JENBACHER

# Technical Description

## Genset

## JGS 316 GS-N.L

Grid Parallel with Island Operation

no special Grid Code


Electrical output 851 kW el.

Emission values

NOx < 500 mg/Nm³ (5% O2) | < 190 mg/Nm³ (15% O2)

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# 0.01 Technical Data (at genset)

| | | | 100% | 75% | 50% |
|---|---|---|---|---|---|
| Power input | [2] | kW | 2.107 | 1.609 | 1.126 |
| Gas volume | *) | Nm³/h | 205 | 156 | 109 |
| Mechanical output | [1] | kW | 876 | 657 | 438 |
| Electrical output | [4] | kW el. | 851 | 636 | 420 |
| | | | | | |
| **Heat to be dissipated (calculated with Glykol 37%)** | **[5]** | | | | |
| ~ Intercooler 1st stage (Engine jacket water cooling circuit) | [9] | kW | 137 | 71 | 26 |
| ~ Intercooler 2nd stage (Low temperature circuit) | | kW | 79 | 60 | 36 |
| ~ Lube oil (Engine jacket water cooling circuit) | | kW | 106 | 97 | 87 |
| ~ Jacket water | | kW | 259 | 221 | 182 |
| ~ Surface heat | ca. [7] | kW | 73 | ~ | ~ |
| | | | | | |
| | | | | | |
| Spec. fuel consumption of engine electric | [2] | kWh/kWel.h | 2,48 | 2,53 | 2,68 |
| Spec. fuel consumption of engine | [2] | kWh/kWh | 2,41 | 2,45 | 2,57 |
| Lube oil consumption | ca. [3] | kg/h | 0,26 | ~ | ~ |
| Electrical efficiency | | | 40,4% | 39,5% | 37,3% |
| | | | | | |
| Fuel gas LHV | | kWh/Nm³ | 10,3 | | |

*) approximate value for pipework dimensioning
[_] Explanations: see 0.10 - Technical parameters

All heat data is based on standard conditions according to attachment 0.10. Deviations from the standard conditions can result in a change of values within the heat balance and must be taken into consideration in the layout of the cooling circuit/equipment (intercooler; emergency cooling; ...).

## Main dimensions and weights (at genset)

| | | |
|---|---|---|
| Length | mm | ~ 5.200 |
| Width | mm | ~ 1.800 |
| Height | mm | ~ 2.300 |
| Weight empty | kg | ~ 10.400 |
| Weight filled | kg | ~ 11.100 |

## Connections

| | | |
|---|---|---|
| Jacket water inlet and outlet | DN/PN | 80/10 |
| Exhaust gas outlet [C] | DN/PN | 250/10 |
| | | |
| Fuel Gas (at genset) [D] | DN/PN | 80/16 |
| Water drain ISO 228 | G | ½" |
| Condensate drain | mm | ~ |
| Safety valve - jacket water ISO 228 [G] | DN/PN | 1½"/2,5 |
| Lube oil replenishing (pipe) [I] | mm | 28 |
| Lube oil drain (pipe) [J] | mm | 28 |
| Jacket water - filling (flex pipe) [L] | mm | 13 |
| Intercooler water-Inlet/Outlet 1st stage | DN/PN | 80/10 |
| Intercooler water-Inlet/Outlet 2nd stage [M/N] | DN/PN | ~ |

## Output / fuel consumption

| | | |
|---|---|---|
| ISO standard fuel stop power ICFN | kW | 876 |
| Mean effe. press. at stand. power and nom. speed | bar | 18,00 |
| Fuel gas type | | Natural gas |
| Based on methane number \| Min. methane number | MZ | 85,2 d) |
| Compression ratio | Epsilon | 12,5 |
| | | |
| Min./Max. fuel gas pressure at inlet to gas train | mbar | 3000 - 6000 c) |
| Max. rate of gas pressure fluctuation | mbar/sec | 10 |
| Maximum Intercooler 2nd stage inlet water temperature | °C | 50 |
| Spec. fuel consumption of engine | kWh/kWh | 2,41 |
| Specific lube oil consumption | g/kWh | 0,30 |
| Max. Oil temperature | °C | ~ 90 |
| Jacket-water temperature max. | °C | ~ 95 |
| Filling capacity lube oil (refill) | lit | ~ 275 |
| | | |

c) Lower gas pressures upon inquiry
d) based on methane number calculation software AVL 3.2 (calculated without N2 and CO2)

# 0.02 Technical data of engine

| | | |
|---|---|---|
| Manufacturer | | JENBACHER |
| Engine type | | J 316 GS-D05 |
| Working principle | | 4-Stroke |
| Configuration | | V 70° |
| No. of cylinders | | 16 |
| Bore | mm | 135 |
| Stroke | mm | 170 |
| Piston displacement | lit | 38,93 |
| Nominal speed | rpm | 1.500 |
| Mean piston speed | m/s | 8,50 |
| Length | mm | 2.852 |
| Width | mm | 1.457 |
| Height | mm | 1.800 |
| Weight dry | kg | 4.200 |
| Weight filled | kg | 4.690 |
| Moment of inertia | kgm² | 8,97 |
| Direction of rotation (from flywheel view) | | left |
| Radio interference level to VDE 0875 | | N |
| Starter motor output | kW | 7 |
| Starter motor voltage | V | 24 |

## Thermal energy balance

| | | |
|---|---|---|
| Power input | kW | 2.107 |
| Intercooler | kW | 216 |
| Lube oil | kW | 106 |
| Jacket water | kW | 259 |
| Exhaust gas cooled to 180 °C | kW | 401 |
| Exhaust gas cooled to 100 °C | kW | 512 |
| Surface heat | kW | 40 |

## Exhaust gas data

| | | | |
|---|---|---|---|
| Exhaust gas temperature at full load | [8] | °C | 458 |
| Exhaust gas temperature at bmep= 13,5 [bar] | [8] | °C | ~ 468 |
| Exhaust gas temperature at bmep= 9 [bar] | [8] | °C | ~ 490 |
| Exhaust gas mass flow rate, wet | | kg/h | 4.609 |
| Exhaust gas mass flow rate, dry | | kg/h | 4.279 |
| Exhaust gas volume, wet | | Nm³/h | 3.658 |
| Exhaust gas volume, dry | | Nm³/h | 3.247 |
| Max.admissible exhaust back pressure after engine | | mbar | 60 |

## Combustion air data

| | | |
|---|---|---|
| Combustion air mass flow rate | kg/h | 4.462 |
| Combustion air volume | Nm³/h | 3.453 |
| Max. admissible pressure drop at air-intake filter | mbar | 10 |

**basis for exhaust gas data: natural gas: 100% CH4; biogas 65% CH4, 35% CO2**

## Sound pressure level

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Aggregate a)** | | | dB(A) re 20µPa | | 97 | | |
| 31,5 | Hz | | dB | | 85 | | |
| 63 | Hz | | dB | | 87 | | |
| 125 | Hz | | dB | | 95 | | |
| 250 | Hz | | dB | | 90 | | |
| 500 | Hz | | dB | | 91 | | |
| 1000 | Hz | | dB | | 89 | | |
| 2000 | Hz | | dB | | 90 | | |
| 4000 | Hz | | dB | | 87 | | |
| 8000 | Hz | | dB | | 91 | | |
| **Exhaust gas** b) | | | dB(A) re 20µPa | | 117 | | |
| 31,5 | Hz | | dB | | 104 | | |
| 63 | Hz | | dB | | 116 | | |
| 125 | Hz | | dB | | 131 | | |
| 250 | Hz | | dB | | 110 | | |
| 500 | Hz | | dB | | 109 | | |
| 1000 | Hz | | dB | | 107 | | |
| 2000 | Hz | | dB | | 107 | | |
| 4000 | Hz | | dB | | 104 | | |
| 8000 | Hz | | dB | | 103 | | |

## Sound power level

| | | |
|---|---|---|
| Aggregate | dB(A) re 1pW | 117 |
| Measurement surface | m² | 99 |
| Exhaust gas | dB(A) re 1pW | 125 |
| Measurement surface | m² | 6,28 |

a) average sound pressure level on measurement surface in a distance of 1m (converted to free field) according to DIN 45635 and ISO 3744, precision class 3.
b) average sound pressure level on measurement surface in a distance of 1m according to DIN 45635 and ISO 3744, precision class 2.

