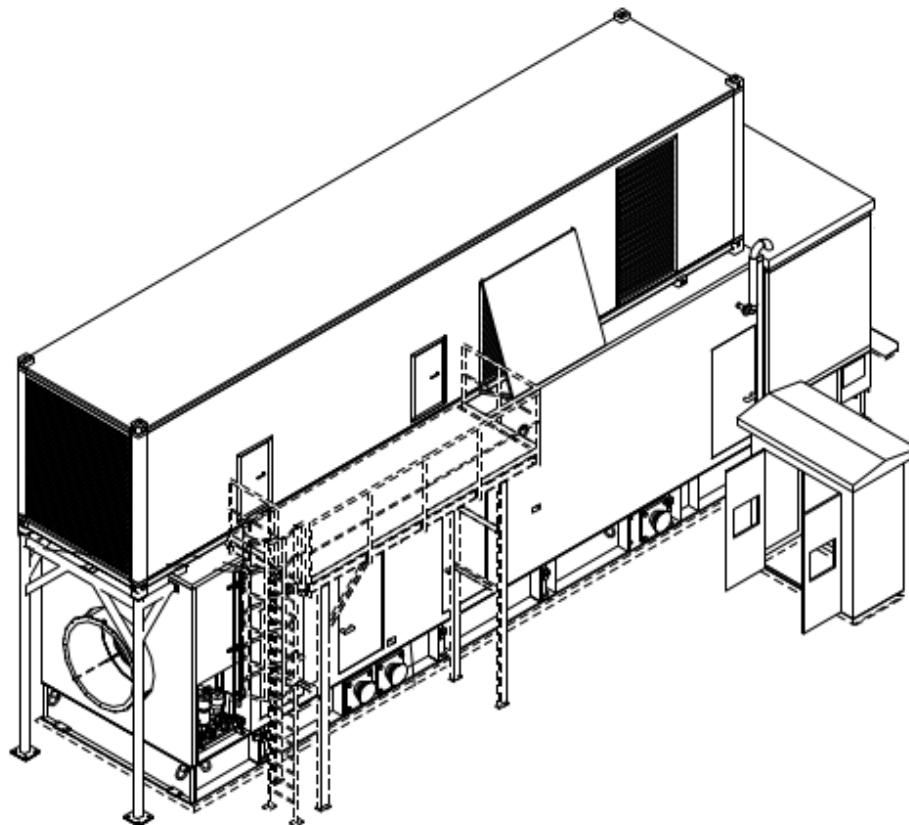


## Offer Summary

**Each/The** MGT6000 Package consists of:

- **Package – Base Module**
  - MAN MGT6000-1S Industrial Gas Turbine, Axial Exhaust
  - Synchronous AC Generator, 8.14MVA, 10.5kV, 3-Ph, 1500rpm, 4-pole
  - Base Frame with Integrated Lube Oil Tank
  - Subsystems
    - Acoustic Enclosure for Turbine and Generator
    - Control System and LV Switchgear
- **Package – Top Module**
  - Air Intake System
  - Gas Turbine Intake
  - Enclosure Ventilation
- **Gas Turbine Auxiliary Systems (Off – Package)**



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## Scope of Supply

The MGT6000 Package is a MGT6000 gas turbine connected to an electrical generator including on-skid and off-skid auxiliary equipment as listed in the following paragraphs.

### 1. Package – Base Module

The Package – Base Module is basically comprised of the MGT6000 Gas Turbine on a supporting base frame. On the base frame are also mounted related subsystems, the electrical generator, the load gear and the acoustic thermal enclosure. The control compartment is detachable and connected to the base frame for transport only. The acoustic thermal enclosure itself includes provisions for connection to the combustion and cooling air intake ducts as well as for the connection to the exhaust system and the cooling air outlet duct.

The combustion and cooling air intake system and the cooling air outlet duct are described in section 2.2.

#### 1.1. MGT6000 Gas Turbine

Basic Gas Turbine Type:	MGT6000-1S-01
Manufacturer:	MAN Energy Solutions SE of Oberhausen Germany
Exhaust Gas Exit:	Axial



## 1.2. Load Gear Box

Planetary load gear mounted on base frame.

## 1.3. Start System

The gas turbine is started via electric motor (frequency controlled). The motor is mounted to the load gear box, which couples to the turbine rotor and accelerates the rotor up to the self-sustaining speed for turbine start-up. A pneumatically actuated clutch disengages the motor once it has been deactivated.

The electric motor is also used during offline compressor wash cycle.

Stator Motor Design Standard:	IEC/EN 60034
Rated Power:	270 kW
Rated Current:	540 A
Connection Cable:	Double-shielded EMC cable
Protection Class:	IP 55
Frame Size:	280



## 1.4. On skid compressor wash system

Washing system (offline and online) for cleaning the compressor while the MGT6000 Gas Turbine is cold respectively during operation at slightly reduced load. Water based system with spray nozzles located inside inlet plenum with outside connectors for water supply.

## 1.5. On skid exhaust duct

This consists of only the exhaust transition duct ending up at enclosure wall for connection to Buyer's supplied exhaust system. Not included are the fastening pieces for expansion joint, gasket for expansion joint, the expansion joint, exhaust silencer and the exhaust stack, etc.

## 1.6. Base frame (Skid)

The base frame supports the gas turbine with fuel, starting and lubrication systems as well as the load gear, the electrical generator and the enclosure. It contains:

- Integrated lube oil tank made of carbon steel

## 1.7. On skid fuel gas system

Fuel gas system is located within the MGT6000 Package and consists of:

- 6x ACC-combustion chambers
- 2x Fuel control valves
- 2x block & bleed valves (1x inside enclosure, 1x outside)
- 1x Strainer
- On-skid instrumentation, piping, cabling, drain and vent lines within the gas turbine package

## 1.8. On skid lube oil system

On skid lube oil system is a closed system with pumps, filter, cooler and tank located on the base frame and feeding also the lube oil circuit of the load gear and electrical generator.

- Main oil pump driven via load gear
- Standby oil pump, driven by an AC motor, for pre-lubrication and post-lubrication during start-up and shut-down
- Emergency oil pump, driven by a DC motor, for emergency post-lubrication during shut-down
- Heating system with immersion heater
- Stainless steel piping with stainless steel flanges and connectors (lube oil tank excepted); including interconnecting piping up to electrical generator and to on skid plate type heat exchanger (exception: piping downstream of oil demister is in galvanized carbon steel)
- Lube oil tank in carbon steel
- Valves
- Strainer, carbon steel
- Double oil filter, switchable during operation, carbon steel
- Oil demister
- Plate type heat exchanger 1x 100% (water to oil)
- Local instrumentation including tubing
- Cabling up to control panel in the control compartment on base frame.

## 1.9. On skid auxiliary piping

- Vent, drain and water wash piping

## 1.10. On skid Electrics and Instrumentation (E & IC Package)

- Electrical equipment and wiring up to panels in the control compartment on base frame.

## 1.11. Acoustic enclosure for gas turbine & electrical generator

The acoustic enclosure is designed for outdoor installation and consists of:

- a. Transition duct for combustion air (CS)
- b. Expansion joint to inlet casing of gas turbine
- c. One maintenance crane in gas turbine enclosure (1 ton) for installation and removal of lube oil pumps, starter motor and so on.
- d. One maintenance crane in gas turbine enclosure (150 kg) for handling of combustors during maintenance activities.
- e. Enclosure roof with firm-positioned connection flanges for combustion air intake, air inlet and air outlet
- f. Fire detection sensors and CO<sub>2</sub> (or alternative extinguishing gas) firefighting equipment featuring:
  - i. Fire detection with 4 temperature sensors and 2 infrared detectors
  - ii. Automatic injection of extinguishing gas into the turbine enclosure in case of fire
  - iii. CO<sub>2</sub> (or alternative extinguishing gas) injection system with distribution piping and injector nozzles in the sound-proofing enclosure
  - iv. Gravity activated louvers to retain the extinguishing gas installed in the air intake and in the air outlet of the sound-proofing enclosure
- g. Gas leakage detection with 2 detectors

The acoustic enclosure contains technical provisions inside to remove and re- install gas turbine (without the load gear); special tools outside of gas turbine enclosure required for removal and re-installation of gas turbine are excluded.

