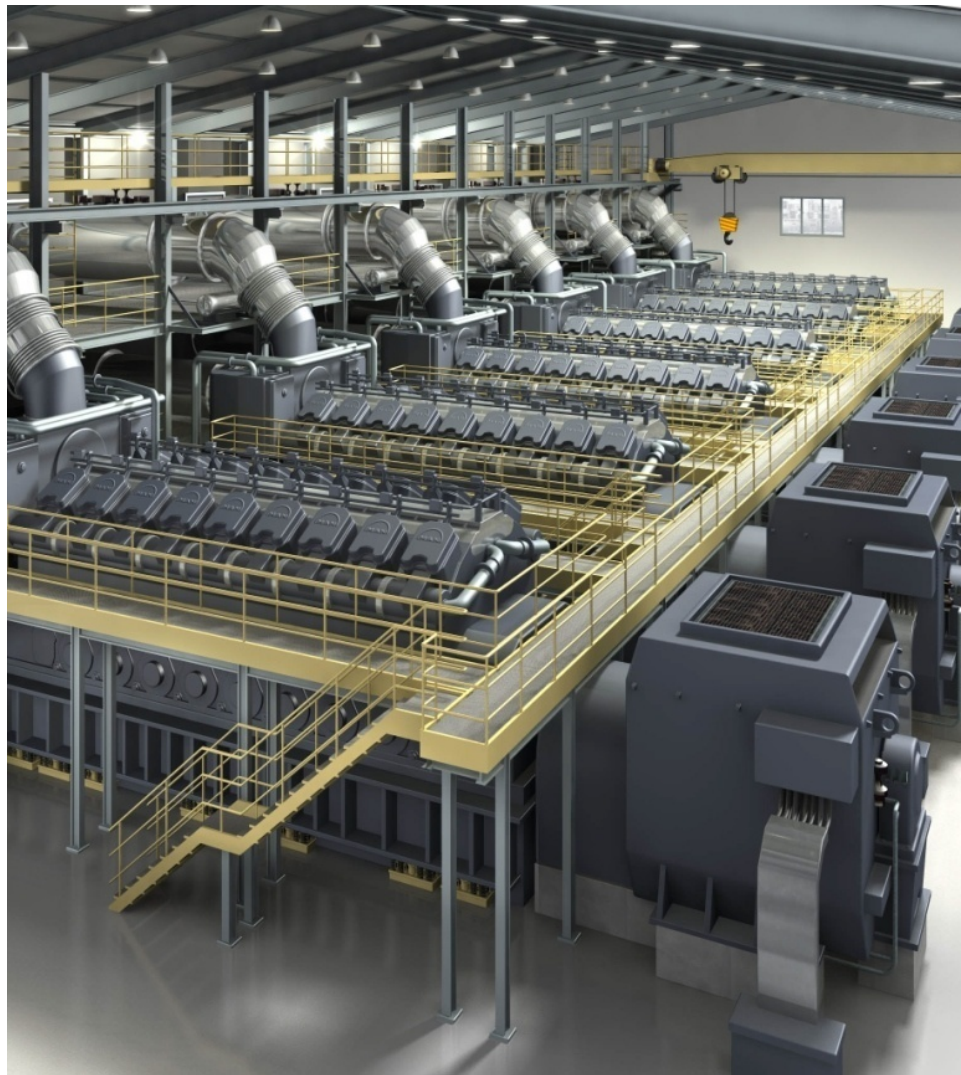




Table of Contents

1	Design data and performance guarantees	1
1.1	Design data	1
1.2	Performance data	4
2	Gas engine 35/44GTS	7
2.1	Engine System	8
2.2	Detailed Technical Specification of one engine 35/44GTS	10
3	Generating set	12
3.1	Connecting elements	13
3.2	Genset	13
4	Mechanical scope	16
4.1	Auxiliary systems, engine related	16
4.2	Auxiliary systems, plant related	19
4.3	Exhaust gas system	22
5	Electrical scope	24
5.1	Control and monitoring system	24
5.2	Electric plant system	26
6	Miscellaneous	30
6.1	Documentation	30
7	Tools, spare and wear parts	31
7.1	Tools and spares	31
8	Services	33
8.1	Quality Management, Quality Assurance	33
8.2	Project engineering	34
8.3	Logistics	36
8.4	Site activities	36
8.5	Project services	39
9	Requirements and limitations	41
9.1	Quality requirements for operating media	41
9.2	Limits of supply	44
10	Standards and Guidelines	45
10.1	Applicable standards	45
10.2	General guidelines	45
11	List of sub suppliers	47
12	Drawings	48
12.1	Drawing of the generating set 11.74500-1835	48



1 Design data and performance guarantees

Our quotation is based on the following design data as well as the

- Drawing of the generating set 11.74500-1835

1.1 Design data

1.1.1 Site conditions

Site conditions

All offered equipment is designed to operate within the following ambient conditions:

- Altitude above sea level 1100 m
- Wet bulb temperature 20 °C
- Minimum ambient air temperature -20 °C
- Maximum ambient air temperature 40 °C

Operation outside of these limits is without guarantee.

1.1.2 Generating sets

Generating sets

In response to your request, this quotation is for 3 generating sets based on the MAN 12V35/44GTS engine.

- Number of generating sets 3
- Engine type 12V35/44GTS
- Engine speed 750 min⁻¹
- Lube oil pump engine driven
- HT cooling water pump engine driven
- LT cooling water pump engine driven

Electrical system

The offered equipment is based on the following electrical values:

- Operation mode base load
- Frequency 50 Hz
- Power factor Cos ϕ (lagging) 0,8
- Medium voltage 11 kV
- Low voltage 400 V



1.1.3 Other design data

<i>Foundation</i>	– Soil bearing capacity ¹ > 200 kN/m² Earthquake design according to Peak Ground Acceleration – PGA ² 0,4 g
<i>Lube oil</i>	Engine lube oil has to be in accordance with the requirements as stated in section 9.1.1 Requirements for viscosity: – Viscosity class (40°) SAE 40
<i>Cooling method</i>	The cooling system is designed for cooling water in accordance with the requirements as stated in section 9.1.2. Features of the cooling water system: – Type of cooling system radiator
<i>Fuel system</i>	The fuel system is designed based on the fuel gas in accordance with the requirements as stated in section 9.1.4.
<i>Intake air</i>	Ambient air dusty and sandy air, aspirated from outside power house Intake air has to be in accordance with the requirements as stated in section 9.1.5.
<i>Exhaust gas</i>	Exhaust gas concept Vertical silencer with tail pipe Height of stack 16 m
<i>Power house ventilation</i>	The powerhouse ventilation air is blown directly onto the alternator. The maximum temperature inside power house, measured at floor level, next to engine / alternator is 50 °C ($t_{\text{ambient}} + 10 \text{ K}$). At gallery level a temperature of 55 °C ($t_{\text{ambient}} + 15 \text{ K}$) is permissible. The alternator design temperature is 43 °C.

¹ The complete offer is based on the abovementioned minimum soil bearing capacity with a low settlement.
² Peak ground acceleration with a probability of 10% to be exceeded in 50 years and a return period of 475 years based on reference ground with a shear wave velocity > 800 m/s



Permissible frequency limits in grid parallel operation

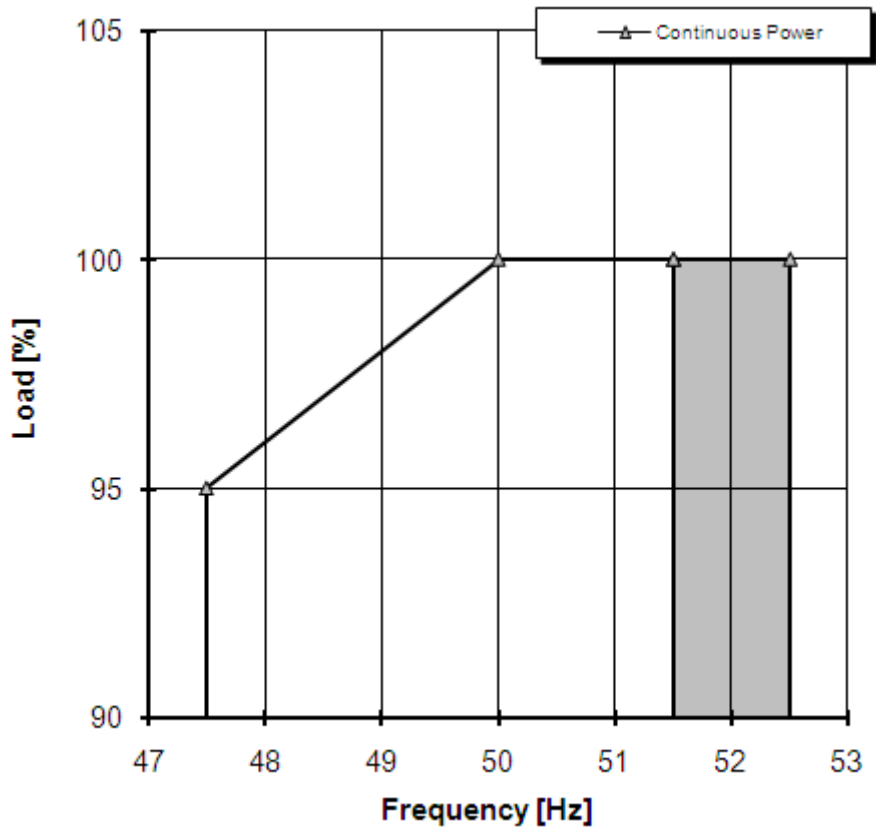


Table 1: Diagram of permissible frequency and load limits in grid parallel operation

Table 1 show that the maximum continuous engine output is ensured at a mains grid frequency exceeding up to max. +3%, whereas at a frequency drop to max. -5%, the power output is continuously reduced to 95% MCR. We permit operation of the engines up to +5% frequency fluctuations for maximum 120 seconds. In any case, the maximum permissible mains grid frequency deviation is $\pm 5\%$.

In grid parallel operation, the frequency of the grid varies according to the current consumer load and the input from power suppliers. The plant responds as described above.

Load application in island mode

When load is suddenly applied to a generating set there will be a transient deviation in voltage and frequency. The maximum permissible load increase is limited to steps of 15% of the nominal power of all generating sets in operation. Further, it depends on the base load before load increase.

The offered generating sets comply with ISO 8528-5 class G2.