The spectra are valid for aggregates up to bmep=18 bar. (for higher bmep add safety margin of 1dB to all values per increase of 1 bar pressure).
Engine tolerance ± 3 dB

## 0.03 Technical data of generator

| | | |
|---|---|---|
| Manufacturer | | Leroy-Somer(-0,92cap) e) |
| Type | | LSA 50.2 VL10 e) |
| Type rating | kVA | 1.317 |
| Driving power | kW | 876 |
| Ratings at p.f. = 1,0 | kW | 851 |
| Ratings at p.f. = 0,8 | kW | 843 |
| Rated output at p.f. = 0,8 | kVA | 1.054 |
| Rated reactive power at p.f. = 0,8 | kVar | 632 |
| Rated current at p.f. = 0,8 | A | 1.521 |
| Frequency | Hz | 50 |
| Voltage | V | 400 |
| Speed | rpm | 1.500 |
| Permissible overspeed | rpm | 1.800 |
| Power factor (lagging - leading) (UN) | | 0,8 - 0,92 |
| Efficiency at p.f. = 1,0 | | 97,1% |
| Efficiency at p.f. = 0,8 | | 96,3% |
| Moment of inertia | kgm² | 26,33 |
| Mass | kg | 3.300 |
| Radio interference level to EN 55011 Class A (EN 61000-6-4) | | N |
| Cable outlet | | left |
| Ik" Initial symmetrical short-circuit current | kA | 17,29 |
| Is Peak current | kA | 44,02 |
| Insulation class | | H |
| Temperature (rise at driving power) | | F |
| Maximum ambient temperature | °C | 40 |

### Reactance and time constants at rated output (saturated)

| | | |
|---|---|---|
| xd direct axis synchronous reactance | p.u. | 1,944 |
| xd' direct axis transient reactance | p.u. | 0,144 |
| xd" direct axis sub transient reactance | p.u. | 0,087 |
| x2 negative sequence reactance | p.u. | 0,076 |
| Td" sub transient reactance time constant | ms | 20 |
| Ta Time constant direct-current | ms | 30 |
| Tdo' open circuit field time constant | s | 4,06 |

e) JENBACHER reserves the right to change the generator supplier and the generator type. The contractual data of the generator may thereby change slightly. The contractual produced electrical power will not change.

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**connection variant 1K**

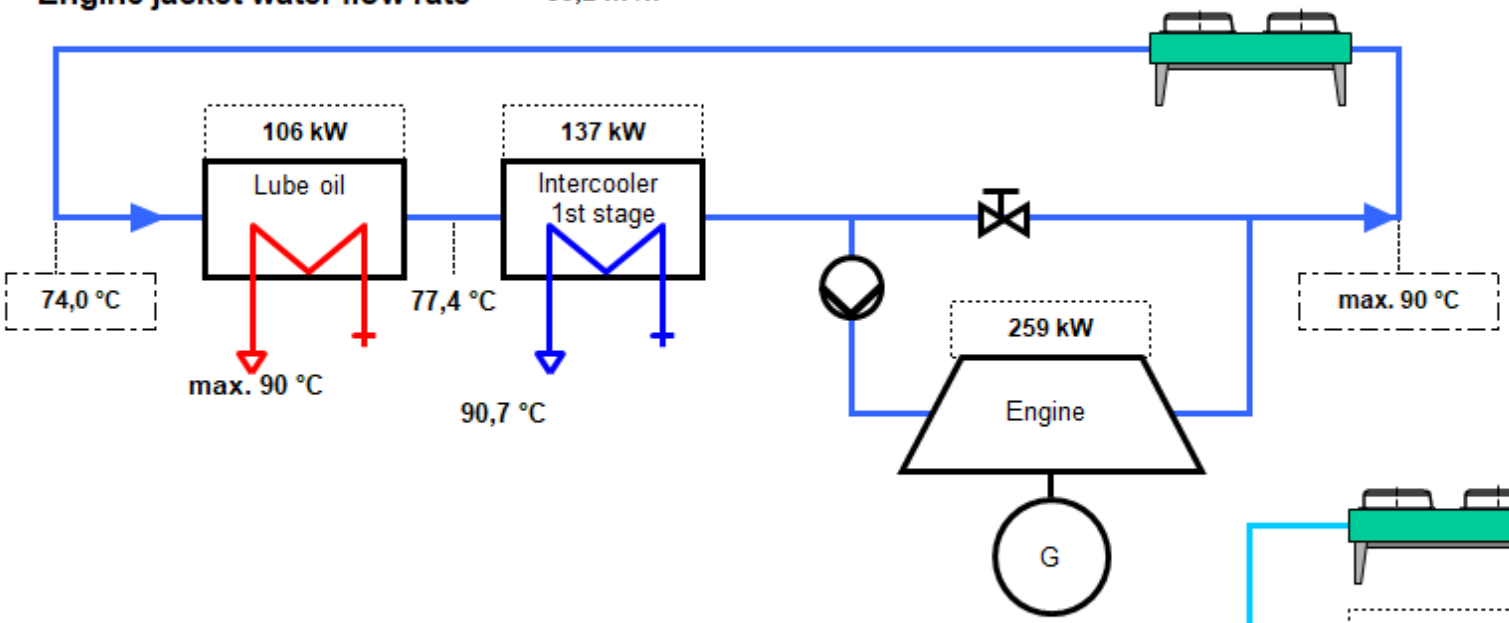
**J 316 GS-D05**

## Engine jacket water cooling circuit (calculated with Glykol 37%)

**Heat to be dissipated =** 502 kW

(+12/-8 % tolerance)

**Engine jacket water flow rate =** 30,2 m³/h

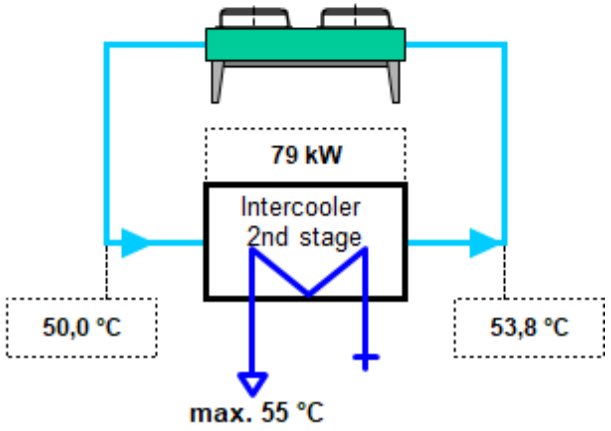



## Low temperature circuit (calculated with Glykol 37%)

**Heat to be dissipated =** 79 kW

(+12/-8 % tolerance)