The acoustic enclosure includes sound insulation to meet a sound pressure level of 85 dB(A) according to EN ISO 3746 and ISO 6190 in 1m distance and 1.5m height above ground level. For removal and re-installation of the generator and load gear removable panels in the roof are foreseen.

## 1.12. Control Compartment complete on skid

Has its own enclosure and base frame, which is connected to the main base frame for transport and single lift only, to house and consists of:

- Control panel for MGT6000 Gas Turbine
- Control and protection panel for electrical generator
- Variable frequency converter panel (VFC) for starter motor
- Low Voltage Switchgear for unit power consumers (LVS)
- Battery system / UPS system

1.13. Control panel for MGT6000 gas turbine

- a. MAN TurboLog© control system based on Siemens Simatic© STEP7 & WinCC flexible technology (or similar) providing:
  - i. Gas turbine control
  - ii. Unit sequencing
  - iii. HMI – human machine interface (19" screen)
  - iv. Unit alarm – and shut down system
- b. Data collector system based upon IRDS® (Intelligent Remote Diagnostic System)
  - i. Recording and storage of various engine parameters during operation
  - ii. For data access via modem an internet connection or a telephone line (to be provided by the buyer) is required

1.14. Control and protection panel for electrical generator

- Automatic Voltage Regulator (AVR)
- Digital generator protection relay
- (Protection settings to be provided by Buyer)
- Monitoring facilities
- Auto synchronizing unit
- Synchro-check-relay

1.15. Variable frequency converter panel (VFC) for starter motor

- Variable speed control of starter motor

1.16. Low Voltage Switchgear (LVS)

Low Voltage Switchboard is installed in Control Compartment to supply power to the 400/230VAC-consumers and to protect the 400VAC motors of the gas turbine generator-set. The LVS consists of:

- Motor control center with fixed mounted feeder modules for the 400VAC-consumers/motors excluding feeder for VFD-starter motor panel
- 230VAC distribution with fixed mounted feeder modules for the 230VAC-consumers

1.17. Battery system / UPS system

- Battery system for 110 V DC supply

The Battery system / UPS system is needed as the emergency lube oil pump (110 VDC) and the unit control system (230 VAC) must be provided with electricity for a minimum of 2.5 hours independently of the main electrical supply in order to guarantee the safe shutdown of the MGT6000 Gas Turbine unit in the event of a main power failure.



## 1.18. Coupling for driven equipment

- Coupling, flexible disc type
- Coupling guard

## 1.19. Electrical Generator

- Synchronous generator:  
approx. 8.14 MVA @ 15°C, 10.5 kV, 3-phase, 50 Hz, 4 pole-, 1500 min-1, power factor 0.80, generator efficiency approx. 97.2%, direct air cooled
- Neutral point and line side cubicle
- Air duct for generator cooling designed for taking cooling air from the enclosure

The electrical generator is for indoor installation in a non-hazardous area. It is rated to match the gas turbine power output versus combustion air intake temperature. Located on common base frame with gas turbine under acoustic enclosure.

## 1.20. Vent piping

This will be supplied loose with a length to reach the top of the base module. The vent piping must be installed to conduct gas to a safe area.

## 2. Package – Top Module

### 2.1. Air Intake System (Integrated in Top Module)

The top module consists of the combustion air intake, the ventilation air inlet and the ventilation air outlet systems which are integrated in a modified 40 feet container.

### 2.2. Filter house

The filter house is provided since combustion air must be filtered to prevent dust, dirt and other foreign objects from entering the gas turbine.

The filter house is based on depth loading cartridges system consists of :

- Static depth loading cartridges system for trapping airborne dust in filter material, ideal for most industrial applications
- Air intake duct made of carbon steel with intake silencer to meet a sound pressure level of 85 dB(A) at the inlet of the filter house according to EN ISO 3746 and ISO 6190 in 1m distance and 1.5m height above ground level; baffles made of marine grade aluminum or stainless steel.

This system is for operation in non-hazardous areas and features:

- High dust accumulation capacity
- Filtration class:  
Pre-filter = G4; Fine-filter = F9
- Insensitivity to ice blockage



## 2.3. Separate enclosure air filtration

Static depth loading cartridges system

This system has a filtration class of pre filter = G4 and fine filter = F9

## 2.4. Air inlet duct with silencer for enclosure air

- Air inlet duct made of carbon steel
- Silencer designed to meet a sound pressure level of 85 dB(A) at the inlet of the filter house according to EN ISO 3746 and ISO 6190 in 1m distance and 1.5m height above ground level.

## 2.5. Enclosure cooling air system (positively pressurizing)

- Internal ventilation system with 2x50% AC motor driven fans.

## 2.6. Air Outlet System (enclosure air) (integrated in Top Module)

## 2.7. Air outlet duct with silencer for enclosure air

- Air outlet duct made of carbon steel
- Silencer designed to meet a sound pressure level of 85 dB(A) at the outlet of the enclosure air according to EN ISO 3746 and ISO 6190 in 1m distance and 1.5m height above ground level

## 2.8. Enclosure cooling air system (negatively pressurizing)

- Internal ventilation system with 2x50% AC motor driven fans

## 2.9. Supporting steel structures

- necessary supports for the Top Module

## 3. Gas turbine Auxiliaries Systems (Off-Package)

### 3.1. Fire extinguishing equipment and fire monitoring computer

- Fire monitoring computer
- Firefighting equipment off-skid including cabinet and off-skid distribution piping
- CO2 (or alternative extinguishing gas) cylinders with leakage detection

The above items must be installed by the buyer in non-hazardous area.

## 4. Test, Quality assurance

Inspections will be performed and certificates issued in accordance with **MAN-ES Standards**.  
Certificates issued will be included in the manufacturing data book.

## 5. Painting

### 5.1. Gas turbine / Package

According MAN-ES standard painting specification

### 5.2. Electrical Generator

According to electrical generator manufacturer's standard

## 6. Packaging and preservation

- Preservation according to MAN-ES standard
- Packaging for road transport according to MAN-ES standard

## External Power Supplies

The following power supplies need to be provided externally to the MGT6000 package. Power consumption is shown in the electrical consumer table.

- Low Voltage Switchgear Feeder 400V
  - 400 VAC  $\pm 5\%$ , 50Hz, 3-Ph
  - External fuse rating: 630A
- Starter Motor VFC Feeder 400V
  - 380 – 480 VAC  $\pm 10\%$ , 47 – 63 Hz, 3-Ph
  - External fuse rating: 630A
- Low Voltage Switchgear Feeder 230V UPS
  - 230 VAC  $\pm 5\%$ , 50Hz  $\pm 1\%$ , 1-Ph
  - External fuse rating: 80A