*Power
fluctuations*

It is an intrinsic property of the power train of a generating set that it acts as a torsional vibration system. This complex system consists of the engine, coupling and generator (within scope of MAN Diesel & Turbo), the plant's electric network, consisting of further power producers and consumers, transformers, bus bars or circuit breakers and the power grid (not within scope of MAN Diesel & Turbo). The reciprocating engine, as well as the power grid or the other consumers and producers excite the system. As a consequence, the active power at the generator terminals is not completely constant with respect to time and some additional power oscillations so-called power fluctuations occur. These power fluctuations do not affect the operational safety of the generating set. In addition, this behavior is in accordance with ISO 8528-5 and does as per MDT experience not affect net stability in an unacceptable range. Gas operated engines tend to show higher load fluctuations than engines operated on diesel fuels. This belongs to the typical cyclical fluctuations of the Otto combustion process that uses a premixed combustion. In general, it is expected that power fluctuations are higher in net-parallel operation than in island-mode.

Please note that MAN Diesel & Turbo quotations do not consider any specific limitations regarding power fluctuations.

1.2 Performance data

The guarantee data is shown in **underlined bold letters**. Other values are for information only and without guarantee.

The stated performance data is based on the design data as per section 1.1 and calculated for the following reference conditions:

*Site Reference
conditions*

- Air Inlet temperature (before air inlet filter) 30 °C
- Wet bulb temperature 20 °C
- Air Inlet pressure (before air inlet filter) 888 mbar
- Charge air temperature before cylinder 50 °C
- Exhaust gas back pressure ≤ 30 mbar
- Intake air pressure loss ≤ 20 mbar

In case the site conditions / technical parameters at performance test are different from the site reference conditions defined above, the performance guarantees will be adapted in accordance with MAN standard procedure.

*Measuring
tolerances*

Tolerances in the measuring equipment shall be considered additionally and are not included in the guarantee figures stated below. Tests will be done according to ISO 15550:2002 (ISO 3046-1:2002).



1.2.1 Continuous power of the generating set

The continuous power of one generating set 12V35/44GTS at above defined reference conditions is:

Continuous power of the generating set **7239 kW_{el}**

The abovementioned power is the electrical output of the generating set as measured at the generator terminals. The generator efficiency is calculated with 97,3%.

Applicable standard is ISO 3046. The continuous power of the generating set at other site altitudes as defined above is shown in the following diagram.

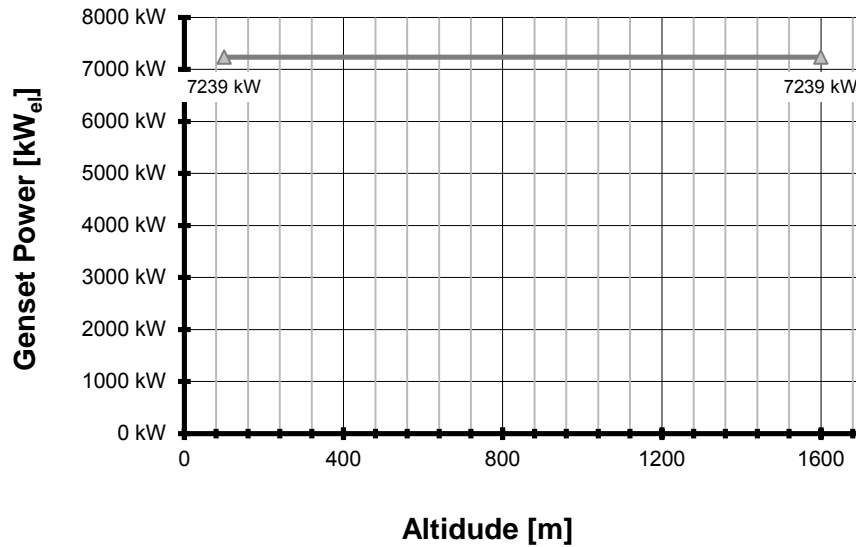


Table 2: Power in relation to site altitude

If the gas' methane number is less than 70, the power of the generating set needs to be reduced. Injection and ignition need to be adjusted.

Natural gas with a methane number less than 60 cannot be used.

Corresponding to ISO 3046-1:2002, clause 11.3 and ISO 8528-1:2005, clause 13.3, the engine power will be blocked at 110 % load of the MCR, whereas the 10 % overload will be used for governing purposes only; it shall not be used for the supply of electrical consumers.



1.2.2 Specific fuel gas consumption (SFC)

The specific fuel gas consumption at continuous power as per section 1.2.1 and at above defined reference conditions will not exceed the following value:

Specific fuel gas consumption **7732 kJ/kWh_{el}**

+ 0 % tolerance.

Genset efficiency 46,6%

Remark: The specific fuel gas consumption is valid for fuel gases with a Net Calorific Value (NCV) of min. 32,400 kJ/m³ (STP) and a methane number³ = 80. Worse natural gases require further calculation/engine design.

The stated guaranteed value is based on ISO 3046-1:2002. Corrections due to site conditions differing from the site reference conditions stated above must be executed according to the MAN standard procedure. The value stated above is the average of all generating sets.

1.2.3 Lubricating oil consumption

The lube oil consumption of one generating set at reference conditions as defined above will not exceed the following value:

Lube oil consumption **2.6 kg/h**

+ 20 % tolerance.

The value stated above is without any losses due to cleaning of filter or lube oil charge replacement.

The stated guaranteed value is based on ISO 3046-1:2002. Corrections due to site conditions differing from the site reference conditions stated above must be executed according to the MAN standard procedure. The value stated above is the average of all generating sets.

1.2.4 Exhaust gas emissions

The exhaust gas emissions⁴ at continuous power as per section 1.2.1 and at guarantee conditions as defined above will not exceed the following values:

Nitrogen oxide (NO_x) 200 mg/Nm³

at 15% O₂ in dry exhaust gas. Measuring after the engine.

The nitrogen oxide (NO_x) value is calculated as NO₂ contingent and on the fuel gas as defined in section 9.1.

Applicable standards for exhaust gas emissions: Pollution Prevention and Abatement Handbook, Part III, The World Bank Group, 2007/2008.

O₂ and NO_x measurements as per ISO-8178.

³ If the methane number is below the minimum, the engine output has to be reduced and the ignition-injection have to be adjusted.

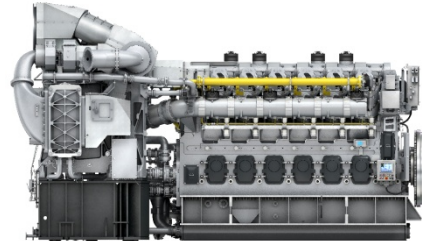
⁴ Reference conditions to a normal cubic meter (Nm³):
pressure = 1,013 mbar, temperature = 0°C.



2 Gas engine 35/44GTS

General description

The MAN engine 12V35/44GTS is a four-stroke, medium-speed gas engine, 2 stage turbocharged and charge air-cooled. The engine is spark-ignited, prepared for operation on natural gas. Compared to other medium-speed engines, within the same power range, the 12V35/44GTS produces high power from a compact, efficient design.



Technical data

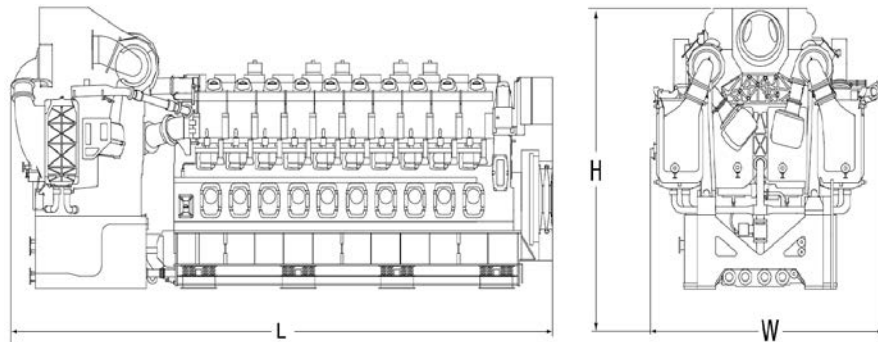
The technical data of the engine at ISO conditions⁵ is summarized in the following table:

– Cylinder bore	350 mm
– Piston stroke	440 mm
– Engine speed	750 min ⁻¹
– Piston speed	11 m/s
– Mean effective pressure	23,4 bar
– Power per cylinder	620 kW/cyl
– Power of the engine (at crankshaft)	7440 kW _m

Continuous development

The engine family is developed specially for stationary power generation. This new and highly efficient spark-ignited gas engine is ideal not only for decentralized applications, but also as prime mover in large base load power applications up to 200 MW. The engine type is based on the proven gas engine 35/44G and is subject to continuous development to ensure reliability under the most severe service conditions.

Outline dimensions



Dimensions and weight⁶ of the engine 12V35/44GTS:

– Height (H)	5200 mm
– Length (L)	9028 mm
– Width (W)	4925 mm
– Weight (dry)	106000 kg

⁵ Standard Reference Conditions according to ISO 15550 Section 5:
Air temp = 25°C, CW temp = 25°C, Air pressure = 1.000 mbar, humidity = 30%,
SFOC including attached pumps

⁶ The dimensions and weight stated correspond to the engine only. All given masses are valid for a dry engine without lube oil and cooling water. Dimensions and weights are for guidance only and subject to change without notice.



Item	Q'ty	Description
2.1 Engine System		
2.1.1 Engine System		
010 MJA10 AV010	3	Engines 12V35/44GTS, mounted on steel foundation frame, suitable for operation on natural gas, as per following detailed Technical Specification
2.1.2 Lubrication system		
010.220.010 MJV21 AP050	3	Engine attached lube oil pump(s)
2.1.3 Cooling water system		
010.230.010 MJG31 AP030	3	Engine attached HT cooling water pump Capacity approx. 84 m ³ /h
010.230.020 MJG32 AP030	3	Engine attached LT cooling water pump nominal capacity 211 m ³ /h. The cooling water flow through the charge air cooler will be adapted to 140 m ³ /h by installation of orifices.
2.1.4 Engine control system SaCoS One		
010.285.070	3	<p>SaCoSone Interface cabinet</p> <p>The Interface Cabinet is the interface between the engine electronics and the plant control system. It is the central connecting point for electric power supply to the engine from the plant power distribution. Besides, it connects the engine control system with the power management and other periphery parts.</p> <p>Properties:</p> <p>Each interface cabinet is located in the engine hall next to the engine.</p> <p>This floor-standing cabinet (H 2,200 mm x W 1,200 mm x D 400 mm) has lockable front doors with rubber gasket. Cable insert from bottom through plinth. Panel protection degree is IP55, color light grey (RAL7035) with plinth in umbra grey (RAL7022). It is equipped with a gateway module for plant communication via interfaces to the plant automation system.</p>