**Cooling water flow rate =** 20,0 m³/h



# 0.05 Cooling water circuit

## Oil - heat (Engine jacket water cooling circuit)

| | | |
|---|---|---|
| Nominal output | kW | 106 |
| Max. Oil temperature | °C | 90 |
| Loss of nominal pressure of engine jacket water | bar | 0,20 |
| Safety valve - max press. set point | bar | 2,50 |

## Engine jacket water - heat (Engine jacket water cooling circuit)

| | | |
|---|---|---|
| Nominal output | kW | 259 |
| Max. engine jacket water temperature (outlet engine) | °C | 90 |
| Engine jacket water flow rate | m³/h | 30,2 |
| Safety valve - max press. set point | bar | 2,50 |

## Mixture Intercooler (1st stage) (Engine jacket water cooling circuit)

| | | |
|---|---|---|
| Nominal output | kW | 137 |
| Max. inlet cooling water temp. (intercooler) | °C | 77,4 |
| Nominal pressure of cooling water / (max. operating pressure) | PN | 10 |
| Loss of nominal pressure of engine jacket water | bar | 0,20 |
| Safety valve - max press. set point | bar | 2,50 |

## Mixture Intercooler (2nd stage) (Low temperature circuit)

| | | |
|---|---|---|
| Nominal output | kW | 79 |
| Max. inlet cooling water temp. (intercooler) | °C | 50 |
| Aftercooler water flow rate | m³/h | 20,0 |
| Nominal pressure of cooling water / (max. operating pressure) | PN | 10 |
| Intercooler water pressure drop | bar | 0,20 |
| Safety valve - max press. set point | bar | 2,50 |

The final pressure drop will be given after final order clarification and must be taken from the P&ID order documentation.

## 0.10 Technical parameters

All data in the technical specification are based on engine full load (unless stated otherwise) at specified temperatures and the methane number and subject to technical development and modifications.

All pressure indications are to be measured and read with pressure gauges (psi.g.).

[1] At nominal speed and standard reference conditions ICFN according to ISO 3046-1, respectively
[2] According to ISO 3046-1, respectively, with a tolerance of +**5** %.
Efficiency performance is based on a new unit (immediately upon commissioning).Effects of degradation during normal operation can be mitigated through regular service and maintenance work.

[3] Average value between oil change intervals according to maintenance schedule, without oil change amount
[4] At p. f. = 1.0 according to IEC 60034-1:2017 with relative tolerances, all direct driven pumps are included
[5] Total output with a tolerance of +12/-8 %
[6] According to above parameters [1] through [5]
[7] As a guiding value at p.f. 0.8 and only valid for (engine, generator, TCM). Other peripheral equipment is not considered.
[8] Exhaust temperature with a tolerance of ±8 %
Note: an optimised operating mode to minimise methane slip can result in changed exhaust gas data (exhaust gas temperature, NOx emissions, etc.) and must be taken into account in the design of the exhaust gas aftertreatment
[9] Mixture temperature at:
If the engine is designed for intake air temperatures of > 30°C, then the stated mixture heat of the 1st stage is to be increased from 25°C in 2%/°C increments. The additional temperature must be added to the resulting full load point.

**Radio interference level**
The ignition system of the gas engines complies the radio interference levels of CISPR 12 and EN 55011 class B, (30-75 MHz, 75-400 MHz, 400-1000 MHz) and (30-230 MHz, 230-1000 MHz), respectively.

**Definition of output**
- ISO-ICFN continuous rated power:
  Net break power that the engine manufacturer declares an engine is capable of delivering continuously, at stated speed, between the normal maintenance intervals and overhauls as required by the manufacturer. Power determined under the operating conditions of the manufacturer's test bench and adjusted to the standard reference conditions.
  - Standard reference conditions:

| | |
|---|---|
| Barometric pressure: | 1000 mbar (14.5 psi) or 100 m (328 ft) above sea level |
| Air temperature: | 25°C (77°F) or 298 K |
| Relative humidity: | 30 % |

- Volume values at standard conditions (fuel gas, combustion air, exhaust gas)
  Pressure: 1013 mbar (14.7 psi)
  Temperature: 0°C (32°F) or 273 K

**Loss of engine performance**

**a) Performance reduction due to gas quality**

If the reference methane number is not reached and the knock control responds, the ignition timing at full performance is adjusted in conjunction with the engine management system; only then is performance reduced.

H2 admixtures in the range of 3–5 Vol% into the natural gas network are generally regarded as non-critical. Prerequisites for this are rates of change according to TA 1000-0300, as well as the knock resistance (minimum methane number) of the natural gas-H2 mixture according to the specification. For reliable compliance with required NOx emissions, the JENBACHER LEANOX$^{plus}$ control is recommended (measurement of NOx emissions and correction of the LEANOX controller). Higher H2 addition rates into the natural gas network must be assessed on a project-specific basis.

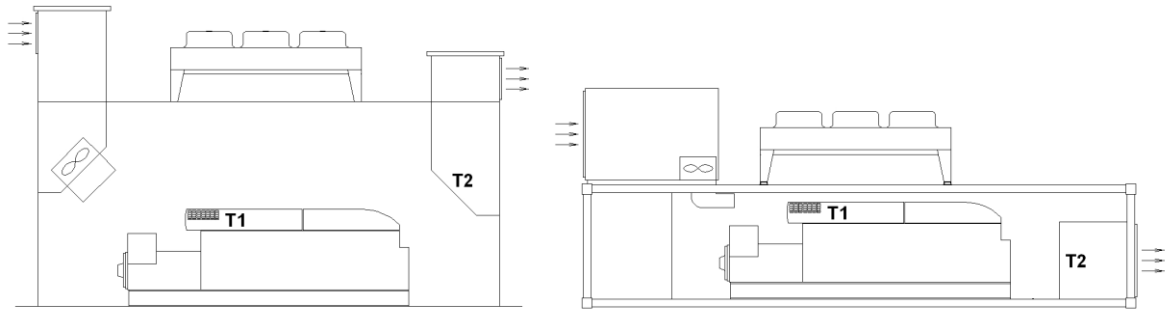
**b) Performance reduction due to voltage and frequency limits**

If the voltage and frequency limits for generators specified in IEC 60034-1 Zone A are exceeded, performance is reduced.

**c) Performance reduction due to environmental conditions**

Standard rating of the engines is for an installation at an altitude ≤ **300m** and combustion air temperature ≤ **40°C** (T1)

Engine room outlet temperature: **50°C** (T2) -> engine stop




The minimum recommended air change ratio (C) must be observed to maintain the required air quality and prevent unwanted gas accumulations (refer to Section ⇨ Potentially explosive Atmospheres as per TA1100-0110). The calculation is based on TA 1100-0110 and is $C_{min}$= 50$h^{-1}$ for JENBACHER modules.

**Parameters for the operation of JENBACHER gas engines**

The genset fulfils the limits for mechanical vibrations according to ISO 8528-9.

The following forms an integral part of a contract and must be strictly observed: **TA 1000-0004, TA 1100 0110, TA 1100-0111**, and **TA 1100-0112.**

Transport by rail should be avoided. See **TA 1000-0046** for further details

Failure to adhere to the requirements of the above-mentioned TA documents can lead to engine damage and may result in loss of warranty coverage.

**Ready for H2** means a possible adaptation up to 100vol% H2 operation. Performance data, timeline and costs can be determined on a project-specific basis.

**Parameters for the operation of control unit and the electrical equipment**

Relative humidity 50% by maximum temperature of 40°C.
Altitude up to 2000m above the sea level.