Rev.	Tag No	System	Consumer	P (kW)	U (V)	In (A)	UPS	Start	Operation	Post Lube	Standby
	A/C X0406431	GT	AIR CONDITIONING FFS	0,68	230	1.5		X	X	X	X
	A/C X1707011	CONTROL SYSTEM	AIR CONDITIONING COMPARTMENT	1,5	230	6.82		X	X	X	X
	HEA X0405100	GT	STANDSTILL HEATER STARTER MOTOR	11	230	0.4		X			X
	HEA X1003010	OIL SYSTEM	ELECTRICAL HEATER OIL TANK	9	380	13.7		X			X
	HEA X1003011	OIL SYSTEM	ELECTRICAL HEATER INSIDE OIL HEATER	0,05	230	0.24		X			X
	HEA X8001311	GENERATOR	GENERATOR HEATER	0,3	230	1.3				X	X
	HEA X8001312	GENERATOR	GENERATOR HEATER	0,3	230	1.3				X	X
01	-	GT	BATTERY RECTIFIER SUPPLY	-	400	80	X		X	X	X
01	-	GT	MISCHELLANEOUS CONSUMERS	10	400	18,9			X		
01	-	GT	CONTROL SYSTEM CABINET SUPPLY	1,5	230	16	X	X	X	X	X
01	-	GT	CONTROL SYSTEM CABINET SUPPLY	1	230	16	X	X	X	X	X
01	-	GT	ENCLOSURE EMERGENCY LIGHTING	0,2	230	6				X	X
01	-	GT	INLET FILTER HOUSE SUPPLY	0,5	230	16		X	X		
	MOT X0405100	GT	STARTER MOTOR	230	360	430		X			
	MOT X0405631	GT	ENCLOSURE FAN 1	11	380	21.9		X	X	X	
	MOT X0405632	GT	ENCLOSURE FAN 2	11	380	21.9		X	X	X	
	MOT X0405633	GT	ENCLOSURE FAN 3	11	380	21.9		X	X	X	
	MOT X0405634	GT	ENCLOSURE FAN 4	11	380	21.9		X	X	X	
	MOT X1003020	OIL SYSTEM	OIL MIST FAN	2,2	380	4.6		X	X	X	
	MOT X1003051	OIL SYSTEM	AUXILIARY LUBE OIL PUMP	15	380	27.9		X			X
	MOT X1003101	OIL SYSTEM	EMERGENCY LUBE OIL PUMP MOTOR 1 PH	4	110	44.5	X			X	
			<b>TOTAL CONSUMPTION (kW):</b>				7	316	59	56	41

## Termination Points

### Lube Oil

QTY	Type	Lube Oil System	DN Size	Press. Rating Class	ASME Flange	Face	Material	Note	Medium	Working Press. Barg	Working Temp. °C	Medium Quantity (Operation)
1	T/C	Lube Oil Filling Nozzle	4"	150 lb.	B16.5	RF	AISI F316L	WN Flange	Lube Oil	atm	--	4.5 m3
1	T/C	Drain Lube Oil Tank	2"	150 lb.	B16.5	RF	AISI F316L	Valve with WN flange, outlet up	Lube Oil	atm	max 80	4.5 m3
1	P/M	Outlet Oil Cooler	3"	150 lb.	B16.5	RF	AISI F316L	WN Flange	Cooling water	6	55	~440 l/min
1	P/M	Inlet from Oil Cooler	3"	150 lb.	B16.5	RF	AISI F316L	WN Flange	Cooling water	6	55	~440 l/min
1	P/M	Oil Demister Vent Line	4"	sch10s	B36.19		316		Oil mist	100 Pa	80	250 m3/h
1	T/C	Drain Lube Oil Filter	3/4"				AISI F316L	Plug	Lube Oil	6	60	2 L
1	T/C	Drain Lube Oil Header	1/2"				AISI F316L	Valve	Lube Oil	6	80	50 L

### Fuel Gas

QTY	Type	Fuel Gas System	DN Size	Press. Rating Class	ASME Flange	Face	Material	Note	Medium	Working Press. Barg	Working Temp. °C	Medium Quantity (Operation)
1	P/C	Inlet Fuel Gas Plate	2"	300 lb.	B16.5	RF	AISI F316L		Fuel Gas	Max. 30	Max. 80	2600 Nm3/h
1	P/C	Vent Bleed Valve 1	Union SS-1610-6				AISI F316	Swagelok. Route to safe loc.	Fuel Gas	30 to atm	Max. 60	0.04 Nm3
1	P/C	Vent Bleed Valve 2	Union SS-1610-6				AISI F316	Swagelok. Route to safe loc.	Fuel Gas	30 to atm	Max. 60	0.04 Nm3
1	P/M	Outlet Fuel Gas Plate	2"	300 lb.	B16.5	RF	AISI F316L		Fuel Gas	Max. 30	Max. 80	2600 Nm3/h
1	P/M	Inlet Fuel Gas GT-Package	2"	300 lb.	B16.5	RF	AISI F316L		Fuel Gas	Max. 30	Max. 80	Max. 2600 Nm3/h

### Auxiliaries

QTY	Type	Auxiliary System	DN Size	Press. Rating Class	ASME Flange	Face	Material	Note	Medium	Working Press. Barg	Working Temp. °C	Medium Quantity (Operation)
1	T/C	Drain Manifold	Bulkhead Union SS-1610-61				AISI F316L		De-min Water	Atm.	40	0.320 m3
1	T/C	Washwater (on/off-line)	Swagelok SS-QF8-B-810 with cap SS-QF8-BP				316L		De-min Water + Detergent	60	60	80 L / cycle
1	T/C	Inlet Instrument Air	1"	150 lb.	B16.5	RF	AISI F316L	Slip on flange	Instrument Air	4 - 8	Max. 45	< 0.5 Nm3/h

### Air Systems

QTY	Type	Air Systems	DN Size	Press. Rating Class	ASME Flange	Face	Material	Note	Medium	Working Press. Barg	Working Temp. °C	Medium Quantity (Operation)
1	P/M	Intake Combustion Air	Rectangular Flange, see drawing (top of enclosure)				CS coated	To be connected free of loads	Filtered air (min. class F9)	Atm.	-20 to +45	82,500 Nm3/h
1	P/M	Inlet Enclosure Ventilation Air	Rectangular Flange, see drawing (top of enclosure)				CS coated	To be connected free of loads	Filtered air (min. class G4, or per generator requirments)	Atm.	-20 to +45	53,000 Nm3/h
1	P/M	Outlet Enclosure Ventilation Air	Rectangular Flange, see drawing (top of enclosure)				CS coated	To be connected free of loads	Air	Atm.	-10 up to +65	53,000 Nm3/h
1	P/C	Outlet Exhaust Gas	Round Flange, see drawing (top of enclosure)				CS coated		Exhaust Gas	Atm.	Acc. Performance Data	

Type: T=Temporary (Maintenance) P=Permanent M=MAN connection C=Client connection

## Utilities / Mechanical Consumption List

	No.	System	Medium	Flow / Quantity	Operating Press.	Operating Temp.	Remarks
Continuous consumer	1	Fuel gas system	Gas Fuel	Max. 2600 Nm <sup>3</sup> /h	Min. 21 barg Max. 30 barg	Min. 5°C above dew point, Max. 80°C	Specific flow acc. Performance data.
	2	Lube oil system	Oil mist	Appr. 0.04 L/h	Atm	Max. 80°C	From oil mist eliminator
	3	Cooling Water (for plate HE)	Water	Appr. 500 L/min	Min. 2 barg Max. 5 barg	Max. 45°C at cooler inlet	Fresh water
Non-continuous consumer	4	Instrument Air	Air	Max. 1 Nm <sup>3</sup> /h	Min. 5 barg Max. 8 barg	Max. 60°C	Dry, clean, oil-free air, acc. to ISO 8573-1 class 2
	5	Washing system	De-min Water	64L plus 16L for soaking and 3x 80L/min for post rinse	Will be provided by wash trolley		
	6	Pulse jet air filter system	Air	Min. 24 Nm <sup>3</sup> /h Max. 40 Nm <sup>3</sup> /h	Min. 6 barg Max. 8 barg	Max. 60°C above dew point	Dry, clean, oil-free air, acc. to ISO 8573-1 class 2
	7	Drying air (optional)	Air	Appr. 180 m <sup>3</sup> /h	Appr. 1.0 barg	Max. 60°C	Ambient air
	8	Lube oil system	ISO VG46 Oil	Max. 5300 L			