Item	Q'ty	Description
010.285.080	3	<p>SaCoSone Auxiliary Cabinet</p> <p>The Auxiliary Cabinet contains the driver unit for the speed governor as well as the starters for the engine attached motors.</p> <p>Properties:</p> <p>Each Auxiliary Cabinet is located in the engine hall next to the engine.</p> <p>This floor-standing cabinet (H 2,200 mm x W 1,200 mm x D 400 mm) has lock-able front doors with rubber gasket. Cable insert from bottom through plinth. Panel protection degree is IP55, color light grey (RAL7035) with plinth in umbra grey (RAL7022). Starters for engine attached cylinder lubrication pump as well as temperature control valves for cooling water.</p>
010.285.120	3	<p>Control cabinet for gas control line</p> <p>Wall mounted cabinet, consisting of I/O modules for monitoring of the gas control line</p>
010.285.130	3	<p>Turbocharger control unit</p>

2.1.5 Factory Acceptance Test (FAT)

010.330.020	1	<p>Factory Acceptance Test of one engine</p> <p>The test will be done with the MAN Diesel & Turbo test bed equipment and installations but without other offered equipment.</p> <p>Pre tests:</p> <ul style="list-style-type: none"> - Checking of systems and installations - Testing of monitoring and safety equipment - Running-in and adjusting - Running up to 100% load - Adjusting of ignition pressure - Adjusting of governor - Checking of all operation data <p>Workshop test procedure:</p> <ul style="list-style-type: none"> - Starting tests approx. 15 min. - Warming up to 100% load approx. 25 min. - Continuous power of 100% load 60 min. - Continuous power of 85% load 30 min. - Governor test approx. 15 min. <p>For the FAT natural gas and lube oil will be used in line with the MAN Diesel & Turbo standards. The test will be executed according to the actual conditions prevailing at our workshop. The operating values to be expected at site can be calculated by using well-proven methods on basis of the main operating values ascertained on the test bed. The measuring parameters, including relevant accuracies, are based on ISO 3046.</p> <p>Extension or changes of our test program would result in additional cost and have to be clarified upon request.</p>
-------------	---	--



2.2 Detailed Technical Specification of one engine 35/44GTS

<i>Design features</i>	<p>One-part crankcase with safety valves on crankcase covers</p> <p>Crankshaft made of forged steel with torsion vibration damper at free end</p> <p>Main bearings and big-end bearings with two-part thin-walled bearing shells and main bearings cross-braced by tie-rods</p> <p>Connecting rod (split with flange) drop-forged from steel</p> <p>Piston with forged steel crown and steel skirt</p> <p>Cast-iron cylinder liners with fire land ring</p> <p>Nodular cast-iron cylinder head with armor-plated inlet and exhaust valves, valve seat rings for the inlet and exhaust valves. Valve rotators on the inlet and exhaust valves.</p> <p>Pipes on the engine with counter flanges or connecting screws</p>
<i>Natural gas and ignition system</i>	<p>The 35/44GTS is an Otto gas engine with spark plugs.</p> <p>Electronically controlled gas valves, individually for each cylinder</p> <p>Gas supply line with indicator filter, shut-off by means of solenoid valve</p> <p>The ignition system provides a scavenged pre-chamber, optimized for low NO_x emissions and stable ignition. The ignition system using spark plugs ensures reliable ignition.</p>
<i>Turbo charging and charge-air cooling</i>	<p>Two-stage turbo charging with intermediate charge air cooling, installed on a free-standing module, decoupled from the engine, consisting of:</p> <p>2 low pressure turbocharger , one for each cylinder bank. Dry cleaning device for the exhaust gas turbine and wet cleaning device for the compressor.</p> <p>2 charge air cooler after low pressure stage in fresh water and two-stage design; with counter flanges</p> <p>2 high pressure turbocharger , one for each cylinder bank. Wet cleaning device for the exhaust gas turbine.</p> <p>2 charge air cooler after high pressure stage in fresh water and two-stage design; with counter flanges</p> <p>Waste gate to increase the exhaust gas temperature after engine</p> <p>Air pipe sound insulated between compressor and charge air cooler (including air intake casing)</p> <p>Exhaust gas piping on the engine, un-cooled, thermally insulated and lagged</p>
<i>Operation and control</i>	<p>Engine safety and control system SaCoS_{one}, comprising of:</p> <p>SaCoS_{one} Injection unit</p> <p>resiliently mounted on engine, consisting of injection module(s) for electronic speed governing and gas injection valve control</p> <p>SaCoS_{one} Control unit</p> <p>resiliently mounted on engine, consisting of highly integrated control modules, one for safety system and one for alarm handling and control, including the following functions:</p> <ul style="list-style-type: none">- Splash oil temperature monitoring- Lube oil temperature and pressure monitoring- Cooling water temperature and pressure monitoring- Charge air temperature and pressure monitoring- Exhaust gas temperature monitoring- Speed monitoring and over speed protection- Engine control



	<p>SaCoS_{one} Atex unit resiliently mounted on engine, consisting of explosion protected I/O modules for main bearing monitoring</p> <p>SaCoS_{one} Knock control unit resiliently mounted on engine, consisting of knock detection device</p> <p>Local operating panel resiliently mounted on engine, with TFT touch screen for:</p> <ul style="list-style-type: none">- Indication of engine operating data- Indication of status and alarm messages- Engine start/stop- Control station change-over- Increase/decrease of speed set point- Emergency stop <p>Oil mist detector Schaller VN115</p>
<i>Temperature measuring</i>	Thermocouples for measuring the exhaust gas temperature after each cylinder, before and after turbocharger
<i>Lubricating and cooling</i>	Forced-feed lubrication for all bearing points of running gear, camshaft, timing gear and turbocharger Cylinders, cylinder heads and charge-air coolers are water-cooled, pistons are oil-cooled
<i>Starting system</i>	The engine uses a compressed air starter that transmits the torque directly to the flywheel. The starter module also includes a flexible turning gear.
<i>Engine painting</i>	The exterior surface of the engine is painted in WINDOW GRAY (RAL7040). Painting consists of one finishing coat, approx. 20 µm.
<i>Acceptance</i>	Works acceptance / factory approval.
<i>Calculation</i>	Torsion vibration calculation



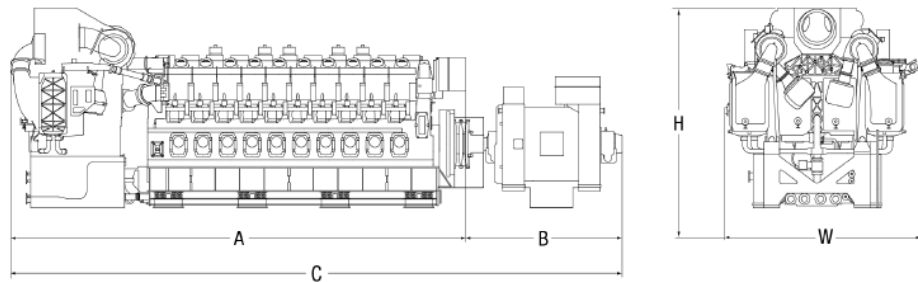
3 Generating set

General description

Our generating sets are designed for power generation in continuous, durable and safe operation. The area of application comprises ranges from supplies of basic loads in public mains or coverage of peak loads to isolated applications for industrial consumers.

The engine is rigidly mounted on a steel frame, acting as the lubricating oil service tank, which is resiliently seated on a simple concrete foundation by spring isolators. The alternator is connected to the engine by a flexible coupling, rigidly mounted and grouted onto a separate and elevated concrete foundation.

Outline dimensions



Dimensions and weight⁷ of the generating set:

- Height (H)	5200 mm
- Length (C)	13358 mm
- Width (W)	4925 mm
- Weight (dry)	144000 kg

⁷ The dimensions and weight stated correspond to the complete unit including alternator. The total weight varies depending on the alternator make. All given masses are without lube oil and cooling water. Dimensions and weights are for guidance only and are subject to change without notice. The length of the genset unit depends on the alternator make.



Item Q'ty Description

3.1 Connecting elements

3.1.1 Coupling arrangement

020.010.010 3 Flexible coupling
MJK10 AU010
The flexible coupling is mounted between engine flywheel and alternator shaft. The scope includes a connection hub for the alternator shaft and fixing bolts for connection to the flywheel.
A standard coupling is used. Size and rubber quality are determined by the torsional vibration calculation.

020.010.040 3 Flywheel cover
MJP10 AU011

3.1.2 Pipe adapters

020.030.025 3 Flexible pipe connections for the engine

020.030.080 6 Rubber expansion joint for intake air duct
to be installed upstream of turbocharger, delivered with counter flange.

3.2 Genset

3.2.1 Alternator system

025.020.010 -1 3 Three phase synchronous alternator
MKA10 AG010

Design:

The stator frame is a rigid, welded steel structure construction. The stator core is built of thin electric sheet steel laminations which are insulated on both sides with heat-resistant inorganic resin. The radial cooling ducts in the stator core ensure uniform and effective cooling of the stator.

The rotor consists of a forged steel shaft, a hub and sheet steel poles fixed on the hub. The pole laminations are pressed together with steel bars fixed to the end plates.

The windings, epoxy resin impregnated, are provided with very strong bracing which withstand all expected mechanical and electrical shocks and vibrations.

Engine-independent, self lubricated bearing design, to avoid possible lube oil contamination by the engine.

The alternator is self-ventilated and needs no external forced air flow. The surrounding air is used for cooling. The cooling air is drawn in through air filters and blown out to the surrounding environment.

Rated technical data:

- Output approx.
- Voltage

9049 kVA
11 kV



Item	Q'ty	Description
		<ul style="list-style-type: none"> - Current approx. 475 A - Frequency 50 Hz - Power factor 0,8 - Temperature rise stator/rotor F/F - Insulation class F - Mounting design IM1001 or IM7201 - Protection class alternator IP23 - Protection class terminal box IP54 - Cooling method IC0A1 (Air cooled) - Operation S1, continuous - Operation mode - Applicable standard IEC 60034 <p>The alternator is optimized for voltage-stability in case of load variation.</p> <p>Accessories:</p> <ul style="list-style-type: none"> - Anti-condensation heater - Pt100 sensors for winding temperature detection - Pt100 element and lubrication oil sight-glass for monitoring, for each bearing - Main terminal box (terminals U/V/W/N) and auxiliary terminal box (for accessories) inclusive suitable cable glands for bottom entry - Brushless self-excitation system including rotating diodes and protection against overvoltage - Droop current transformer installed in main terminal box - Star point current transformers for protection purposes installed in main terminal box - Painting similar to engine color - Foundation bolts <p>Final series test report according to manufacturer's standard is included.</p>
025.020.050	3	<p>Automatic voltage regulator (AVR)</p> <p>Digital excitation control system type BASLER DECS 250 installed on a mounting plate integrated in the Genset Interface Panel (GCP).</p> <p>Features:</p> <ul style="list-style-type: none"> - Voltage Regulation accuracy <0,25% - Proportional (P), integral (I) and derivative (D) stability control - Limiter functions to ensure, that the alternator does not exceed its capabilities, e.g. Over/Under Excitation Limiter, Stator Current Limiter, V/Hz Limiter - Paralleling compensation of two or more alternators using reactive droop - Automatic Voltage Regulation Mode (AVR Mode), Power Factor Mode, Field Current Regulation (Manual Mode) - Several protection functions (e.g. Loss of sensing voltage, Loss of excitation) - Rotating Diode Monitoring - Serial bus coupling interface for read out of different measuring values - Synchro check relay functionality



Item Q'ty Description

3.2.2 Foundation system

025.030.030 3 Grouting material for seating of alternator

025.030.050 -2 3 Foundation frame seating
MJA10 BF021 Spring elements for resilient, vibration-isolated mounting of the steel foundation
frame with engine on the concrete foundation including equipment for lining
(balancing aids) and fixing.