## 0.20 Mode of Operation

**Grid Parallel and Island Operation - Multi Units (Auto Re-sync)**
While Grid connected, the unit/units load can be adjusted via its power control set point or designated option. In the event of a loss of utility, the unit/units will be able to continue operating locally without utility power. When the mains monitor relay (protective relay ANSI No. 27, 59, 81, 78- provided either by JENBACHER or the customer) is activated due to a mains failure, the engine is isolated from the mains by opening the mains circuit breaker.

The load adding and shedding capabilities of the genset documented in
- TA 2108-0031 - general island operation
- TA 2108-0027 for type 2 engines
- TA 2108-0025 for type 3 engines
- TA 2108-0029 for type 4 engines
- TA 2108-0026 for type 6 engines
- TA 2108-0032 for type 9 engines

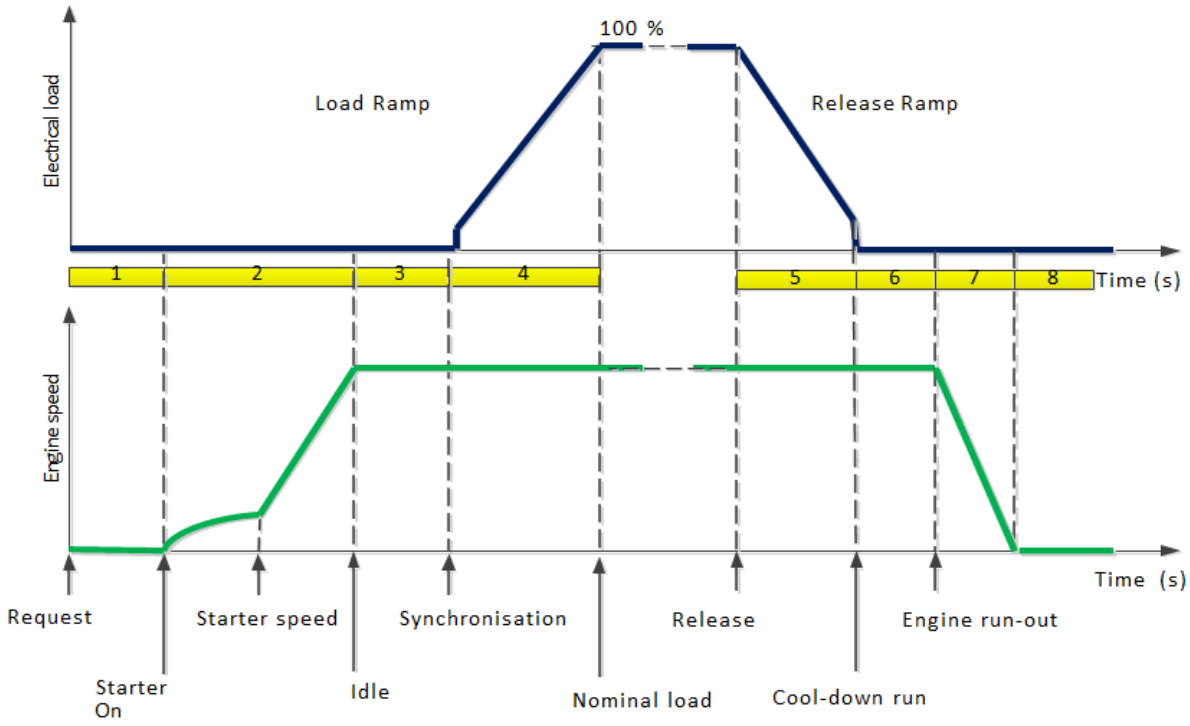
needs to be considered by the customer in order to ensure proper operation of the equipment.

When grid is restored, the unit is provided with an automatic re-synchronization feature which will synchronize the units back to the utility through a JENBACHER Master Synchronizing Control (optional, see appropriate Spec Section) or a higher-level control system provided by the customer. The unit(s) can perform "Black-out" start without external auxiliary power supply to the "dead busbar".

# 0.20.01 Guide values for genset - start/stop times and el. load ramps

**Basic boundary conditions for engine start:**

| Engine conditions | Oil temperature (°C / °F) | Cooling-water temperature (°C / °F) |
|---|---|---|
| Fast start release | > 27 / 80.6 | > 55 / 131 |
| Start enable automatic start | | > 37 / 98.6 |
| synchronization release | | > 55 / 131 |




The following time data of the individual start sections up to the nominal load are **guideline values** for a fully automatic start under preheated conditions for mains parallel operation. Only the total start time is observed under the various engine conditions. The individual time periods specified in the table therefore do not necessarily add up to the specification of the total start time in mains parallel operation.

**Deviations are possible for special designs.**

| | J208 | Type 3 | Type 4 | Type 612 – 620 | J624 |
|---|---|---|---|---|---|
| **(1)** Start preparation [1] *) | 0 | 0 | 20 | 70 | 90 |
| **(2)** Engage starter until reaching nominal speed [s] *) | 20 | 20 | 25 | 40 | 40 |
| **(3)** Synchronisation [s] *) **) | 1-50 | 1 – 50 | 1 – 50 | 1 – 50 | 1 – 50 |
| **(4)** Load application up to nominal load [s] *) **) | 180 | 180 | 180 | 160 | 160 |
| Total start-up time from request to nominal load [s] | <300 | <300 | <300 | <300 | <330 |

The following **times for unloading the engine** are guide values for engine/generator combination inertia constant H<1 kWs/kVA (with LS, CGT, TDPS generators) and the hot operating condition.

| | | | | | |
|---|---|---|---|---|---|
| **(5)** Load reduction ramp [s] | 160 | 160 | 160 | 160 | 120 |
| **(6)** Cool-down run [s] | 60 | 60 | 60 | 10 | 10 |
| **(7)** Run-down [s] | 60 | 60 | 60 | 60 | 60 |
| Total time from nominal load to run-down time [s] | 280 | 280 | 280 | 220 | 180 |
| **(8A)** gas tightness control [s] | <100 | <100 | <100 | <100 | <100 |
| **(8B)** Flushing time exhaust tract after shutdown [s] | | | | 100 | 100 |
| **(8C)** Flushing time exhaust tract after shutdown with SD and WT [s] | | | | 180 | 300 |
| **(8D)** Flushing time exhaust tract after shutdown with SD, WT, SCR and greenhouse [s] | | | | 225 | 400 |
| **(8E)** Blocking time for restart [s] | 30 | 30 | 30 | 30 | 30 |

*) The times for start-up preparation and synchronisation can vary greatly and depend on project specifications.
****) Fast start function and faster load ramps are available on request.**

The table shows the waiting time between stopping the engine and starting it again, with the gas tightness check (8A), exhaust gas scavenging (8B-D) and blocking time (8E) being carried out in parallel. The flushing times can be extended project-specifically depending on the exhaust system.
It should also be noted that the exhaust gas purge must be performed after each unsuccessful start attempt once the gas valve has been opened. (SD = silencer, WT = heat exchanger)

## 1.00 Scope of supply - module

**Design:**
The module is built as a compact package. Engine and generator are connected through a coupling and are mounted to the base frame. To provide the best possible isolation from the transmission of vibrations the engine is mounted to the frame by means of anti-vibrational mounts. The remaining vibrations are eliminated by mounting the module on isolating pads (e.g. Sylomer). This, in principle, allows the module to be placed directly on any floor capable of carrying the static load.

## 1.01 Spark ignited gas engine

Four-stroke, air/gas mixture turbocharged, aftercooled, with high performance ignition system and electronically controlled air/gas mixture system.
The engine is equipped with the most advanced

LEANOX® LEAN-BURN COMBUSTION SYSTEM

developed by JENBACHER.

## 1.01.01 Engine design

**Engine block**
Single-piece crankcase and cylinder block made of special casting; crank case covers for engine inspection, welded steel oil pan.