## Preliminary Weight Data

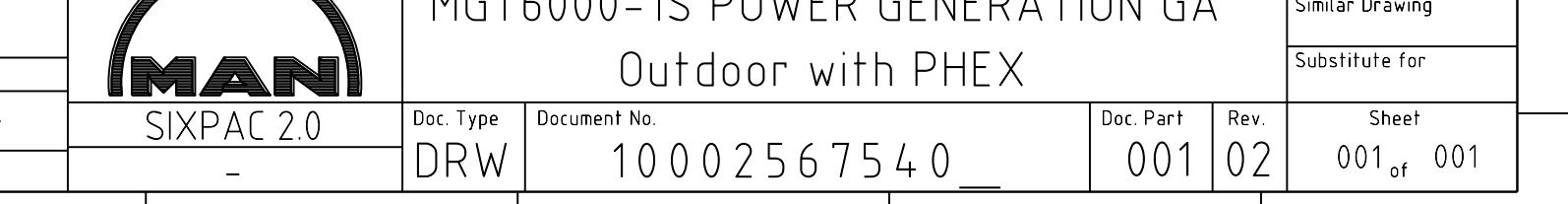
Description	Weight (kg)
Base Frame	15,000
Gas Turbine	7,165
Gearbox	5,700
Starter Motor	1,130
Coupling	110
Generator	17,850
Lube Oil Cooler	250
Lube Oil Filter	469
Main Lube Oil Pump	260
Aux. Lube Oil Pump	408
Emergency LO Pump	306
Oil Heater	41
Control Compartment	2,090
Electrical Equipment	750
Enclosure	11,500
<b>Operating Weight</b>	<b>69,629</b>
<b>Dry Weight</b>	<b>64,629</b>

## Exclusions

Please note that the following items are not included in the pricing of this proposal:

- Applicable local, state or federal taxes, duties or fees
- Consideration of local/state ordinances, codes, standards or regulations
- Cost for Third Party Inspection
- Wind, seismic or snow load calculations
- Any testing not specifically mentioned
- Transportation to the site
- Loading for shipment
- Off-loading, hauling or rigging
- Foundation for supporting the equipment
- Field installation labor or materials necessary to install the equipment at site
- Supervision, installation or startup unless specifically mentioned
- Any materials outside skid limits not specifically mentioned
- Electric motor starters, contactors, breakers or switchgear unless specifically mentioned
- Power or control wiring to skid mounted motors or heaters
- Thermal insulation or trace heating or personnel protection insulation
- Immersion heater, thermal insulation, or heat tracing
- Mill Test Reports (MTRs)
- Waste Heat Recovery equipment
- Cable trays, cleats and ducts for off-skid cabling, external cables (off-skid) to and from the specified take-over points including electrical connections as well as cable glands for off-skid cables
- MV-cables / bus bars
- Medium Voltage switchgear
- Washing trolley
- Special tools





# Technical Data of Generator for MGT6000



## General

Manufacturer:	Siemens	Standard	IEC 60034
Type:	1DC	Duty	S1 (24/7 continuous)
Mounting	IM1001	Cooling	IC01
Enclosure	IP20 / IP54	Insulation class	F
Altitude	1000m	Stator utilization class	B*
Temperature	-20°C (max-power)	Rotor utilization class	B*

## Nominal Data

Output	$S_n$	10170	kVA	Voltage	$U_n$	10500	V
	$P_n$	8136	kW	Current	$I_n$	559	A
Power factor	p.f. <sub>n</sub>	0.80	overexc.	Frequency	$f_n$	50	Hz
	p.f. <sub>min</sub>	0.95	underexc.	Speed	$n_n$	1500	rpm

## Reactances and time constants

	<i>unsat.</i>	<i>sat.</i>		<i>unsat.</i>	<i>sat.</i>		
$x_d$	331.93%	257.68%	$x_q$	190.45%	-	$T_{do}'$	4.564s
$x_d'$	38.22%	30.73%	$x_q'$	190.45%	-	$T_d'$	0.525s
$x_d''$	18.72%	16.53%	$x_q''$	20.9%	18.41%	$T_d''$	0.027s
$x_{s1}$	11.54%	9.36%	$x_0$	7.8%	-	$T_q''$	0.032s
$x_p$	15.6%	-	$x_2$	19.81%	17.47%	$T_a$	0.083s
R	63.98mΩ	<i>per phase @20°C</i>					

## Efficiency

	P/P <sub>n</sub>	25	50	75	100	110	%
Power factor 0.80		95.69	97.11	97.32	97.20	97.12	%
Power factor 1.00		95.96	97.54	97.91	97.97	97.95	%

## Notes

MAN reserves the right to change the generator supplier and the generator type. The technical data of the generator may thereby change slightly. The electrical power data will not change.

The generator is not designed to fulfill special grid code requirements. In case these specific requirements need to be considered individual verification is necessary. Please contact MAN.

\*Utilization class B may be exceeded in certain operating points

Description:	<b>Technical Data of Generator for MGT6000</b>			Project:	<b>Nigeria</b>		
Document:	<b>10002860312</b>	Type:	<b>TED</b>	Part:	Rev:	<b>00</b>	Language: EN
					<b>Page 1/1</b>		

Exterran:  
CAI: KK



**MGT6000-1S ISO Performance Data (Generator Drive)**

Fuel : Natural Gas  
 LHV : 48000 kJ/kg  
 ACC (Dry Low NOx Combustion Chamber)  
 Generator Speed : 1500 rpm (50 Hz)

The data are corrected for the following site conditions :

Altitude : 0 m  
 Ambient Pressure : 101.3 kPa  
 Relative Humidity : 60 %  
 Inlet Pressure Loss : 0 kPa  
 Exhaust Pressure Loss : 0 kPa  
 Gearbox Efficiency : 98.8 %  
 Generator Efficiency : 97.2 %

**Expected Performance for Base Load**

Inlet Temperature [°C]	15
Electrical Power Output [MW]	6.63
Electrical Efficiency [%]	32.2
Heat Rate [kJ/kWh]	11190
Exhaust Gas Flow [kg/s]	26.2
Exhaust Gas Temperature [°C]	505

Emissions *)	
NOx [mg/Nm³]	30
CO [mg/Nm³]	30

\*) ref. to 15% O2, dry; 50 % - 100% Load

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Exterran:  
CAI: KK

Revision	00	01	02	03	04	05	06	
Date	04.03.2016	22.02.2018	11.12.2018	22.05.2019				
Drawn	Jeskulke	Boje	Boje	Boje				Sheet
Checked	Boje	Jeskulke	Jeskulke	Jeskulke				1 of 1
Dept.: ETETC								



**MGT6000-1S**  
**Performance Data**

**Document No.:**  
**10002085242**

**Rev.:**  
**03**

**MGT6000 Performance Data**

Fuel : Natural Gas  
 LHV : 48000 kJ/kg  
 Dry Low NOx Combustion Chamber (ACC)  
 Generator Speed : 1500 rpm

**The data are corrected for the following site conditions :**

Altitude : 0 m  
 Ambient Pressure : 101.3 kPa  
 Inlet Pressure Loss : 0.75 kPa  
 Exhaust Pressure Loss : 2.50 kPa  
 Gearbox Efficiency : 98.8 %  
 Generator Efficiency : 97.2 %

**Expected Performance for Full Load**

Inlet Temperature [°C]	17	28	33	40
Relative Humidity [%]	50	90	55	35
Electrical Power Output [MW]	6.30	5.73	5.47	5.11
Electrical Efficiency [%]	31.2	29.9	29.5	28.7
Heat Rate [kJ/kWh]	11540	12020	12220	12560
Exhaust Gas Flow [kg/s]	26.0	24.7	24.2	23.4
Exhaust Gas Temperature [°C]	507	518	524	532
Fuel Flow [kg/h]	1510	1430	1390	1340

Exhaust Gas Composition [Vol.%]				
Nitrogen	75.2	73.4	73.9	74.0
Oxygen	14.5	14.1	14.3	14.4
Carbon Dioxide	2.9	2.8	2.8	2.8
Argon	0.9	0.9	0.9	0.9
Water	6.5	8.8	8.2	7.9