3.2.3 Genset add-ons

025.035.060 3 Lube oil tank level monitoring



4 Mechanical scope

Item Q'ty Description

4.1 Auxiliary systems, engine related

4.1.1 Lube oil service system

030.020.010 -1 MJV21 AC010	3	<p>Lube oil module consisting of:</p> <ul style="list-style-type: none"> - Lube oil heat exchanger - Lube oil priming pump with e-motor - Lube oil temperature regulating valve - Terminal box <p>The above equipment is mounted on a frame with corresponding fittings completely piped and wired.</p>
030.020.150 MJV23 AA010	3	<p>Lube oil replenishing and flow rate measuring device Consisting of:</p> <ul style="list-style-type: none"> - Oval gear meter including pulse trigger - Solenoid valve
030.020.270 MJV22 AT040	3	<p>Lube oil fine filter Consisting of:</p> <ul style="list-style-type: none"> - Fine filter with cartridge - Feed pump with motor (2-3 times circulation of lube oil volume in 24 hours). - Pressure switch to indicate cartridge change. <p>Fine filters are simple to operate and do not need any process water. The filters can be changed quickly and easily without engine shutdown.</p>
030.020.280 -1 MJV28 AT010	3	<p>Oil mist fan The vent gases originate from the following:</p> <ul style="list-style-type: none"> - Crankcase: Gases from the combustion chamber leak past the piston rings - Turbocharger vent: The bearing housing of the turbocharger is pressurized to prevent the hot exhaust gases entering the bearing housing. It is pressurized by letting some of the gases from the compressor side of the turbocharger into bearing housing. The oil mist eliminator reduces the oil emissions from the vents of the engine crankcase chamber and the turbocharger.
030.020.290 MJV21 AP040	3	<p>Lube oil preheating pump Pump for lube oil circulation in the pre-heating circuit.</p>

4.1.2 HT cooling water service system

030.030.035 MJG31 AP020	3	<p>Cooling-down pump, free-standing Capacity 30 m³/h, with e-motor.</p>
----------------------------	---	--



Item	Q'ty	Description
030.030.035 -1 MJG31 AP020	3	HT cooling water temperature regulating valve With electric actuator, to be fitted in the cooling water pipe to radiator and resistance thermometer Pt 100 to be fitted in HT cooling water pipe downstream mixing point.
030.030.035 -2 MJG31 AP020	3	Resistance thermometer for HT cooling water, loose supply
030.030.060 MJG31 BB011	3	Cooling water expansion tank The tank is designed with two separate compartments for HT and LT circuit, capacity 500 l/250 l, with mechanical level indicator and minimum alarm contact

4.1.3 Low temperature cooling water system

030.040.050 -1 MJG32 AA025	3	Charge air temperature control valve (CHATCO)
030.040.050 -2 MJG32 AA025	3	Resistance thermometer for charge air temperature
030.040.050 -3 MJG32 AA025	3	LT cooling water temperature control valve with electric actuator and resistance thermometer Pt100, to be installed in LT cooling water pipe downstream the mixing point

4.1.4 Two circuit radiator cooling system

030.050.010 -1 MJG32 AC020	3	Two-circuit radiator cooling system The engines are cooled with outside mounted radiators with electrically driven induced draft fans with space heaters. Scope of supply: <ul style="list-style-type: none"> - Radiator cooler with separate cooling circuits for high and low temperature cooling water - Frame material: hot dipped galvanized steel. - Tube material: copper - Fin material: aluminum The radiator coolers are designed for a minimum temperature of -20 °C (with glycol) and a maximum ambient temperature of 40 °C. Supply without steel supporting structure. Each engine is cooled by separate radiator units. Noise power level of the radiators for one engine is 110 dB(A).
-------------------------------	---	--



Item Q'ty Description

4.1.5 Fuel gas system

030.100.010 3 Gas control line
EKG91 BP010
Rated for gas supply overpressure as per minimum requirements for natural gas, consisting of:

- Shut-off valve
- Gas filter
- Pressure gauges / pressure switch
- Gas regulator system with safety shut-off
- 2 Trip action stop valves
- 2 Main venting valves
- Terminal box, explosion-proof.

The maximum allowed distance between the gas control line outlet and the engine gas inlet is 10 m. The piping between gas control line and engine gas inlet has to be made of stainless steel (min. X6CrNiMoTi17-12-2, being fluid and ambient resistant).

030.100.050 3 Set of shut off valves for natural gas
EKG91 AA020
Consisting of:

- main shut off valve
- shut off valve for priming the main gas pipe
- venting valve

As an additional safety and maintainability measure MDT recommends the installation of a manual ball valve within the natural gas supply line in each engine related branch in front of the power house. This valve is not in scope of supply of MDT.

4.1.6 Combustion air system

030.120.010 -1 3 Intake air filter unit
MJQ61 AT010
Consisting of:

- Weather protection
- Droplet separator
- Pulse filter, self-cleaning with pressurized air
- Silencer for a noise attenuation of approx. 40 dB(A)
- Transition piece to intake air duct(s)
- Intake air pre-heating
- Filter control unit

4.1.7 Engine exhaust gas system

030.130.020 3 Expansion joint for exhaust gas duct
to be installed after adapter, without counter flange



Item Q'ty Description

4.2 Auxiliary systems, plant related

4.2.1 Lube oil supply system

- | | | |
|----------------------------|---|---|
| 040.010.010
MJV21 AC020 | 1 | <p>Lube oil preheater set</p> <p>To heat engine lube oil to 40°C before engine start, heating capacity 48 kW, consisting of:</p> <ul style="list-style-type: none">- Temperature controller with limiter- Temperature sensor- Safety valve- Switch cabinet with control and power part- Saddle support. <p>The preheater set is designed to preheat the lube oil of one engine.</p> |
| 040.010.030
MJV23 AP030 | 2 | <p>Lube oil supply pump</p> <p>1 x operation and 1 x stand-by, capacity 3 m³/h each, with e-motor. The pump is used to supply lube oil from the storage tank to the service tank.</p> |
| 040.010.040
MJV23 AP060 | 1 | <p>Lube oil transfer pump</p> <p>Capacity 3 m³/h, with motor and attached pressure relief valve. The transfer pump is used to refill the foundation frame (lube oil service tank) with the lube oil stored in the maintenance tank.</p> |

4.2.2 HT cooling water supply system

- | | | |
|----------------------------|---|---|
| 040.030.010
MJG31 AC010 | 1 | <p>Pre-heater set for cooling water</p> <p>After a longer engine shut down pre-heating is necessary before the start-up of the engine. A pre-heater set delivers the necessary energy. A circulating pipe interconnects the pre-heating set with the engine.</p> <p>Cooling water pre-heating module, consisting of:</p> <ul style="list-style-type: none">- Continuous flow water heater, electrical type (heating capacity approx. 120 kW)- Temperature regulator- Switch cabinet, ready for connecting and service, with control and power part. <p>The preheater is designed for heating the engines consecutively.</p> |
|----------------------------|---|---|

4.2.3 Main water supply system

- | | | |
|----------------------------|---|---|
| 040.040.010
GBK35 BB050 | 1 | <p>Cooling water collecting tank</p> <p>Capacity 3000 l with mechanical level indicating.</p> |
| 040.040.020 | 1 | <p>Replenishing pump module</p> <p>Consisting of 2 pumps (1 x operation + 1 x stand-by), capacity 3 m³/h each, with e-motor and expansion pot, capacity 200 l.</p> |



Item Q'ty Description

4.2.4 Fuel gas system

040.065.010 -1 1 Gas alarm unit
UMF15 CQ010
Consisting of:
– Monitoring panel
– Set of gas detectors
The final locations of the gas detectors in the powerhouse have to be verified by customer (e.g. with smoke plume test). In case of gas alarm (highest stage) all equipment within the monitored area, which can be a source of ignition, needs to be de-energized/ black.

4.2.5 Starting air system

040.070.010 2 Starting air receiver
SCB71 BB010
Capacity 3000 l, working pressure 30 bar, with valve head, fittings, pressure gauge, supports and retaining bracket. The starting air receivers are connected in parallel, each one can be isolated from the system by shut-off valves.
The capacity of the starting air receivers is designed for 3 starts of one engine without refilling. After a longer standstill of the engine a slow turn manoeuvre is required which needs additional starting air. 1 slow turn manoeuvres are considered in dimensioning of total capacity of the starting air receivers.

040.070.030 2 Automatic draining equipment for starting air receiver
SCA71 AT020

040.070.040 1 Compressor module
SCA71 AN010
Consisting of 2 compressors with electric motor, 30 bar pressure, capacity 120 m³/h each at 20°C and 1013 mbar barometric pressure, with suction filter, air cooled, intermediate and final cooler, oil and water traps, electro-magnetic water drain and switch and control device.
Module complete with three-phase motor, flywheel and flexible coupling.
Equipment mounted on a skid for resilient mounting.

4.2.6 Control air system

040.073.010 1 Control air receiver
QFB72 BB010
Capacity 1000 l, 11 bar maximum pressure, vertical receiver, hot galvanized, with safety valve, pressure gauge and condensate discharge valve.
The control air receiver to be installed in the power house.