**Crankshaft and main bearings**
Drop-forged, precision ground, surface hardened, statically and dynamically balanced; main bearings (upper bearing shell: 3-material bearing / lower bearing shell: sputter bearing) arranged between crank pins, drilled oil passages for forced-feed lubrication of connecting rods.

**Vibration damper**
Maintenance free viscous damper

**Flywheel**
With ring gear for starter motor

**Pistons**
Single-piece made of light metal alloy, with piston ring carrier and oil passages for cooling; piston rings made of high quality material, main combustion chamber specially designed for lean burn operation.

**Connecting rods**
Drop-forged, heat-treated, big end diagonally split and toothed. Big end bearings (upper bearing shell: sputter bearing / lower bearing shell: grooved bearing) and connecting rod bushing for piston pin.

**Cylinder liner**
Chromium alloy gray cast iron, wet, individually replaceable.

**Cylinder head**
Specially designed and developed for JENBACHER-lean burn engines with optimized fuel consumption and emissions; water cooled, made of special casting, individually replaceable; Valve seats, valve guides and spark plug sleeves individually replaceable; exhaust and inlet valves made of high quality material.

**Crankcase breather**
Connected to combustion air intake system.

**Valve train**
Camshaft, with replaceable bushings, driven by crankshaft through intermediate gears, valve lubrication by splash oil through rocker arms.

**Combustion air/fuel gas system**
Motorized carburetor for automatic adjustment according to fuel gas characteristic. Exhaust driven turbocharger, mixture manifold with bellows, water-cooled intercooler, throttle valve and distribution manifolds to cylinders.

**Ignition system**
Most advanced, fully electronic high performance ignition system, external ignition control.
**MORIS / SEMIC:** Automatically, cylinder selective registration and control of the current needed

**Lubricating system**
Gear-type lube oil pump to supply all moving parts with filtered lube oil, pressure control valve, pressure relief valve and full-flow filter cartridges. Cooling of the lube oil is arranged by a heat exchanger.

**Engine cooling system**

Jacket water pump complete with distribution pipework and manifolds.

**Exhaust system**
Turbocharger and exhaust manifold

**Exhaust gas temperature measuring**
Thermocouple for each cylinder

**Electric actuator**
For electronic speed and output control

**Electronic speed monitoring for speed and output control**
By magnetic inductive pick up over ring gear on flywheel

**Starter motor**
Engine mounted electric starter motor

## 1.01.02 Additional equipment for the engine (spares for commissioning)

The required spare parts for commissioning are included in the scope of supply.

## 1.01.03 Engine accessories

**Insulation of exhaust manifold:**
Insulation of exhaust manifold is easily installed and removed

**Sensors at the engine:**
- Jacket water temperature sensor
- Jacket water pressure sensor
- Lube oil temperature sensor
- Lube oil pressure sensor
- Mixture temperature sensor
- Charge pressure sensor
- Minimum and maximum lube oil level switch
- Exhaust gas thermocouple for each cylinder
- Knock sensors
- Gas mixer / gas dosing valve position reporting.

**Actuator at the engine:**
- Actuator - throttle valve
- Bypass-valve for turbocharger
- Control of the gas mixer / gas dosing valve

## 1.01.04 Standard tools (per installation)

The tools required for carrying out the most important maintenance work are included in the scope of supply and delivered in a toolbox.

## 1.03 Module equipment

**Module frame**
Welded steel profile frame for mounting the engine, generator and heat exchangers

**Flexible coupling**
Plug-in, backlash-free coupling with torque limiter, connecting the engine and generator. The coupling isolates the generator from the main harmonic vibrations of the alternating torque of the engine.

**Coupling housing**
For a rigid centred connection between the engine and generator, with two ventilation and inspection openings for the coupling covered with perforated sheet

**Flexible mounting**
Rubber rails spaced evenly at the centre of gravity between the engine and the frame and the generator and the frame respectively, and Sylomer strips between the module frame and the foundation base plate to insulate against vibrations

**Exhaust gas piping on the module**
Connection to the turbocharger, including a compensator for taking up the thermal expansion and for isolation against vibrations

**Intake air filter**
Dry air filter with replaceable filter cartridges, flexible connections to the gas mixer, maintenance indicator for filter inspection.

**Interface cabinet**
Fully enclosed sheet steel upright cabinet, door with rubber sealing strip. Mounted on the module, wired and ready for operation.

Paintwork: RAL 7035

Degree of protection: IP54 outside, IP20 inside (protection against accidental direct contact with live components)

Designed to comply with EN 61439-2 / IEC 61439-2
Ambient temperature 5 - 40°C, 70% relative humidity.

Dimensions:
- Height: 1000 mm
- Width 1000 mm
- Depth: 300 mm

Control current supplied from the battery charger.

Power supply to the auxiliaries: (from the supplier of the power supply systems for the auxiliaries)
3 x **380** / **220** V, **50** Hz, 16 A

**Contains:**
- Terminal strip
- Decentralised input/output modules connected via a data bus interface to the central engine control system in the module control cabinet

- Speed detection
- Relays, fuses, miniature circuit breakers, engine emergency circuit breaker for controlling valves and auxiliaries
- Air-conditioning unit

## 1.03.01 Engine jacket water system

Closed cooling circuit, consisting of:
- Expansion tank
- Filling device (check and pressure reducing valves, pressure gauge)
- Safety valve(s)
- Thermostatic valve
- Required pipework on module
- Vents and drains
- Jacket water pump, including check valve
- Jacket water preheat device

## 1.03.02 Automatic lube oil replenishing system

**Automatic lube oil replenishing system:**
Includes float valve in lube oil feed line, including inspection glass. Electric monitoring system will be provided for engine shut-down at lube oil levels "MINIMUM" and "MAXIMUM". Solenoid valve in oil feed line is only activated during engine operation. Manual override of the solenoid valve, for filling procedure during oil changes is included.

**Oil drain**
By set mounted cock

**Aftercooling oil pump:**
Mounted on the module base frame; it is used for the aftercooling of the turbocharger; period of operation of the pump is 15 minutes from engine stop.
Consisting of:
- Oil pump  250 W, 380/220 V
- Oil filter
- Necessary pipework

## 1.05.02 Gas train >500mbar

Pre-assembled, delivered loose, for installation into gas pipework to the module.

**Consisting of:**
- Shut off valve
- Gas filter, filter fineness <3 µm
- High pressure regulator with safety-cut-off-valve (SAV)
- Calming distance with reducer
- Safety-blow-off-valve (SBV)
- Pressure gauge with push button valve

- Automatic shut-off valves
- Leakage detector
- Gas pressure switch (min.)
- TEC JET

The gas train complies with DIN - DVGW regulations.
Maximum distance from TEC JET outlet to gas entry on engine, including flexible connections, is 1 m (39,37 in).

## 1.07 Painting

| | | |
|---|---|---|
| • Quality: | Oil resistant prime layer<br>Synthetic resin varnish finishing coat | |
| • Colour: | Engine: | RAL 6018 (green) |
| | Base frame: | RAL 6018 (green) |
| | Generator: | RAL 6018 (green) |
| | Module interface panel: | RAL 7035 (light grey) |
| | Control panel: | RAL 7035 (light grey) |

## 1.11 Engine generator control panel per module- DIA.NE XT4 incl. Single synchronization of the generator breaker

**Dimensions:**

| | |
|---|---|
| • Height: | 2310 mm (including 200 mm (8 in) pedestal *) |
| • Width: | 800 -1200mm *) |
| • Depth: | 600 mm *) |

Protection class:
- external IP42
- Internal IP 20 (protection again direct contact with live parts)

*) Control panels will be dimensioned on a project specific basis. Actual dimensions will be provided in the preliminary documentation for the project.