**Gas Turbine Emissions (ref. to 15% O<sub>2</sub>, dry) at ISO conditions**

NOx [mg/Nm<sup>3</sup>] 30  
 CO [mg/Nm<sup>3</sup>] 30

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**Gas Turbine Data Sheet**

Code Word : MGT6000 for Nigeria

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 MGT6000

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**MGT6000 Performance Data**

Fuel : Natural Gas  
 LHV : 48000 kJ/kg  
 Dry Low NOx Combustion Chamber (ACC)  
 Generator Speed : 1500 rpm

**The data are corrected for the following site conditions :**

Altitude : 0 m  
 Ambient Pressure : 101.3 kPa  
 Inlet Pressure Loss : 0.75 kPa  
 Exhaust Pressure Loss : 2.50 kPa  
 Gearbox Efficiency : 98.5 %  
 Generator Efficiency : 97.1 %

**Expected Performance for 75% Load**

Inlet Temperature [°C]	17	28	33	40
Relative Humidity [%]	50	90	55	35
Electrical Power Output [MW]	4.72	4.30	4.10	3.83
Electrical Efficiency [%]	28.4	27.3	26.9	26.2
Heat Rate [kJ/kWh]	12660	13170	13390	13760
Exhaust Gas Flow [kg/s]	22.2	21.0	20.6	19.9
Exhaust Gas Temperature [°C]	508	518	523	531
Fuel Flow [kg/h]	1240	1180	1140	1100

Exhaust Gas Composition [Vol.%]				
Nitrogen	75.3	73.5	73.9	74.1
Oxygen	14.8	14.3	14.5	14.6
Carbon Dioxide	2.8	2.7	2.7	2.7
Argon	0.9	0.9	0.9	0.9
Water	6.3	8.6	8.0	7.8

**Gas Turbine Emissions (ref. to 15% O<sub>2</sub>, dry) at ISO conditions**

NOx [mg/Nm<sup>3</sup>] 30  
 CO [mg/Nm<sup>3</sup>] 30

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**Gas Turbine Data Sheet**

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**MGT6000 Performance Data**

Fuel : Natural Gas  
 LHV : 48000 kJ/kg  
 Dry Low NOx Combustion Chamber (ACC)  
 Generator Speed : 1500 rpm

**The data are corrected for the following site conditions :**

Altitude : 0 m  
 Ambient Pressure : 101.3 kPa  
 Inlet Pressure Loss : 0.75 kPa  
 Exhaust Pressure Loss : 2.50 kPa  
 Gearbox Efficiency : 98.0 %  
 Generator Efficiency : 96.7 %

**Expected Performance for 50% Load**

Inlet Temperature [°C]	17	28	33	40
Relative Humidity [%]	50	90	55	35
Electrical Power Output [MW]	3.15	2.86	2.73	2.55
Electrical Efficiency [%]	24.3	23.2	22.8	22.1
Heat Rate [kJ/kWh]	14830	15500	15810	16280
Exhaust Gas Flow [kg/s]	18.3	17.5	17.1	16.6
Exhaust Gas Temperature [°C]	507	518	523	531
Fuel Flow [kg/h]	970	930	900	870

Exhaust Gas Composition [Vol.%]				
Nitrogen	75.4	73.6	74.1	74.2
Oxygen	15.1	14.6	14.8	14.9
Carbon Dioxide	2.6	2.6	2.6	2.6
Argon	0.9	0.9	0.9	0.9
Water	6.0	8.3	7.7	7.5

**Gas Turbine Emissions (ref. to 15% O<sub>2</sub>, dry) at ISO conditions**

NOx [mg/Nm<sup>3</sup>] 30  
 CO [mg/Nm<sup>3</sup>] 30

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**Gas Turbine Data Sheet**

Code Word : MGT6000 for Nigeria

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**MGT6000 ISO Performance Data (Generator Drive)**

Fuel : Natural Gas  
 LHV : 48000 kJ/kg  
 ACC (Dry Low NOx Combustion Chamber)  
 Generator Speed : 1500 rpm (50 Hz)

The data are corrected for the following site conditions :

Altitude : 0 m  
 Ambient Pressure : 101.3 kPa  
 Relative Humidity : 60 %  
 Inlet Pressure Loss : 0 kPa  
 Exhaust Pressure Loss : 0 kPa  
 Gearbox Efficiency : 98.8 %  
 Generator Efficiency : 97.2 %

**Expected Performance for Base Load**

Inlet Temperature [°C]	15
Electrical Power Output [MW]	7.15
Electrical Efficiency [%]	32.7
Heat Rate [kJ/kWh]	11030
Exhaust Gas Flow [kg/s]	27.6
Exhaust Gas Temperature [°C]	505

Emissions *)	
NOx [mg/Nm³]	30
CO [mg/Nm³]	30

\*) ref. to 15% O2, dry; 50 % - 100% Load

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Date	17.07.2019							
Drawn	Boje							Sheet
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Dept.: ETETC	Project: 33 19 044 / Nigeria							



**MGT6000-1S**  
**Performance Data**

**Document No.:**  
**10002864090**

**Rev.:**  
**00**

**MGT6000 Performance Data**

Fuel : Natural Gas  
 LHV : 48000 kJ/kg  
 Dry Low NOx Combustion Chamber (ACC)  
 Generator Speed : 1500 rpm

**The data are corrected for the following site conditions :**

Altitude : 0 m  
 Ambient Pressure : 101.3 kPa  
 Inlet Pressure Loss : 1.20 kPa  
 Exhaust Pressure Loss : 2.50 kPa  
 Gearbox Efficiency : 98.8 %  
 Generator Efficiency : 97.2 %

**Expected Performance for Full Load**

Ambient Temperature [°C]	17	28	33	40	17	28	33	40
Relative Humidity [%]	50	90	55	35	50	90	55	35
Chiller Status	off	off	off	off	off	on	on	on
Inlet Temperature [°C]	17	28	33	40	17	18	18	20
Electrical Power Output [MW]	6.74	6.13	5.86	5.49	6.74	6.69	6.69	6.58
Electrical Efficiency [%]	31.5	30.4	29.6	29.1	31.5	31.5	31.5	31.2
Heat Rate [kJ/kWh]	11420	11860	12170	12390	11420	11440	11440	11540
Exhaust Gas Flow [kg/s]	27.5	25.9	25.7	24.0	27.5	27.1	27.1	27.0
Exhaust Gas Temperature [°C]	506	518	525	543	506	508	508	510
Fuel Flow [kg/h]	1600	1510	1490	1420	1600	1590	1590	1580
Exhaust Gas Composition [Vol.%]								
Nitrogen	75.2	73.4	73.9	74.0	75.2	74.6	74.6	74.4
Oxygen	14.5	14.1	14.2	14.2	14.5	14.3	14.3	14.3
Carbon Dioxide	2.9	2.9	2.8	2.9	2.9	2.9	2.9	2.9
Argon	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Water	6.6	8.8	8.2	8.1	6.6	7.3	7.3	7.5

**Gas Turbine Emissions (ref. to 15% O<sub>2</sub>, dry) at ISO conditions**

NOx [mg/Nm<sup>3</sup>] 30  
 CO [mg/Nm<sup>3</sup>] 30

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**MGT6000 Performance Data**

Fuel : Natural Gas  
 LHV : 48000 kJ/kg  
 Dry Low NOx Combustion Chamber (ACC)  
 Generator Speed : 1500 rpm

**The data are corrected for the following site conditions :**

Altitude : 0 m  
 Ambient Pressure : 101.3 kPa  
 Inlet Pressure Loss : 1.20 kPa  
 Exhaust Pressure Loss : 2.50 kPa  
 Gearbox Efficiency : 98.5 %  
 Generator Efficiency : 97.1 %