Item	Q'ty	Description
040.073.030 QFA72 AN020	1	<p>Control air compressor module</p> <p>Consisting of 1 screw type compressor, 10 bar pressure, air cooled, designed for continuous operation.</p> <p>Complete module with energy saving screw type compressor block, three-phase motor, belt drive with automatic belt tensioner or flexible coupling, intake air filter, electro-magnetic water drain, final air cooler. Flexible hose line and cyclone separator with electro-magnetic condensate trap are part of the module or supplied as separate components.</p> <p>Equipment being part the module is installed on a steel frame inside a housing with operator control module.</p>
040.073.050 QFB72 AT020	1	<p>Control air adsorption dryer</p> <p>Dehumidification of control air down to a pressure dew point of -20°C. Dryer consisting of:</p> <ul style="list-style-type: none"> - Two adsorbent tanks - Valves for automatically regulated drying cycle - Valve and pressure indicator for regeneration air adjustment - Automatic condensate discharge - Humidity indicator for visual check - Inlet and outlet filter <p>Above mentioned equipment will be supplied installed on a steel frame for floor installation or as unit for wall-fastening. An additional filter element will be supplied as separate component for backup purpose or special requirements.</p>
040.073.060 QFA71 AA010	1	<p>Pressure reducing station 30/10 bar</p> <p>The pressure reducing station is connecting starting air and control air. The starting air pressure is reduced to 10 bar, to provide control air to the plant related systems. It is used as back-up for the control air compressor.</p> <p>Reducing station, complete with:</p> <ul style="list-style-type: none"> - Air filter - Reduction valve with pressure indicator - Safety valve - Connectors and pipes.
040.073.070 QFB72 AA010	2	<p>Pressure reducing station bar</p> <p>The pressure reducing station is used to provide control air to the plant related systems. 1 x operation + 1 x stand-by.</p> <p>The reducing station is equipped with:</p> <ul style="list-style-type: none"> - Air filter - Reduction valve with pressure indicator - Safety valve - Connectors and pipes.
040.073.080	1	<p>Compressed air filter</p>



Item Q'ty Description

4.2.7 Power house inlet ventilation system

040.083.010 -1 3 Set of inlet ventilation units
UMF15 AN010
Consisting of 2 units, equipped with:
– High efficiency ventilator
– Silencer with noise attenuation of approx. 30 dB(A)
– rain-proof housing
– Adjustable flaps with electric actuator
– Weather louvre
Units including supporting structure, maintenance platform, ladders.

4.2.8 Power house outlet ventilation

040.086.030 -1 3 Power house ventilation outlet unit
UMF15 BS020
The outlet units in the roof consists of weather protection and silencer with a noise attenuation of approx. 20 dB(A)

4.2.9 Turning gear

040.120.010 1 Electric drive set for turning gear

4.3 Exhaust gas system

4.3.1 Exhaust gas silencer

060.005.010 3 Freestanding exhaust gas silencer:
MJR65 BS010
Silencer for vertical installation outside of the power house (freestanding) on a supporting steel structure,
Technical features:
– Reactive and/or absorptive attenuation principle
– Noise attenuation approx. 25 dB(A)
– Total pressure loss < 10 mbar
– Material of main components S235JR
– Absorptive material, if any, within special cushions retained by perforated plates
Scope of supply for silencer including:
– Static design
– Corrosion protection of non-insulated external surfaces
– Fixing accessories for vertical installation on a supporting steel structure
– Delivery loose, without counter flange and insulation material
– Insulation works by Third Parties according to engineering specification



Item Q'ty Description

4.3.2 Exhaust gas duct

060.010.130
MJR65 AN020

3 Ventilation system for exhaust gas duct

A ventilation system is installed for natural gas and dual fuel engine applications. The module is placed inside the powerhouse at the exhaust gas duct close to the engines outlet. The flue gas system must be purged with fresh air. The purging with fresh air avoids the ignition of explosive gas compositions.

During normal operation of the engine the module is protected from the hot exhaust gas by two shut-off valves before the fan. The valves are normally closed. They are opened only during the ventilation. The gas tight closing is guaranteed by sealing air, which is inserted between the valves. The ventilation system consists of:

- Air fan with suction filter
- Two shut-off valves with limit switches
- Sealing air connection
- Pressure sensor to check the functionality of the fan
- Temperature sensor to guarantee no hot exhaust gas enters the fan
- Skid with pre-mounted and cabled system
- Junction box

4.3.3 Exhaust gas stack

060.020.011
MJR65 BR020

15 meter of exhaust gas stacks

for each MAN Diesel & Turbo engine, to be installed on top of the vertically mounted silencer. Lengths of each tail pipe 5 m.



5 Electrical scope

Item Q'ty Description

5.1 Control and monitoring system

5.1.1 Genset control panel (GCP_NG)

070.021 -1
0 3 Genset control panel (GCP_NG)

Purpose:
The new generation of the Genset Control Panel (GCP_NG) controls and supervises the GenSet (engine and alternator) and their systems in combination with the local engine control SaCoS. It realizes the control, synchronization and protection of the alternator circuit breaker in MV switchgear and accomodates the AVR. The GCP is located in the control room.

Properties:
The GCP is arranged for floor mounting without plinth, totally closed and front door with rubber gasket. Door lever is key-less. Cable insert from bottom. Connection to the alternator medium voltage switchgear, neutral earthing switchgear and SCADA system. Also connected to Common Control Panel (CCP) for safety related signals and to Fire Fighting and BCP (Boiler Control Panel) for safety relevant signals.

Dimensions of each panel (Type Rittal TS):

- Width: approx. 800mm
- Height: approx. 2000mm
- Depth: approx. 600mm

The panels are equipped with door fans and roof mounted top filters. AC 230 V UPS power supply input for generation of 24 V DC for control. With touch panel for operation, supervision and monitoring. With panel light and socket outlet (AC 230V).

- Panel protection degree IP41
- Color RAL 7035

Alternator protection:

- Digital multifunction protection relay

Control system (PLC):

- Siemens SIMATIC System S7-400.

Integrated devices:

- Automatic Voltage Regulator (item 025.020.050).

070.021 -2
0 1 Common control panel (CCP)

Purpose:
The Common Control Panel (CCP) controls and supervises the plant related (not genset related) equipment of the power plant. Furthermore, it realizes the protection and synchronization of the step-up transformers and the station transformers, the medium voltage bus bar couplers and the outgoing feeders whichever is applicable. The CCP is located in the control room.

Properties:



Item	Q'ty	Description
		<p>The CCP is arranged for floor mounting without plinth and front door with rubber gasket. Door levers are key-less. Cable insert from bottom. Connection to SCADA system.</p> <p>Dimensions of each panel (Type Rittal TS):</p> <ul style="list-style-type: none"> - Width: approx. 3200mm - Height: approx. 2000mm - Depth: approx. 600mm <p>Cooling is realized by door fans and roof mounted top filters</p> <p>AC 230 V UPS power supply input for generation of 24 V DC for control</p> <p>With touch panel PC for operating and supervision by MAN Diesel & Turbo SCADA visualization system</p> <p>With panel light and socket outlet (AC 230V)</p> <ul style="list-style-type: none"> - Panel protection degree IP41 - Color RAL 7035 <p>Protection:</p> <ul style="list-style-type: none"> - 1 multifunctional protection relay for step-up transformer - 1 multifunctional protection relay for station transformer - 1 protection relay for MV bus bar - Independent over current time relays for neutral earthing protection <p>Control system (PLC):</p> <ul style="list-style-type: none"> - Siemens SIMATIC System S7-400

5.1.2 CoCoS-System

070.090.010	1	<p>"CoCoS-EDS" engine diagnosis system</p> <p>CoCoS EDS is a personal computer-based system for the supervision of plant operation, which allows the user far more than simply the visualization of current operating data in various forms (monitoring function).</p> <p>The engine diagnosis system consists of:</p> <p>Hardware</p> <ul style="list-style-type: none"> - 1 Personal computer with interface card to the alarm system - 1 colour monitor - 1 keyboard - 1 printer <p>Software:</p> <ul style="list-style-type: none"> - Software for recording of values measured by the - Engine-specific data and maps. <p>Trends</p> <p>The trend function of CoCoS EDS allows the user to study all relevant engine operating data, in short term trend mode, i.e. at very short intervals, over a period of 2 weeks, and in long term trend mode, i.e. at longer intervals, over several years, and thus to recognise developments and changes of operating values long before they have an effect on the plant operation.</p> <p>Diagnosis</p> <p>Based on current readings taken during operation of the plant, the diagnosis function provides the user with a clear analysis of defects and failures, which symptoms lead to this conclusion (which operating figures are not as they</p>
-------------	---	--



Item	Q'ty	Description
		<p>should be) and which remedial measures should be taken.</p> <p>CoCoS EDS, with its functions monitoring, trend and diagnosis, does not replace the engine alarm system. It is in fact subordinate to the engine alarm system. However, due to its sensitivity in detecting and reporting occurrences, it responds prior to the engine alarm system. Thus CoCoS EDS allows the user to take the necessary countermeasures long before any serious defects or failures appear. In this way, unnecessary stoppages of the engines can be avoided, maintenance work reduced and availability of the plant increased.</p> <p>To achieve these unique features, CoCoS EDS relies on performance graphs which are generated by our engineers for each single engine at the place of installation, whether in the power plant or on board a vessel. This way the real, at site operating conditions are considered, which is not possible with performance graphs that are created on the test bed only.</p> <p>As CoCoS EDS can be freely configured and extended, it is also possible to include further plant auxiliaries in its functions.</p>
070.090.015	1	<p>Connecting cables between EDS-Databox and CoCoS-EDS Hardware</p> <p><i>Optional equipment</i></p>
070.090.060 -1	1	<p><i>Online Service Reporting</i></p> <p><i>With Online Service PrimeServ provides a set of remote service product modules to enable an optimized engine operation. Thanks to effective data transmission via a secure IPsec protocol Online Service can transmit important engine and installation information throughout the world, can evaluate it and make available the know-how of the MAN Diesel & Turbo PrimeServ experts in real time. Main goal of Online Service is to support our customers globally. The remote connection will be established via the remote access device in our scope of supply. The Online Service portfolio contains small solutions like online assistance with real time remote connection on demand as well as daily data transfers including limit check, trend analysis and regular reporting.</i></p> <p><i>The Online Service shall begin with TOC of the power plant and is limited to a period of one year. Online Service shall be exclusively governed by the currently valid MAN Diesel & Turbo General Terms and Conditions on Online Services, available on our homepage.</i></p>

5.2 Electric plant system

5.2.1 LV sub distribution

080.050.010 -1	3	<p>Engine Auxiliary Panel (EAP)</p> <p>Purpose:</p> <p>The Engine Auxiliary Panel (EAP) is the low voltage sub-distribution, the Motor Control Center (MCC) for the power supply of the genset related auxiliaries and for manual local operation of genset related auxiliaries which have no own control. It is the control part for the decentralized periphery, collecting all genset related signals from the field, e.g. pipes, auxiliaries, modules and not genset attached parts. The EAP is located in the mechanical annex of the genset area in the engine hall.</p>
----------------	---	--