Control supply voltage from starter and control panel batteries: 24V DC

Auxiliary equipment supply (by the supplier of the auxiliary equipment supply system)
The following network forms are possible for the supply of the auxiliary equipment. Depending on these, appropriate protective measures are provided:

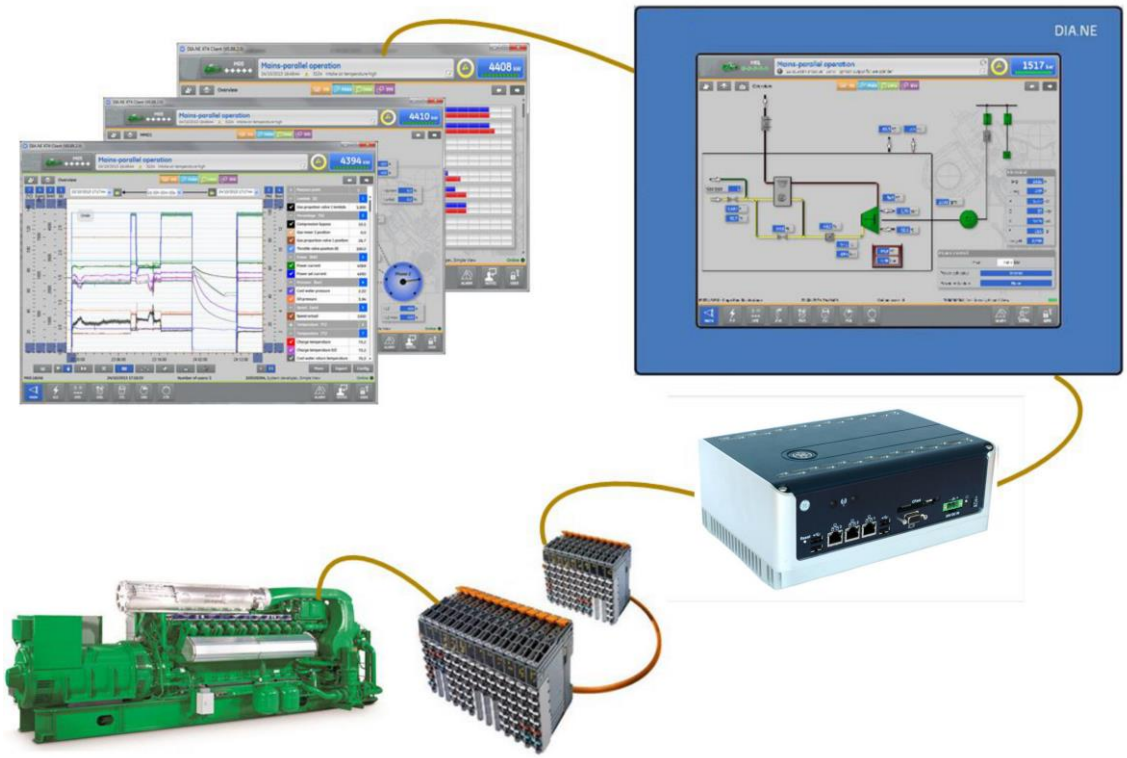
**TN- S (L1/2/3, N, PE)**
- Power supply via the module control cabinet via connection terminals or directly at the 3-pole mains disconnection unit. Protection against electric shock by automatic disconnection with miniature circuit breaker or fuse.
- Additional protection for sockets with fault current breaker (RCD) type A, 30 mA
- Option:

- According to national requirements or customer wishes, a 4-pole mains disconnecting device can also be used. Especially if the neutral conductor is not considered to be reliably earthed.
- Downstream outputs for auxiliary equipment with neutral conductors are fused using 2 or 4 poles.

3 x **380/220** V, **50** Hz

**Consisting of:**
Motor - Management - System DIA.NE

**Setup:**
- Touch display visualization
- Central engine and unit control




## Touch Display Screen:

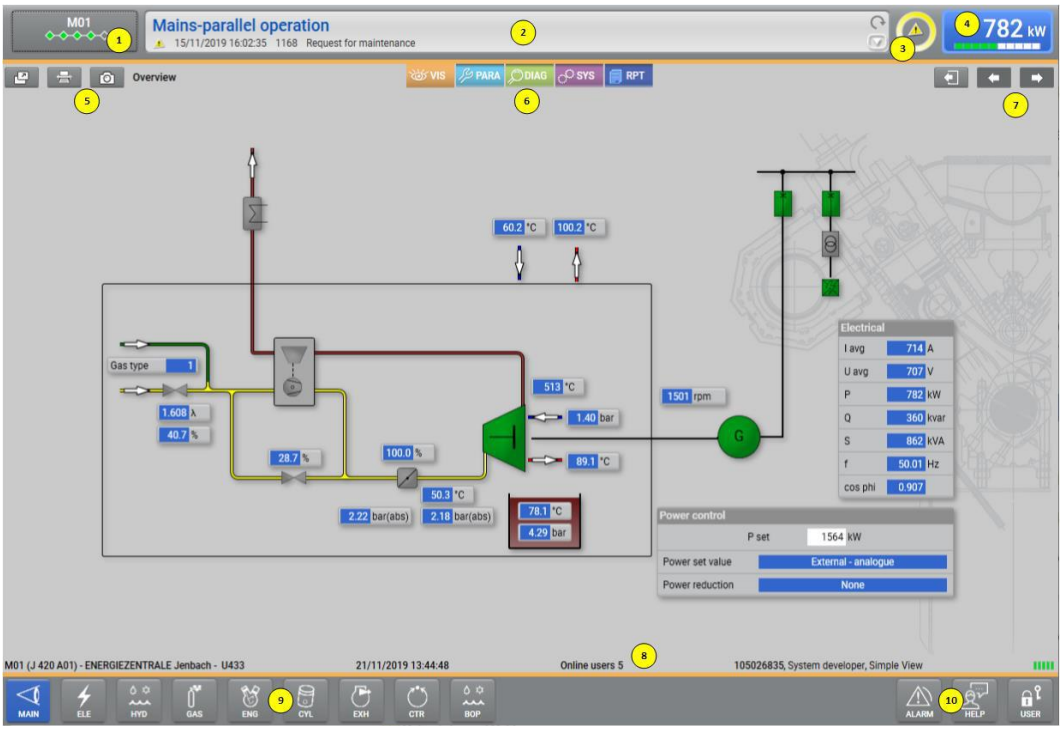
15“Industrial color graphic display with resistive touch.