**Expected Performance for 75% Load**

Ambient Temperature [°C]	17	28	33	40
Relative Humidity [%]	50	90	55	35
Chiller Status	off	off	off	off
Inlet Temperature [°C]	17	28	33	40
Electrical Power Output [MW]	5.06	4.60	4.40	4.11
Electrical Efficiency [%]	29.2	27.9	27.5	26.8
Heat Rate [kJ/kWh]	12350	12880	13100	13440
Exhaust Gas Flow [kg/s]	23.0	21.9	21.4	20.7
Exhaust Gas Temperature [°C]	507	518	524	530
Fuel Flow [kg/h]	1300	1230	1200	1150

Exhaust Gas Composition [Vol.%]				
Nitrogen	75.2	73.4	73.9	74.1
Oxygen	14.7	14.3	14.4	14.5
Carbon Dioxide	2.8	2.8	2.7	2.7
Argon	0.9	0.9	0.9	0.9
Water	6.4	8.7	8.0	7.8

**Gas Turbine Emissions (ref. to 15% O<sub>2</sub>, dry) at ISO conditions**

NOx [mg/Nm<sup>3</sup>] 30  
 CO [mg/Nm<sup>3</sup>] 30

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**MGT6000 Performance Data**

Fuel : Natural Gas  
 LHV : 48000 kJ/kg  
 Dry Low NOx Combustion Chamber (ACC)  
 Generator Speed : 1500 rpm

**The data are corrected for the following site conditions :**

Altitude : 0 m  
 Ambient Pressure : 101.3 kPa  
 Inlet Pressure Loss : 1.20 kPa  
 Exhaust Pressure Loss : 2.50 kPa  
 Gearbox Efficiency : 98.0 %  
 Generator Efficiency : 96.7 %

**Expected Performance for 50% Load**

Ambient Temperature [°C]	17	28	33	40
Relative Humidity [%]	50	90	55	35
Chiller Status	off	off	off	off
Inlet Temperature [°C]	17	28	33	40
Electrical Power Output [MW]	3.37	3.07	2.93	2.74
Electrical Efficiency [%]	25.0	23.9	23.5	22.8
Heat Rate [kJ/kWh]	14420	15090	15340	15810
Exhaust Gas Flow [kg/s]	19.0	18.0	17.7	17.1
Exhaust Gas Temperature [°C]	507	519	523	531
Fuel Flow [kg/h]	1010	960	940	900

Exhaust Gas Composition [Vol.%]				
Nitrogen	75.4	73.5	74.0	74.2
Oxygen	15.0	14.6	14.8	14.8
Carbon Dioxide	2.6	2.6	2.6	2.6
Argon	0.9	0.9	0.9	0.9
Water	6.1	8.4	7.7	7.5

**Gas Turbine Emissions (ref. to 15% O<sub>2</sub>, dry) at ISO conditions**

NOx [mg/Nm<sup>3</sup>] 30  
 CO [mg/Nm<sup>3</sup>] 30

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	<p style="text-align: center;"><b>Fuel Specification Gaseous Fuels</b></p> <p style="text-align: center;"><b>MGT6000 Gas Turbines</b></p>	Document No.: 10001034546	Rev.: 04
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## 1 General

This document specifies the requirements for gaseous fuels to be used in MGT6000 gas turbines. Generally, the limits for physical and chemical properties specified in the table below must be adhered to.

Gaseous fuels that do not correspond to the limit values of the table may in some cases still be allowed for MGT6000 gas turbines. To this end, however, the technical department of MAN Energy Solutions SE has to provide a detailed assessment. It may become permissible to exceed individual limits if additional protective measures are carried out on gas turbine components.

When assessing the fuel gas composition particular attention must be paid to those substances that can lead to corrosion, i.e. alkaline metals (sodium, potassium etc.) or sulphur compounds so that adequate steps can be taken to minimize corrosion in the gas turbine and fuel system.

In addition to reviewing the composition and contaminants of the gaseous fuels being considered for use, the customer is urged to institute good fuel management, handling and treatment systems.

The table lists limits for the concentration of various contaminants. A further possible source of contaminants is the inlet air. The limit values in the table apply under the assumption that no additional contaminants will be added through air.

If this is the case, however, the limit values for each component of the fuel gas are to be reduced as shown in the following formula:

$$C_{\text{max, corrected}} = C_{\text{max, table}} - \text{AFR} \times C_{\text{Air}}$$

$C_{\text{max, corrected}}$  = corrected max. allowable concentration of contaminants


$C_{\text{max, table}}$  = max. allowable concentration of contaminants from table

$C_{\text{Air}}$  = expected concentration of contaminants in the air

AFR = Mass flow ratio air to fuel (typically approx. 60 : 1)

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Checked	Benninghoven	Boje	Jeskulke	Orth	Jeskulke	

	<b>Fuel Specification Gaseous Fuels</b>  <b>MGT6000 Gas Turbines</b>	Document No.: 10001034546	Rev.: 04
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## 2 Fuel gas properties

Table 1: Fuel gas properties

Property	Max. limit value
Methane content (CH <sub>4</sub> )	100% by vol.
Ethane and Propane content (C <sub>2</sub> H <sub>6</sub> + C <sub>3</sub> H <sub>8</sub> )	15% by vol.
Butane content (C <sub>4</sub> H <sub>10</sub> )	4% by vol.
Pentane and higher hydrocarbons (C <sub>5</sub> +)	2% by vol.
Hydrogen content (H <sub>2</sub> )	10% by vol.
Carbon monoxide content (CO)	3% by vol.
Inert content (N <sub>2</sub> + CO <sub>2</sub> )	20% by vol.
Water content (H <sub>2</sub> O)	Note 1
Particulate matter	20 ppm by wt.
Particle size > 10 µm	0% by vol.
Particle size 2 - 10 µm	10% by vol.
Contaminants with corrosive effects :	
Total sulphur content (Note 2)	max. 100 ppmv (without special coatings in turbine section)  max. 1.5% by vol. (with special coatings in turbine section)
Sodium + Potassium	max. 0.5 ppm by wt.
Wobbe Index (Note 3)	40 - 60 MJ/m <sub>N</sub> <sup>3</sup>
Allowable fluctuation of Heating Value (LHV) and Wobbe Index (Note 3) with set control	± 10%

**Note:** Depending on total fuel composition, single limit values of those listed above may be exceeded or further restricted. Please contact the technical department of MAN Energy Solutions SE to provide a detailed assessment.

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	<b>Fuel Specification Gaseous Fuels</b>  <b>MGT6000 Gas Turbines</b>	Document No.: 10001034546	Rev.: 04
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### 3 Fuel gas pressure

The following table contains limits that are valid at battery limit. (Note 4)

Table 2: Limit values for fuel gas pressure at battery limit (Note 4)

Property	Limit value
Minimum fuel gas inlet pressure (Note 5)	19.0 bar (g)
Max. allowable fuel gas inlet pressure	30.0 bar (g)
Allowable change of pressure	± 2.5%
Allowable hysteresis of pressure	4%
Allowable deviation of fuel gas pressure from set-point value with minimum flow rate	15%
Allowable transient pressure change	0.2 bar/s


### 4 Fuel gas temperature

Liquid components in the fuel gas are not allowed. The min. temperature must be 20 K above the dew point of heavy hydrocarbons and 20 K above the dew point of water.

Table 3: Limit values for fuel gas temperature at battery limit (Note 4)

Property	Limit value
Minimum fuel gas temperature	5°C
Maximum dew point temperature	60°C
Maximum fuel gas temperature	80°C
Allowable transient temperature change	4 K/min

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**Note 1**

The water content must not exceed a max. concentration at which gas hydrates can develop directly in front of the fuel gas control valve, taking into consideration the fuel gas temperatures which are possible during operation. Gas hydrates are not allowed. Pre-heating of the fuel is permissible.

**Note 2**

Sulphur dioxide (SO<sub>2</sub>) develops due to combustion of sulphur compounds in the fuel gas. Therefore, the total sulphur content has to be limited such that the emission limits set by the local permitting authorities are not exceeded.