Item	Q'ty	Description
		<p>Properties:</p> <p>The EAP consists of a fully enclosed metal cabinet in steel frame construction, arranged for floor mounting with a plinth, totally closed and the front doors with rubber gasket. The door lever is with a key. Cables insert from bottom through plinth. Connection to the GCP for safety relevant signals and to the GIP/ECP for the emergency stop of the auxiliaries.</p> <p>Dimensions of each panel (Type Rittal TS):</p> <ul style="list-style-type: none"> - Width: approx. 2000mm - Height: approx. 2200mm - Depth: approx. 600mm <p>The panels are equipped with fans, thermostat, air filters and anti-condensation heating</p> <p>AC 230 V UPS power supply input for generation of 24 V DC for control</p> <p>With panel light and socket outlet (AC 230V)</p> <ul style="list-style-type: none"> - Panel protection degree IP54 - Color / plinth color RAL 7035 / RAL 7022 <p>Hardware:</p> <ul style="list-style-type: none"> - Starters for genset related auxiliaries - Power supply feeders for genset related auxiliaries <p>Control system:</p> <ul style="list-style-type: none"> - Siemens ET200M (collecting of signals from genset related auxiliaries, e.g. modules and distribution of these signals to PLC Siemens SIMATIC S7-400 in the GCP)
080.050.020 -1	1	<p>Common Auxiliary Panel (CAP)</p> <p>Purpose:</p> <p>The Common Auxiliary Panel (CAP) is the low voltage sub-distribution, the Motor Control Center (MCC) for power supply of the plant related auxiliaries inside the power house, which are not genset related and for manual local operation of the auxiliaries which don't have an own control. It is the control part of the decentralized periphery, collecting signals from the different plant related pipes sensors, auxiliaries and modules inside the power house. The CAP is located centralized on the level of the mechanical annex of the power house.</p> <p>Properties:</p> <p>The CAP consists of a fully enclosed metal cabinet in steel frame construction, arranged for floor mounting with a plinth, totally closed and the front doors with rubber gasket. The door lever is with a key. Cables insert from bottom through plinth. Connection to the CCP for control purpose.</p> <p>Dimensions of each panel (Type Rittal TS):</p> <ul style="list-style-type: none"> - Width: approx. 2400mm - Height: approx. 2200mm - Depth: approx. 600mm <p>The panels are equipped with fans, thermostat, air filters and anti-condensation heating</p> <p>AC 230 V UPS power supply input for generation of 24 V DC for control</p> <p>With panel light and socket outlet (AC 230V)</p>



Item	Q'ty	Description
		<ul style="list-style-type: none"> - Panel protection degree IP54 - Color / plinth color RAL 7035 / RAL 7022 <p>Hardware:</p> <ul style="list-style-type: none"> - Starters for common auxiliaries located in power house - Power supply feeders for common auxiliaries located in power house <p>Control system:</p> <ul style="list-style-type: none"> - Siemens ET200M (collecting of signals from auxiliaries in the power house and distribution of these signals to PLC Siemens SIMATIC S7-400 in the CCP)
080.050.050 -1	3	<p>Engine Radiator Panel (ERP)</p> <p>Purpose:</p> <p>The Engine Radiator Panel (ERP) is the low voltage sub-distribution, the Motor Control Center (MCC) for the power supply of the engine related auxiliaries and for manual local operation of the auxiliaries, which don't have an own control. The ERP is located in the radiator area, outside of the power house.</p> <p>Properties:</p> <p>The ERP consists of a fully enclosed metal cabinet in stainless steel frame construction, arranged for floor mounting with a plinth, totally closed and the front doors with rubber gasket. The door lever is with a key. Cables insert from bottom through plinth. Connection to the GCP.</p> <p>Dimensions of each panel (Type Rittal TS):</p> <ul style="list-style-type: none"> - Width: approx. 2000mm - Height: approx. 2200mm - Depth: approx. 600mm <p>The panels are equipped with fans, thermostat, air filters and anti-condensation heating</p> <p>AC 230 V UPS power supply input for generation of 24 V DC for control</p> <p>With panel light and socket outlet (AC 230V)</p> <ul style="list-style-type: none"> - Panel protection degree IP54 - Color / plinth color not painted <p>Hardware:</p> <ul style="list-style-type: none"> - Starters for radiators and radiator related auxiliaries <p>Control system:</p> <ul style="list-style-type: none"> - Siemens ET200M (collecting of signals from radiators and radiator related auxiliaries and distribution of these signals to PLC Siemens SIMATIC S7-400 in the GCP)
080.050.120 -1	1	<p>Common PH Ventilation Panel (CVP)</p> <p>Purpose:</p> <p>The Common Ventilation Panel (CVP) is the low voltage sub-distribution, the Motor Control Center (MCC) for the power supply of the power house ventilation. It is the control part for the decentralized periphery, collecting all power-house ventilation related signals and enables local control of the ventilation. The CVP is located outside of the power house.</p>



Item Q'ty Description

Properties:

This panel consists of a fully enclosed metal cabinet in stainless steel frame construction (Rittal TS) arranged for floor mounting without plinth, totally closed and the front door with a rubber gasket. The door lever is with a key. Cables insert from the bottom. Connection to the CCP for control purpose and safety relevant signals.

Dimensions of each panel (Type Rittal TS):

- Width: approx. 1200mm
- Height: approx. 2200mm
- Depth: approx. 600mm

The panels are equipped with fans, thermostat, air filters and anti-condensation heating

AC 230 V UPS power supply input for generation of 24 V DC for control
With panel light and socket outlet (AC 230V)- Panel protection degree IP54

- Color / plinth color not painted

Hardware:

- Starters for the power-house ventilation
- Power supply feeders for the power-house ventilation

Control system:

- Siemens ET200M (collecting of input/output signals and distribution of these signals to PLC Siemens SIMATIC S7-400H in the CCP)



6 Miscellaneous

Item Q'ty Description

6.1 Documentation

6.1.1 Basic plant technical documentation

- 170.010.010 -1 3 Sets of genset and equipment documentation in paper edition
Consisting of:
- Operating manual of delivered equipment
 - General overview including residual risks
 - Reference list of associated documents
 - Instruction manuals of engine and turbo-charger
 - Operating instructions and maintenance schedule
 - Working instructions
 - Spare parts catalogue
 - Tools and spare parts lists
 - Workshop test acceptance certificate
 - Documentation of the genset including:
 - Instruction manual of alternator, etc.
 - Drawings
 - Set of manuals of delivered equipment
- Additionally, the above mentioned documents will be handed over in PDF-format on CD or DVD. Publication of intermediate status of O&M manuals on online platforms (on demand). The documentation will be in English language and in MAN Diesel & Turbo's standard format.



7 Tools, spare and wear parts

Item Q'ty Description

7.1 Tools and spares

7.1.1 Engine tools

- 015.010.010 1 Set of standard and special tools for the engine required for servicing and inspection of the engine, consisting of:
- BASIC TOOLS
- Eye bolt, socket wrench insert with adapters, screw driver inserts, torque spanners
- HYDRAULIC TOOLS
- Pneumatically driven hydraulic high-pressure pump with hydraulic bolt tensioning devices
- DEVICES
- For the crankshaft bearing caps
- Mounting and removing devices for:
- Cylinder heads with rocker arm casing
 - Inlet and outlet valves
 - Gas valves and gas pipes
 - Pistons including insertion bush
 - Cylinder liners
 - Connecting rod bearing caps
 - Connecting rods
 - Camshaft vibration damper
- 015.010.020 1 Crank web deflection measuring device
- 015.010.080 1 Electric valve cone grinder for the exhaust valves, make HUNGER
- 015.010.090 1 Electric valve seat grinder for the inlet and exhaust valve seats (alternating current 230V)
- 015.010.182 1 Assembly and reversing device for the cylinder heads

7.1.2 Engine spare and wear parts

- 015.020.020 3 Set of engine standard spare parts for engine type 12V35/44G, consisting of:
- Piston:
- 1 Set of compression and oil scraper rings
- Cylinder head:
- 1 Valve seat insert for inlet valve with round seal ring
 - 1 Valve seat insert for exhaust valve with round seal ring
 - 1 Valve guide with round seal ring



Item	Q'ty	Description
		Inlet valve: – 1 Inlet valve, complete Exhaust valve: – 1 Exhaust valve, complete Operation/Monitoring: – 1 Three-way solenoid valve – 1 Pressure reduction valve Seals and round seal rings: – 1 Set of seals and seal rings for 1 cylinder Sealing material: – 1 Set of sealing material Gas operation: – 4 round seal ring for gas valve – 4 round seal ring for gas valve guide – 4 gas valve – 1 gas valve drive – 4 prechamber insert – 4 set of round seal rings for pre-chamber insert
015.020.070	1	Spare parts for operating and monitoring the engine
015.020.140	1	Set of spare parts for SACOS

7.1.3 Plant tools

015.030.090	1	Mobile strainer cleaning unit For lube oil automatic filter, consisting of: – Tank – High-pressure pump – Pump protecting filter – Microfilter – Cleaning gun with high-pressure hose – Cleaning liquid
-------------	---	--

7.1.4 Plant spares

015.040.020 -1	1	Set of spare parts for alternator consisting of: – 1 Set of diodes; varistor (for one generator) – 1 Pt100 for bearing
----------------	---	---



8 Services

Item Q'ty Description

8.1 Quality Management, Quality Assurance

205.010 -1 1 Establishing of a Quality Plan

MAN Diesel & Turbo has implemented a Quality Management System that conforms to ISO 9001 and ISO 14001 environmental standards. The integrated quality and environmental management manual is applied to all internal process steps to assure MAN Diesel & Turbo's grade of quality for our engines as well as for equipment delivered by sub-suppliers.

An individual quality plan will be issued, containing order-specific outlines of the quality standard related to quality assurance and quality documentation. In addition, individual processes are scheduled, deliveries are defined and test plans are assigned to the components to be supplied. Factory/Site Acceptance Tests follow the individual items of this plan.

The electronic version of the documentation is consisting of:

- Project specific Quality Plan
- Inspection and Test Plans
- Inspection and Test Records

The above mentioned documents will be handed over in PDF format on CD/DVD. The documents will be in English language and in MAN Diesel & Turbo standard format.

8.1.1 HSE Planning

205.050 -1 1 Establishing of the necessary HSE Measures

MAN Diesel & Turbo has implemented a HSE Management System that conforms to OHSAS 18001, OHRIS and ISO 14001 standards. The integrated quality and HSE management manual is applied to all internal process steps to assure MAN Diesel & Turbo's grade of quality, safety for our people as well as for the environment and others.