Protection class of DIA.NE XT panel front: IP 65

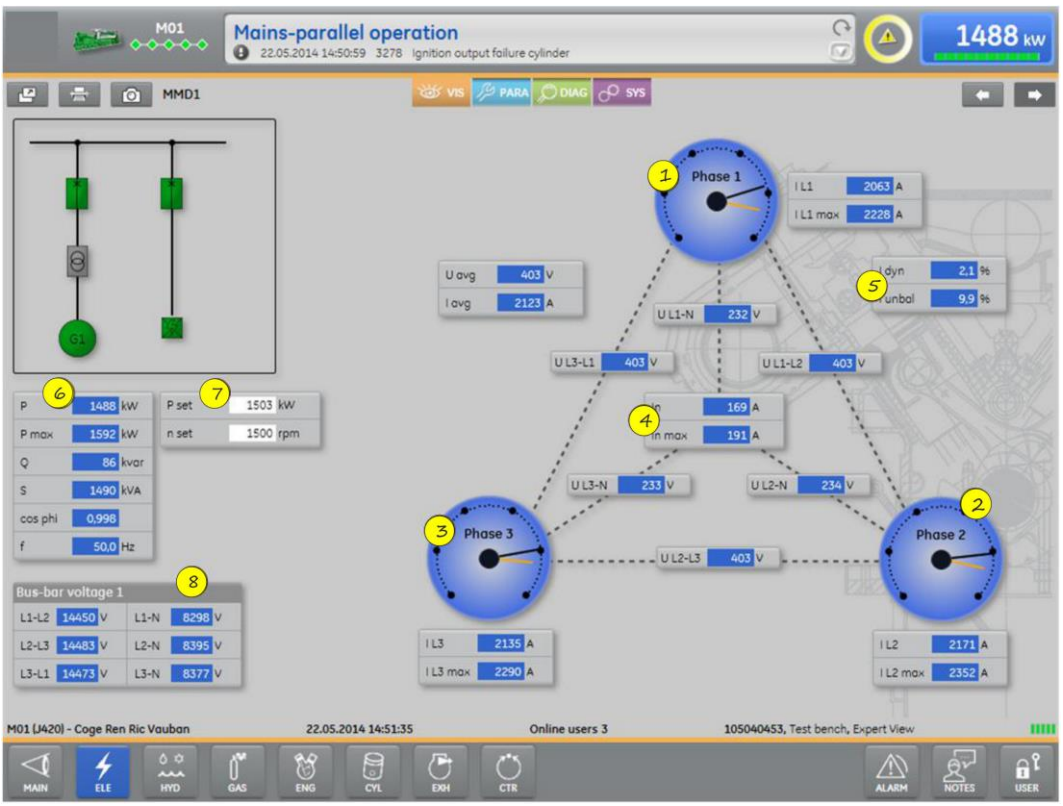
The screen shows a clear and functional summary of the measurement values and simultaneously shows a graphical summary.

Operation is via the screen buttons on the touch screen
Numeric entries (set point values, parameters…) are entered on the touch numeric pad or via a scroll bar. Determination of the operation mode and the method of synchronization via a permanently displayed button panel on the touch screen.

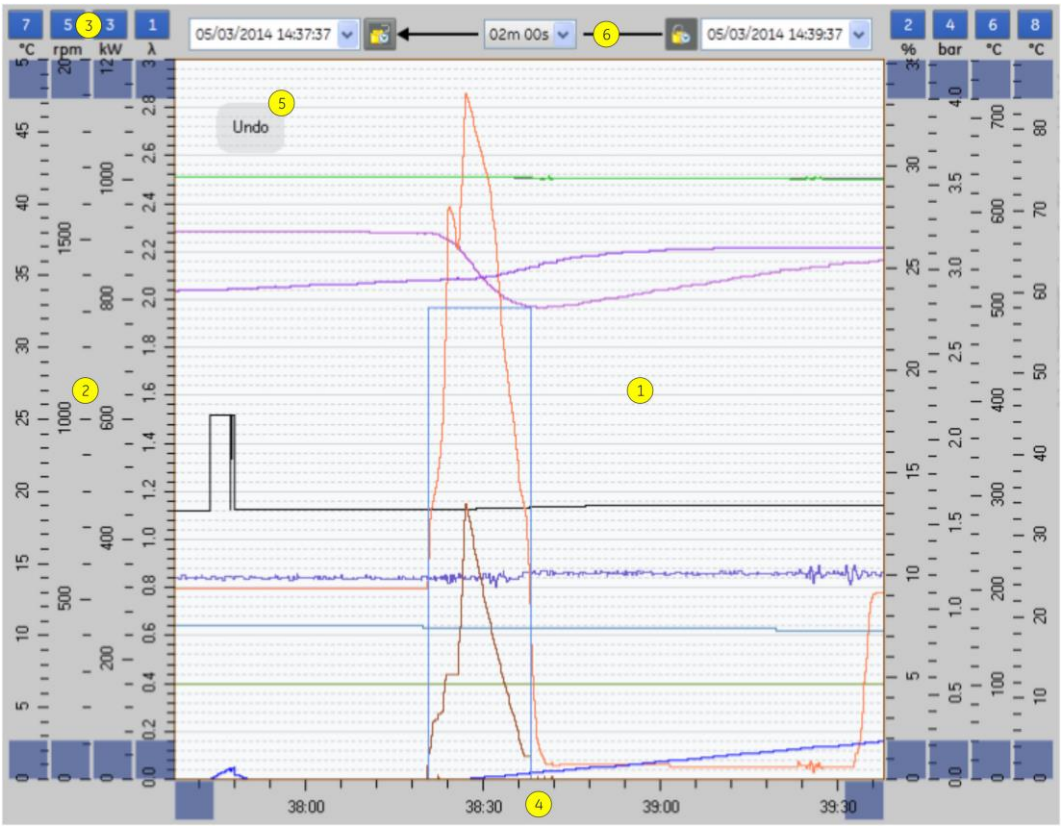
**Main screens (examples):**
Main: Display of the overview, auxiliary's status, engine start and operating data.




ELE: Display of the generator connection with electrical measurement values and synchronization status



Trending
Trend with 100ms resolution




Measurement values:

- 500 data points are stored
- Measurement interval = 100ms
- Raw data availability with 100ms resolution: 24 hours + max. 50.000.000 changes in value at shut down (60 mins per shut down)
- Compression level 1: min, max, and average values with 1000ms resolution: 1 day
- Compression level 2: min, max, and average values with 30s resolution: 1 month
- Compression level 3: min, max, and average values with 10min resolution: 10 years

Messages:
1.000.000 message events

Actions (operator control actions):
100.000 Actions

System messages:
100.000 system messages

## Central engine and module control:

An industrial PC- based modular industrial control system for module and engine sequencing control (start preparation, start, stop, aftercooling and control of auxiliaries) as well as all control functions.

**Interfaces:**
- Ethernet (twisted pair) for remote monitoring access
- Ethernet (twisted pair) for connection between engines
- Ethernet (twisted pair) for the Powerlink connection to the control input and output modules.

**Connection to the local building management system according to the JENBACHER option list**
- MODBUS-RTU Slave

**Control functions:**
- Speed control in idle and in island mode
- Power output control in grid parallel operation, or according to an internal or external set point value on a case by case basis
- LEANOX control system which controls boost pressure according to the power at the generator terminals, and controls the mixture temperature according to the engine driven air-gas mixer
- Knocking control: in the event of knocking detection, ignition timing adjustment, power reduction and mixture temperature reduction (if this feature is installed)
- Load sharing between engines in island mode operation (option)
- Linear power reduction in the event of excessive mixture temperature and misfiring
- Linear power reduction according to CH4 signal (if available)
- Linear power reduction according to gas pressure (option)
- Linear power reduction according to air intake temperature (option)

Multi-transducer to record the following alternator electrical values:
- Phase current (with slave pointer))
- Neutral conductor current
- Voltages Ph/Ph and Ph/N
- Active power (with slave pointer)
- Reactive power
- Apparent power
- Power factor
- Frequency
- Active and reactive energy counter

Additional 0 (4) - 20 mA interface for active power as well as a pulse signal for active energy

The following alternator monitoring functions are integrated in the multi-measuring device:
- Overload/short-circuit [51], [50]
- Over voltage [59]
- Under voltage [27]
- Asymmetric voltage [64], [59N]
- Unbalance current [46]
- Excitation failure [40]
- Over frequency [81>]
- Under frequency [81<]

**Lockable operation modes selectable via touch screen:**
- "OFF" operation is not possible, running units will shut down immediately;
- "MANUAL" manual operation (start, stop) possible, unit is not available for fully automatic operation.
- "AUTOMATIC" fully automatic operation according to external demand signal:

**Demand modes selectable via touch screen:**
- external demand off („OFF“)
- external demand on („REMOTE“)
- overide external demand („ON“)

## Malfunction Notice list:

According to "Fault message list" (part of the documentation)

**Surveillances**
- Priority 1: (ignition off, generator switch open, solenoid valves closed)
  e.g. overspeed
- Priority 2: (solenoid valves closed, generator switch open at P < 10% Pn)
  e.g. oil pressure min.
- Priority 3: (request off, normal shutdown with cooling run)
  e.g. oil temperature max.
- Priority 4: (Warning)
  e.g. cooling water temperature min.