Among others total sulphur includes hydrogen sulphide (H<sub>2</sub>S), carbon disulphide (CS<sub>2</sub>), carbonyl sulphide (COS), mercaptanes, thiophenes and sulphur oxides.

**Note 3**

$$\text{Wobbe-Index} = \frac{LHV}{\sqrt{d \cdot \left( \frac{T + 273}{288} \right)}}$$

(corrected to 15°C)

T = Fuel gas temperature [°C]

d = Ratio of standard density of fuel gas to standard density of air

LHV = Lower heating value [MJ/m<sub>N</sub><sup>3</sup>]

m<sub>N</sub><sup>3</sup> = m<sup>3</sup> referred to normal conditions (0°C & 101.3 kPa)

**Note 4**

Values are valid if battery limit is directly upstream of the fuel gas skid.

**Note 5**

The minimum fuel gas inlet pressure in the table is referred to ISO conditions (15°C inlet air temperature, sea level, no pressure losses) and typical natural gas (CH<sub>4</sub> = 80% by vol.; LHV = 42 MJ/kg; fuel gas temperature: 25°C).

The fuel gas inlet pressure required in a particular application depends on the site and operating conditions as well as on the fuel gas composition and temperature. It can be calculated by MAN Energy Solutions SE.

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# SPECIFICATION



## Quality requirements for lubricants

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Project:	Doc No: 10000494596		Rev.: 02		Page 1 of 7	

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# SPECIFICATION

## 1. Scope

The present specification defines the quality requirements for lubricants, control and governor fluids on petroleum oil basis and partly synthetic (e.g. HC oils) as well as fully synthetic PAO basis (poly-alpha-olefins) — on the basis of the base oils of API Group I to IV — for use in

- gas and combined gas turbine/compressor units
- steam turbines
- turbocompressors
- process gas screw compressor plant units.

Fully synthetic products, e.g. on ester or glycol basis are not covered by this specification.

The stipulations are valid for fresh oils and unused oil fills and can be applied to both the bearing-oil and the control-oil circuit of turbine units and then cover the viscosity classes ISO VG 32, ISO VG 46 and ISO VG 68.

Procedure and handling of service oils in use are not covered by this specification; they are dealt with in the specification TED 10001155287 (Requirements for oil purity during the operation of steam turbines, turbo and screw compressors).

This document makes a uniform lubricant specification available to all sales, design, service and field service departments of MAN Diesel & Turbo SE (MDT).

The specified requirements for a lubricant are a binding part of the Operating Instructions.

Lubricants that are not known to MDT require qualification by department RMC as a matter of principle.

**The viscosity class to be used, determination of the load carrying capacity of a lubricant depending on the type of gear unit (e.g. synchromesh gear or load gear unit, see Point 3.2 of the present Specification) as well as determination of a thermally stable lubricant where higher thermal loads are expected (e.g. plant unit conversions for increasing the efficiency, solar systems) are specified by the competent design departments in collaboration with department RMC (Chemical Lab, Corrosion, Tribosystems Material Technology).**

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# SPECIFICATION

## 2. Basic requirements

The lube oil must have the following basic properties:

- Free from metals or organometallic compounds
- High ageing stability
- High oxidation and temperature stability
- Low tendency to separation of oil-insoluble products under temperature load, no tendency to formation of film layers
- Suitable for high service temperatures in the bearing sections
  - up to 120 °C hot-spot temperatures for turbines and compressors
  - up to 135 °C specifically for gas turbine applications
- Suitable for temperatures in continuous operation up to approx.  $105 \pm 5$  °C
- Suitable for continuous oil reservoir temperatures up to max. 70 °C
- High wear-reducing effect with boundary and mixed frictional conditions
- Favourable air release and water separation property
- Low foaming tendency
- Good corrosion protection for ferrous and non-ferrous metals

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# SPECIFICATION



## 3. Physical and chemical minimum characteristic profile of fresh oils

### 3.1 Lubrication properties

Parameter	Requirement	Test method
Viscosity	<b>ISO VG 46 (Standard MAN Diesel &amp; Turbo SE)</b> <i>ISO VG 32 and ISO VG 68</i> <i>Only with approval by MAN Diesel &amp; Turbo SE</i>	DIN 51 562-1 DIN EN ISO 3104 ASTM D 445
Viscosity index	min. 95	DIN ISO 2909 ASTM D 2270
Density	at 15 °C (59 °F) : $\leq 0.90 \text{ g/cm}^3$	DIN 51 757 ISO 3675 ASTM D 1298
Appearance	light and clear	visually, 10 cm layer thickness
Colour	$\leq 2$	DIN ISO 2049 ASTM D 1500
Flashpoint	$\geq 180 \text{ °C}$ (355 °F)	DIN ISO 2592 ASTM D 92
Pour point	At least 10 °C lower than the minimum ambient temperature of the oil system, in no case, however, higher than <b>-9 °C (16 °F)</b> .	DIN EN ISO 3016 ASTM D 97
Total acid number (TAN)	without EP additive : $\leq 0.25 \text{ mg KOH / g}$ with EP additive : $\leq 0.35 \text{ mg KOH / g}$	ASTM D 664
Neutralization index	without EP additive : $\leq 0.25 \text{ mg KOH / g}$ with EP additive : $\leq 0.35 \text{ mg KOH / g}$	DIN 51 558-1 ASTM D 974 DIN EN ISO 2160 ISO 6618 / 6619
Ash (oxide ash)	$\leq 0.01\%$ by mass	DIN EN ISO 6245 ASTM D 482
Metals/ Organometallic compounds	Zn / Cu : $\leq 5 \text{ mg/kg}$ Others : $\leq 10 \text{ mg/kg}$	optional
Water content	$\leq 150 \text{ mg / kg}$	DIN 51 777-1 DIN EN ISO 12937 ASTM D 1744
Water separation property after steam treatment	$\leq 300 \text{ sec}$	DIN 51 589
Water separation property at 54 °C	40-40-0 : $\leq 20 \text{ min}$	DIN ISO 6614 ASTM D 1401
Air release property at 50 °C (122 °F)	$\leq 5 \text{ min}$ / <i>ISO VG 68 : <math>\leq 6 \text{ min}</math></i>	DIN ISO 7120 ISO 9120 ASTM D 3427
Corrosive effect on copper	100 °C / 3 h : $\leq 2$	DIN EN ISO 2160 ASTM-D 130
Corrosion protection properties in synthetic seawater	Method B : Passed	DIN ISO 7120 ASTM-D 665
Solid foreign matter	0.45 $\mu\text{m}$ filter: $\leq 50 \text{ mg / kg}$	Membrane filtration
Fouling class	$\leq 17 / 15 / 12$ $\leq 6$ $\leq 7$	ISO 4406 NAS 1638 SAE AS 4059
Foaming characteristics Foam formation Foam stability (10 min)	$\leq 150 / 50 / 150 \text{ ml}$ 0 / 0 / 0 ml	DIN 51 566 ASTM-D 892 (Sequence 1 - 3) ISO 6247- Seq. 1

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## 3.2 Load carrying capacity / load stage

Parameter	Requirements	Test method
Load carrying capacity (load stage)	<p><b>Specified by the competent design departments for machines with gear unit depending on the machine type (see Point 1).</b></p> <ul style="list-style-type: none"> <li>For machinery <u>without special</u> gear unit requirements a load stage of <math>\geq 6</math> shall be maintained in any case.</li> <li>Where higher requirements in respect of the load carrying capacity are <b>not</b> specified, EP-free lubricants shall be preferred.</li> <li>Load stage <math>\geq 7</math> shall be observed for screw compressor units.</li> <li>As a standard rule, load stage <math>\geq 8</math> shall be observed for machinery <u>with load gear unit requirements</u>.</li> <li>In case of <u>higher load stage requirements</u> which have to be stipulated by the gear unit manufacturer, special lubricants with high load carrying capacity have to be selected.</li> </ul>	ASTM D 5182 ISO 14 635 – 1 IP 334

## 3.3 Oxidation and temperature stability properties

Parameter	Standard requirements	Higher requirements	Test method
TOST ageing stability	$\geq 4000$ h	$\geq 6000$ h <sup>1)</sup>	DIN 51 587 ASTM D 943 ISO 4263
RPVOT oxidation stability (Rotating Pressure Vessel Oxidation Test)	$\geq 450$ min.	$\geq 600$ min. <sup>1)</sup>	ASTM-D 2272
Temperature stability behaviour of turbine oils <sup>2)</sup>	Good stability, low tendency to form films		MAN – LTAT (in-house standard method)

<sup>1)</sup> Turbines and turbocompressors with higher thermal requirements.