Individual activities for fulfilling the MAN Diesel & Turbo HSE standards as well as the local requirements will be defined. The electronic version of the documentation should consist of:

- Risk assessment
- Adopted HSE-Manual and Site rules (in case of EPC or Consortia)
- Audit planning- Deviations of the MAN Diesel & Turbo standard (if applicable) The HSE Manual and the site rules will be handed over in PDF format on CD/DVD. The documents will be in English language and in MAN Diesel & Turbo standard format. Other Documents will be filed and handed in if necessary.



Item Q'ty Description

8.2 Project engineering

8.2.1 Process & Tender Engineering

210.015.010 -1 1 System engineering
MAN Diesel & Turbo will engineer the offered scope of supply and provide the design data required for specification of the concerned equipment

- Design of the lube oil, cooling water, fuel, intake air and exhaust gas systems
- Heat recovery system for auxiliary consumption
- Explosion protection systems (if applicable)
- Adaption of the engine configuration to site conditions

The results of the system engineering are dimensioning data such as consumption, pressures, flow rates, temperatures, etc. and technical requirements at interfaces which will be used for ordering of the equipment.

MAN Diesel & Turbo will execute P&I Diagrams of all mediums required for the offered scope of supply.

8.2.2 Mechanical project engineering

210.020 -1 1 Mechanical project engineering
MAN Diesel & Turbo will execute following order drawings:

- Site plan showing the outdoor facilities of the power plant
- Power house layout drawing

8.2.3 Calculation of genset foundation

210.033.010 1 Design of the genset foundation base
Based on the genset foundation drawing mentioned above, MAN Diesel & Turbo will execute civil design works for the genset foundation.

As an outcome of the civil design works MAN Diesel & Turbo will prepare following documentation:

- General arrangement drawing
- Reinforcement drawing
- Steel bending and quantity list
- Foundation calculation
- Short construction manual.

Calculation of the foundation is based on the soil bearing capacity as per section 1 and does not consider engineering or design for piling.



Item	Q'ty	Description
		8.2.4 Engineering of auxiliaries
210.040 -1	1	Engineering of auxiliaries Based on the standard system engineering mentioned above, MAN will define and engineer all offered equipment.
		8.2.5 Electrical engineering
210.060 -1	1	Electrical engineering Establishing of the electrical documentation of the offered scope of supply, consisting of: <ul style="list-style-type: none">- Technical specification of electrical equipment- Electrical cabinet drawings- PLC architecture / schematic diagrams- List of measuring and control devices (plant)- List of Electrical Consumers
		8.2.6 Protection study
210.066 -1 0	1	Protection study Purpose: The Protection Study serves for the calculation of the relevant short circuit currents to verify the correct design of the main electrical components in the power plant. The Protection Study determines the setting values for the protection devices of the electrical equipment. Properties: The protection study is the result of a protection engineering service. The study indicates all input data which has been considered for the study. The study based on the IEC 60909 standard for short-circuit calculation, data sheets of the electrical components, requirements of MAN Diesel & Turbo (e.g. protection matrix, protection and measuring scheme), requirements of the grid operator or grid code and studies carried out by others. The protection study will be done for all protection devices (e.g. protection relay of alternator, step-up and station transformer) in the scope of supply of MAN. It provides the setting values for the main LV (Low Voltage) circuit breakers, depending on project specific arrangement. The results and setting values shall ensure the proper protection for the electrical equipment under all operation modes. The study verifies that faults of electrical equipment (e.g. short circuit, earth fault) will be disconnected in a safe manner, in sufficient time and selective.



Item	Q'ty	Description
------	------	-------------

8.2.7 Basic civil engineering

210.070 -1	1	Basic civil engineering Assistance for preparation of: – Site layout proposal – Layout proposal power house – Layout proposal ancillary buildings/tank farm
------------	---	---

8.3 Logistics

8.3.1 Transportation of equipment

The engine will be transported completely assembled and mounted on the foundation frame

220.020.010	1	Transport of engines to FCA North Sea port
220.020.040	1	Transport of auxiliaries to FCA North Sea port

8.4 Site activities

8.4.1 Supervision of installation

230.030.040 -1	70	man days Supervision of genset and mechanical equipment installation This service includes placing of the engine with springs elements on the foundation, coupling and alignment with the alternator, grouting of alternator, as well as placing all the mechanical equipment supplied by MAN Diesel & Turbo. The following prerequisites are necessary: – All engines and alternators are already unpacked and prepared for placement. – The auxiliaries are at site, unpacked and prepared for placement – Power house crane is available and the roof is closed – Hydraulic jacks, lifting devices, hydraulic tools, etc. are available – Supervision as per MAN Diesel & Turbo quality standard.
230.030.060 -1	20	man days supervision of electrical installation

8.4.2 Commissioning

230.110.010 -1	54	man days commissioning of engine by technician The technician will assist the commissioning engineer in performing all mechanical pre-tests, signal testing, starting up the genset, collecting of operational data and adjusting of engine parameters.
----------------	----	--



Item	Q'ty	Description
230.110.020 -1	54	man days commissioning of engine by engineer The commissioning engineer will perform all mechanical and electrical pre-tests and starting up of the individual auxiliary systems. The commissioning engineer is responsible for running-in the engine according to manufacturer's instructions. He verifies functional tests of the engine and plant control and safety system. Additionally he will assist the measurement team during the execution of performance tests.
230.110.030 -1	27	man days commissioning of auxiliaries by technician The technician will assist the commissioning engineer in performing all mechanical and electrical pre-tests and starting up of the individual components and auxiliary systems.
230.110.035 -1	27	man days commissioning of auxiliaries by engineer The commissioning engineer will perform all mechanical and electrical pre-tests and starting up of the individual components and auxiliary systems.
230.110.040 -1	40	man days commissioning of LV / control equipment The electrical commissioning engineer will verify the correct electrical installation of MAN Diesel & Turbo's scope of supply. He will perform the testing of engine and plant related sensors together with the mechanical commissioning engineer. He verifies the correct function of the engine control and safety system.
230.110.200 -1	15	man days commissioning alternator One commissioning engineer from the manufacturer will commission the alternator according to the manufacturer's instruction. He will check the correct installation as well as the function of the alternator protection and control system.
230.110.220 -1	3	man days commissioning cooling system One commissioning engineer will verify the correct installation and set the cooling system into operation according to manufacturers instruction.
230.110.240 -1	1	man days commissioning powerhouse ventilation One commissioning engineer will verify the correct installation and set the power house ventilation into operation according to manufacturers instruction.



Item Q'ty Description

8.4.3 Site Acceptance Test (SAT)

- | | | |
|-------------|---|---|
| 230.120.010 | 1 | <p>Performance test</p> <p>Specialists from MAN Diesel & Turbo will perform measurements to demonstrate the guaranteed values. The measurements will be done by MAN Diesel & Turbo engineers in cooperation with the customers operating personnel.</p> <ul style="list-style-type: none">- Output at site:
Measurements are taken at by using an external high precision power meter Type Zimmer LMG 450.- Fuel gas consumption:
Measurements and calculations of the fuel gas consumption will be carried out in line with ISO 3046, ISO 15550 and MAN Diesel & Turbo standard procedures.- Lube oil consumption:
The measurements and calculations of the lube oil consumption will be carried out in line with ISO 3046, ISO 15550 and MAN Diesel & Turbo standard procedures (engine running in). Due to the required measuring time being minimum 72 hours, lube oil consumption measurement will continue after the fuel consumption test. |
|-------------|---|---|



Item Q'ty Description

8.5 Project services

8.5.1 Mechanical Training at PrimeServ Academy

240.010 -1	1	<p><i>Optional service</i></p> <p><i>Mechanical Training at PrimeServ Academy</i></p> <p><i>Advanced mechanical training course for 10 plant operators at the PrimeServ Academy. Duration of the training is 15 days, training without traveling expenses, boarding and lodging. The training language will be English.</i></p> <p><i>Seminar content:</i></p> <p><i>Standard maintenance (5 days)</i></p> <ul style="list-style-type: none">- <i>Engine design and engine data</i>- <i>Handling manuals</i>- <i>Systems on engine</i>- <i>Engine and turbocharger operation</i>- <i>Basic maintenance tasks up to 6,000 hour service</i>- <i>Hydraulic tensioning equipment</i> <p><i>Advanced maintenance (5 days)</i></p> <ul style="list-style-type: none">- <i>Quality requirements of operating fluids</i>- <i>Overhaul and replacement of sub-assemblies</i>- <i>Turbocharger maintenance overview</i>- <i>Engine maintenance tasks up to 32,000 hour service</i> <p><i>Combustion system of the gas engine (2 days)</i></p> <ul style="list-style-type: none">- <i>Gas operation</i>- <i>Gas safety</i> <p><i>Introduction to engine control system (3 days)</i></p> <ul style="list-style-type: none">- <i>SaCoSone basics</i>- <i>Device manager</i>- <i>Expert tool</i> <p><i>The training is subject to our general terms and conditions published on our homepage www.mandiesel.com.</i></p>
------------	---	---



Item Q'ty Description

8.5.2 On-Site training (mechanical)

240.020 -1	1	<p><i>Optional service</i></p> <p><i>On-Site Training (mechanical)</i></p> <p><i>Mechanical on-site training for your engineers and operators covering the essential elements of the Gas engine power plant. Duration is 10 days. The training language will be English. The course includes theoretical training as well as field exercises.</i></p> <p><i>Seminar contents:</i></p> <ul style="list-style-type: none"><i>– Welcome and general introduction</i><i>– Introduction to the Diesel power plant</i><i>– Design and basic operating principles of the specific plant</i><i>– Explanation of the auxiliary systems and review of piping and installation drawing</i><i>– Routines in normal operation and symptoms/reactions to unplanned situations</i><i>– Engine start and stop procedures</i><i>– Engine operation</i><i>– Measuring and logging of data</i><i>– Control system design</i><i>– Mechanical maintenance</i><i>– Maintenance philosophies, planning, reporting, spare part ordering</i><i>– Planning of major overhauls</i><i>– When equipment accessible: measuring crank web deflection, adjusting valve clearance, testing of injectors, hydraulic tensioning tools</i> <p><i>The course will be held by professional trainers, dedicated to training only, using multi-media equipment. Each participant will receive a personal copy of the full course documentation. In order to achieve the best possible learning results, the max. number of participants per class is limited to 10 persons.</i></p> <p><i>The training is subject to our general terms and conditions published on our homepage www.mandiesel.com.</i></p>
------------	---	---



9 Requirements and limitations

9.1 Quality requirements for operating media

MAN engines are designed for continuous operation on the operation media as listed below. Project-specific system layouts for the respective operating media are mentioned in the respective chapters of our offer.

9.1.1 Lube oil

Use of engine lube oils according to the Approval List for Gas Engines of MAN Diesel & Turbo. More detailed information on the lube oils approved by MAN Diesel & Turbo is available in the engine manuals.