<sup>2)</sup> This *MAN Diesel & Turbo SE* in-house investigation method is applied by department RMC as a standard feature for testing the suitability of hitherto unknown products or new formulations.

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## 4. Initial oil fill, oil check, oil care, oil samples and oil change

### Procedures / work steps and workflows as well as measures / activities

#### ► First fill of oil (reservoir)

Deposit a reserve sample of **approx. 2 kg**.

#### ► First fill of oil / oil analysis

After **500 OH** by comparison with the initial values of the fresh oil.

#### ► Continuous oil check

- In case of high lubricant requirements (e.g. high bearing temperatures, high speeds) oil analysis after **approx. 4000 OH** by comparison with the initial values of the fresh oil.
- In case of moderate lubricant requirements (inconspicuous oil parameters) **annually** by comparison with the initial values of the fresh oil.

#### ► Oil sampling for oil analysis

- Oil quantity for examination of standard parameters **1 to 2 kg**
- Oil quantity for determination of load carrying capacity **at least 3 kg**

#### ► Oil change and new oil fill

- An oil change shall be carried out if the service oil no longer satisfies the lubricant requirements and continued operation of the plant unit is at risk.
- The criteria and warning levels for an oil change are dealt with in the specification TED 10001155287.
- On account of the complex lubricant correlations, the decision as to whether the oil has to be exchanged completely or whether the oil product has to be changed is up to the competent department RMC of MAN Diesel & Turbo SE.

#### ► Oil care / Cleaning of oil

Apart from the present specification the work instructions listed below also apply to assure an adequate lubricant quality for the **first fill or a new fill** and to assure an adequate lubrication quality of **service oils**.

- Doc.No. 10001153426\_Rev.00\_Typ ANW  
Measures for assuring the lubricant quality in oil systems of steam turbine applications.
- Doc.No. 10001155287\_Rev.00\_Typ TED  
Requirements for oil purity during the operation of steam turbines, turbo and screw compressors  
*Quality of service oils (warning levels) and information on possible causes, measures and oil change*

General information about the performance of proper oil sampling as a prerequisite for correct and conclusive results will be found in the work instructions Doc.No. 10000694111\_Rev.00\_Typ PRQ.

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## 5. Qualification of a lubricant

If an initial sample test by MAN Diesel & Turbo SE (MDT) is not available or in case of variations from or incomplete information as concerns the requirements stipulated in the present specification, an initial sample of the lubricant shall be supplied to Messrs MDT - Department RMC, if required.

Special arrangements deviating from the requirements mentioned in this specification require the written approval from MDT.

All special arrangements must be recorded in writing.

## 6. Responsibilities

The specialized department RMC of MAN Diesel & Turbo SE is responsible for the preparation of, compliance with, revision and controlled distribution of this specification.

*End of document*

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# MAN Energy Solutions

## Codes & Standards

### Gas Turbines

This list gives an overview of codes & standards used within MAN Energy Solutions, Gas Turbine department. It is valid for Gas Turbine packages built in China. This document is for information only and non-binding. This data serves informational purposes only and is especially not guaranteed in any way. Depending on the subsequent specific individual projects, the relevant data may be subject to changes and will be assessed and determined individually for each project. This will depend on the particular characteristics of each individual project, especially specific site and operational conditions.

Component	Standard	Remarks
<b>Driver &amp; Driven Equipment</b>		
Gas Turbine	MAN Energy Solutions	API 616 & API 614 with exceptions
Compressor	MAN Energy Solutions	API 617 with exceptions
Generator	Manufacturer	IEC 60034/ GB 755
Gear Box (parallel Shaft)	Manufacturer	API 613 with exceptions
Gear Box (epicyclical)	Manufacturer	ISO 6336/ AGMA 2001-D04
Couplings	Manufacturer	API 671 with exceptions
<b>Electrical Components</b>		
MCC	Low Voltage Directive 2006/95/EC	
Battery System	Low Voltage Directive 2006/95/EC	
Control Panel	Low Voltage Directive 2006/95/EC	
Starter Motor	IEC 60034	
Variable Frequency Controller	IEC 60146-1	
Servo Drives	IEC 60034-1,-5/ VDE 110 part 1, 2	
Instrument & Power Cables	GB/T12706/ EN50288-7/ GB/T9330-2008/ GB/T12706-2008/ BS5308-86 Q/320412HLC002-2010 TICW/06-2009/ IEC60502/ IEC60584-3	
<b>Mechanical Components</b>		
Lube Oil Pumps	IEC60034/ GB755	With motor, DC motor IEC60034-14
Gas Filters	ASME VIII Div.1	
Lube Oil Filters	GB/T700-2006/ GB/ T12224-2015	
Air Filters	EN 779	
Oil Heaters	JB/T2379-1993/GB3836.1 3-2010/GB150-2011	
Waste heat recovery boiler	DIN EN 12952/ 12953/ AD2000	
<b>Exhaust gas stack</b>		
Static	EN V 4133/ EN 13084	
Maintenance platforms	DIN EN ISO 14122	
<b>Exhaust gas silencer</b>		
Design/ Construction	DIN 18800	

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Component	Standard	Remarks
<b>Filter house</b>		
Installation Standard	GB50231-98/ GB50236-98	
<b>Lube oil cooler</b>		
Design/ Construction	NB/T47004-2009	
<b>Gas Skid</b>		
Design/ Construction	ASME – Sect. VIII	
Manufacturing	ASME – Sect. VIII/ Directive 97/23/EG	
<b>Piping</b>		
Calculation	ASME B31.3-2006/ EN 13480	
Pipe	ASME B36.19/ EN ISO 1127	
Flanges	ASME B16.5/ EN 1092-1	
Gaskets	ASME B16.21/ DIN EN 1514-1	
Bolts	ASME B16.5/ DIN 976-1	
Nuts	ASME B18.2.2/ DIN EN ISO 4032	
Fittings	ASME B16.9/ EN 10253-4	
Hex Bolts	ASME B18.2.1/ DIN EN ISO 4017	
<b>Base Frames</b>		
General tolerance	ISO 2768-mk	
Cutting quality	DIN EN ISO 9013	
General welding tolerance	ISO 13920-B	
Welding standards	ISO 2553/ ISO 5817	
Surface properties	ISO 1302	
Thickness tolerances	EN 10029	
Welding	ISO 5817 quality class C	
<b>Enclosures and noise standards</b>		
Measurement and Design	GB50017	
Acoustic	DIN45635	
Load assumptions	GB50009	
Platforms, stairs, ladders	GB4053.3	
<b>Safety Signs</b>		
GT Safety Signs	ISO 7010	
<b>Painting</b>	MAN Energy Solutions	DIN EN ISO 12944 with exceptions

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Component	Standard	Remarks
Quality and safety		
Health and Safety	OHSAS 18001, SCC:2006	
Environment	ISO 14001	
Quality	ISO 9001	
Level of protection and risk assessment	Directive 2006/42/EG Directive 97/23/EG Directive 94/9/EC	(MRL) (DG-RL) (ATEX)

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