Requirements for viscosity:

- Viscosity-class (40°) SAE 40

Requirements for Base Number (BN):

- TBN (Total Base Number) min. 5 mg KOH/g oil

Please note that our cooling systems are designed to operate with the above-mentioned lube oil class SAE 40 only. Operation of the plant with other lube oils requires a detailed modification in the cooling systems and additional equipment cost.

9.1.2 Engine cooling water

The engine cooling water must be carefully selected, treated and controlled. The treatment with an anti-corrosion agent has to be effected before the first commissioning of the plant. During subsequent operation the concentration specified by the engine manufacturer must always be ensured. The approved cooling water additives are defined in the operating instructions.

The characteristics of the water used for engine cooling must be within the following limits:

- Type of water Distillate or freshwater, free from foreign matter
- Total hardness⁹ < 6 °dH
- pH-value > 6.5
- Chloride (Cl) < 50 mg/l
- TSS < 10 mg/l

Seawater, brackish water, brines, industrial waste water and rain water cannot to be used without treatment.

9.1.3 Raw water quality for fresh water

The raw water used should match the following values, before being treated in the water treatment system. If the water quality is different from the values stated below, the water treatment system will have to be modified at an extra cost.

⁹ 1 °dH (German hardness) = 10 mg CaO in 1litre water
= 17.9 mg CaCO₃/litre
= 0.357 mval/litre
= 0.179 mmol/litre



- pH value at 25°C	7.7
- Conductivity at 25°C	511 µS/cm
- Hardness	6 °dH
- TDS (Salinity)	380 mg/l
- Chloride (Cl)	45 mg/l
- Sulfate (SO ₄ ²⁻)	24 mg/l
- TN (NO ₂ ⁻ , NO ₃ ⁻ , NH ₄ ⁺)	1 mg/l
- Calcium	19.1 mg/l
- Magnesium	14 mg/l
- Sodium	100 mg/l
- Potassium	2 mg/l
- Silicate	6 mg/l
- Iron (Fe)	0.01 mg/l
- Manganese (Mn)	0.01 mg/l
- Copper (Cu)	0 mg/l
- Oxygen (O ₂) Dissolved	2 mg/l
- Turbidity	1 NTU
- Fecal coliform	0 / 100 ml

9.1.4 Natural gas

The following fuel specification must be met at the intake of the gas control unit.

- Dust	max. 0.05 g/Nm ³
- Hydrogen sulfide (H ₂ S)	max. 5 mg/Nm ³
- Tar	max. 0.5 g/Nm ³
- Fluorine	max. 5 mg/Nm ³
- Chlorine	max. 10 mg/Nm ³
- Relative humidity	max. 80 %
- Temperature	5 .. 50°C
- Gas operating pressure	9.5 ... 10.5 bar(g)
- Max supply pressure	16.0 bar(g)
- Fluctuations in gas pressure	max. 1.5% of gas pressure

The temperature- and pressure-dependent dew point of natural gas must always be exceeded to prevent condensation.



9.1.5 Intake air

The quality and condition of intake air (combustion air) have a significant effect on the power output of the engine output as well as on the engine's lifetime. In this regard, not only the atmospheric conditions are extremely important, but also contamination by solid and gaseous foreign matter. Mineral dust in the intake air increases wear, chemicals and gases promote corrosion.

The concentrations before the turbocharger inlet must not exceed the following limiting values:

– Particle size	90% ≤ 5 μm; 98% ≤ 10 μm
– Dust (sand, cement, CaO, Al ₂ O ₃ etc.)	max. 5 mg/Nm ³
– Chlorine	max.1.5 mg/Nm ³
– Sulfur dioxide (SO ₂)	max.1.25 mg/Nm ³
– Hydrogen sulfide (H ₂ S)	max.5 mg/Nm ³
– Salt (NaCl)	max.1 mg/Nm ³

If combustion air is drawn from inside the powerhouse, the minimum required filter class is G3 according to EN779 or equivalent. Gas engines or dual-fuel engines must be equipped with a dry filter. If the combustion air is drawn from outside, there is a risk of higher air contamination (e.g. due to sand storms, loading and unloading of grain cargo vessels or a cement plant). In this case additional measures need to be taken. This includes the use of pre-separators, pulse filter systems and an increased filter efficiency class of M5 according to EN779.

The offered intake air filter unit meets the requirements for separation of particles in new condition. During operation, effective cleaning of the intake air and regular maintenance of the air filters are required to stick within the abovementioned limits.

Intake air shall not contain any flammable gases. Make sure that the combustion air is not explosive.

9.1.6 Compressed air

The compressed air systems are divided into a starting air system -- used to start the engines, a control air system -- for auxiliary systems and a service air system – used for tools and working equipment.

Requirements for starting air:

– Pressure	30 bar(g)
------------	-----------

Requirements for control air:

– Water	ISO 8573-1 – Class 2
– Particles	ISO 8573-1 – Class 2
– Oil	ISO 8573-1 – Class 2
– Pressure	7 bar(g)

Requirements for service air:

– Water	ISO 8573-1 – Class 4
– Particles	ISO 8573-1 – Class 4
– Oil	ISO 8573-1 – Class 4
– Pressure	6 bar(g)



9.2 Limits of supply

9.2.1 General remark

The limits of supply are to be read in connection with the offered scope of supply as per the technical specification.

All equipment is supplied largely modularized. Necessary bolts, studs or screws to install the equipment on the foundations or elevated platforms / walkways are included.

Any steel supporting structures, steel mounting elements, etc. necessary to install the equipment / modules / auxiliaries are not included in the scope of supply of MAN Diesel & Turbo.

9.2.2 Generating sets

Mechanical:

- Pipe connection terminal on the engine to connect the engine to various pipes

Electrical:

- Terminal box of the alternator

Civil:

- Steel foundation frame with steel spring elements including necessary erection material
- Grouting material for the alternator basement (Page)

9.2.3 Engine and plant related auxiliaries, modules, equipment and tanks

Mechanical:

- Flanges and counter flanges on the modules / auxiliaries / equipment for connection to the various system pipes (e.g. gas, lube oil, water, pressurized air)

Electrical:

- Terminal boxes on the modules / auxiliaries / sensors for connection to the power and control cables

9.2.4 Electrical equipment / Engine and plant control system

- SaCoS_{one} panel connectors for data transfer (bus cables)
- SaCoS_{one} panel connectors for power supply



10 Standards and Guidelines

10.1 Applicable standards

All materials, equipment and services mentioned in this quotation comply with the respective standards and codes of the country of manufacture.

In particular, equipment supplied from EU countries complies, as far as applicable, with the following standards and codes:

- ISO International Standards Organization
- IEC International Electro technical Commission
- EN standard - European Institute for Standardization
- Manufacturer's QA/QC System
- Manufacturer's standards

MAN Diesel & Turbo advises that national and/or local regulations may differ from the abovementioned standards or guidelines. The national and/or local standards are not considered in our bid. Compliance to national regulations and standards are the sole responsibility of the customer or operator of the plant.

10.2 General guidelines

10.2.1 Heat exchangers for engine cooling

The heat exchangers offered are suitable for non-aggressive raw water (fresh water). If aggressive raw water is used (e.g. brackish water, industrial waste water) we are unable to accept any warranty for the heat exchangers, pumps, pipes and other units in contact with such water.

*Mains water
supply and
water treatment*

For the first filling of the system, water used in the cooling system has to meet the requirements listed in chapter 9. The treatment, kind and amount of added chemicals are related to the water quality available at site.

The water shall be available at the plant premises with a pressure of 4-6 bar.

10.2.2 Painting of the supplied equipment

Auxiliary equipment is delivered in the original color as supplied by the sub supplier, unless otherwise specified in this document.

10.2.3 Miscellaneous

Anything not specifically mentioned in the quoted scope is not included.

Minor changes due to technical development, design and output are reserved.

Other than the performances guarantees, all figures stated in this specification such as pressures, capacities, flows etc. are preliminary only and subject to change during detailed engineering phase.

10.2.4 Required information from the customer

In case of order the customer shall supply to MAN Diesel & Turbo with the following documents and information in due time:

- Current site plan and arrangement drawing showing the exact location and dimension of the area of the power plant and the neighboring installations
- The prevailing wind direction, indicating the value of the basic wind velocity
- Geotechnical report with information on the minimum capacity of the existing



- foundation soil, the presence of groundwater, recommendations for piling
- Information on the reference peak ground acceleration for construction of buildings according to definition as defined in footnote 2, including soil type or value for shear wave velocity
- Minimum load bearing capacity of power plant subsoil or soil investigation report
- List of electrical consumers to be provided locally by customer
- Sample of gas fuel, raw water

10.2.5 Minimum requirements for personnel on site

The customer as well as MDT needs to ensure that adequately qualified personnel will be available for the site activities.

The customer shall send engineers/technicians to site who are well conversant with the English language to avoid difficulties in communication with MDT engineers/technicians.



11 List of sub suppliers

This list includes a selection of the major equipment components and the respective vendors selected and approved by MAN Diesel & Turbo. This list may not be complete. Above that MAN Diesel & Turbo at any time reserves the right to select the vendor who is the most favorable one with respect to technology, quality, delivery time, reliability or price in any individual case. Further vendors may be included in the list following the completion of a vendor assessment.

MAN Diesel & Turbo reserves the right to deliver components manufactured in any of the worldwide production facilities of the respective suppliers.

Generating set

Alternator	ABB, Jeumont, TDPS
Flexible coupling	Centa, Vulkan

Lube oil system

Lube oil module	GenSys, Alfa Laval, Kral, W+Z Rohrsystem-Technik, GEA Westfalia Separator
Lube oil flow rate measuring device	Endress & Hauser, Bopp & Reuther
Lube oil transfer pump	Kracht, Rickmeier, Leistritz

Cooling water system

Cooling water pre-heater set	Elwa, Zoppas
Radiator cooling system	Ecodyne, Alfa Laval Vantaa, Thermofin, Lu-Ve, Friterm

Fuel system

Gas control line	GenSys, RMG Regel+Messtechnik Honeywell
------------------	---

Intake air system

Intake air filter unit	AAF International, IAC, GEA Air Treatment
------------------------	---

Compressed air system

Starting air compressor	Sauer & Sohn, Sperre Industri AS Atlas Copco, VPT, Neuenheuser, Kaeser
Starting air receiver	Römer, Neuenhäuser

Exhaust gas system

Expansion joint for exhaust gas	Eagle Burgmann, Stenflex, Witzemann, HKS
---------------------------------	--

Others

Power house ventilation system	GEA Air Treatment, Robertson Vogue, AAF International
--------------------------------	--



12 Drawings

12.1 Drawing of the generating set 11.74500-1835