**Remote signals:**
(volt free contacts)
1NO = 1 normally open; 1NC = 1 normally closed

| | |
|---|---|
| • Ready for automatic start (to Master control) | 1NO |
| • Operation (engine running) | 1NO |
| • Demand auxiliaries | 1NO |
| • Collective signal "shut down" | 1NC |
| • Collective signal "warning" | 1NC |

**External (by others) provided command/status signals:**

| | |
|---|---|
| • Engine demand (from Master control) | 1S |
| • Auxiliaries demanded and released | 1S |

## Single synchronizing Automatic

For automatic synchronizing of the module with the generator circuit breaker to the grid by PLC-technology, integrated within the module control panel.

**Consisting of:**
- Hardware extension of the programmable control for fully automatic synchronization selection and synchronization of the module and for monitoring of the generator circuit breaker closed signal.
- Lockable synchronization selection via touch screen with the following selection modes:
  - "MANUAL" Manual initiation of synchronization via touch screen button followed by fully automatic synchronization of the module
  - "AUTOMATIC" Automatic module synchronization, after synchronizing release from the module control
  - "OFF" Selection and synchronization disabled
    Control of the generator circuit breaker according to the synchronization mode selected via touch screen.
  - "Generator circuit breaker CLOSED/ Select" Touch-button on DIA.NE XT

- "Generator circuit breaker OPEN" Touch-button on DIA.NE XT
- Measurement Generator breaker closing time last synchronization

**Status signals:**
- Generator circuit breaker closed
- Generator circuit breaker open

**Remote signals:**
(volt free contacts)
- Generator circuit breaker closed 1 NO

**The following reference and status signals must be provided by the switchgear supplier:**

- Generator circuit breaker CLOSED/OPEN each 1 NO
- Generator circuit breaker READY TO CLOSE 1 NO
- Mains circuit breaker CLOSED/OPEN each 1 NO

- Mains voltage via voltage transformers 3x 100 or 110V/v3 - other measuring voltages on request!
- Busbar voltage via voltage transformers 3x 100 or 110V/v3 - other measuring voltages on request!
- Generator voltage via voltage transformers 3x 100 or 110V/v3 - other measuring voltages on request!
- Generator voltage via voltage transformers 3x 100V or 110V/3 homopolar voltage for 59N for medium voltage generators

Voltage transformer in the star/star connection with minimum 50VA and Class 0,5

**The following volt free interface-signals will be provided by JENBACHER to be incorporated in switchgear:**

- CLOSING/OPENING command for generator circuit breaker (permanent contact) 1 NO + 1 NC
- Signal for circuit breaker undervoltage trip 1 NO

| | |
|---|---|
| Maximum distance between module control panel and engine/interface panel: | 30m |
| Maximum distance between module control panel and power panel: | 50m |
| Maximum distance between module control panel and master control panel: | 50m |
| Maximum distance between alternator and generator circuit breaker: | 30m |

**Air conditioning module control panel is included.**

## 1.11.02 Remote information by MODBUS-RTU

Data transfer from JENBACHER-module control to customer's plant management system by MODBUS-RTU-network (RS 485).
The Jenbacher module control panel works as a SLAVE.
The data transmission by the customer's MASTER shall be cyclical.

**Data transmitted:**

Fault messages, operating messages, measured values (generator power, oil pressure, oil temperature, cooling water pressure, cooling water temperature, etc.) according to JENBACHER standard (interface list).

**JENBACHER limit of delivery:**
Interface connector at the PLC in the module control panel.

## 1.11.06 Remote Data-Transfer with DIA.NE XT4

**General**
DIA.NE XT4 offers remote communication using an Ethernet connection.

**1.) DIA.NE XT4 HMI**
DIA.NE XT4 HMI is the Human-Machine-Interface of DIA.NE XT4 engine control and visualization system for JENBACHER gas engines.
The system offers extensive facilities for commissioning, monitoring, servicing and analysis of the site.
By installation of the DIA.NE XT4 HMI client program it can be used to establish connection to site, if connected to a network and access rights are provided.
The system runs on Microsoft Windows Operating systems (Windows 7, Windows 8, Windows 10)

**Function**
Functions of the visualization system at the engine control panel can be used remotely. These functions provide control, monitoring, trend indications, alarm management, parameter management, and access to long term data recording. By providing access to multiple systems, also with multiple clients in parallel, additional useful functions are available like

- Multi-user system
- Remote control
- Print and export functions
- Data backup.

The DIA.NE XT4 is available in several languages.

**Remote Operation:**
**Option1 - remote request/remote blocking (remote start/stop)**
If the operating mode selector switch on the module control cabinet is set to "Automatic" and the request mode selector is set to "Remote", the module can be enabled (requested) or blocked (derequested) by a control element (button) on the DIA.NE XT4 HMI client. The request can come from a Windows PC in the local network or over a secure myPlant remote connection. The myPlant remote connection requires the myPlant Care package as a prerequisite (not included in the price)
Note:
This option also allows an additional on-site request (from the hardware or a data bus) or self-managed operation (JENBACHER station control, mains import control, etc.) to be implemented.

**Option2 – Remote Acknowledgement (remote reset)**
Error messages can also be acknowledged remotely on the DIA.NE XT4 HMI client, apart from those error messages incorporated in the safety loop - see TA 1100-0111, Section 12, for more information.
Remote acknowledgement can come from a Windows PC in the local network or over a secure myPlant remote connection. A myPlant remote connection - myPlant care package is required to use the "remote reset" over the Internet (not included in the price). Use of this function requires an agreement to be concluded between the customer and JENBACHER laying down the procedure to be followed in the

event of damage caused by a remote acknowledgement (preserving evidence) and how to establish responsibility. Proof of OPT training (operator training) and TJE (training on the job) is also required.

**Scope of supply**

- Software package DIA.NE XT4 HMI Client Setup (Download)
- Number of DIA.NE XT4 HMI - Client user license (Simultaneous right to access of one user to the engine control)

| Nr. of license | Access |
|---|---|
| 1 | 1 Users can be logged in at the same time with a PC (Workplace, control room or at home). |
| 2 - "n" (Optional) | 2- "n" Users can be logged in at the same time with a PC (Workplace, control room or at home). If 2- "n" users are locally connected at Computers from office or control room, then it is not possible to log in from home. |

**Caution!** This option includes the DIA.NE XT4 HMI client application and its license only – NO secured, encrypted connection will be provided by JENBACHER! A secured, encrypted connection – which is mandatory – has to be provided by the customer (via LAN connection or customer-side VPN), or can be realized by using option myPlant™.

**Customer requirements**

- Broad band network connection via Ethernet(100/1000BASE-TX) at RJ45 Connector (ETH1) at DIA.NE XT4 server inside module control panel
- Standard PC with keyboard, mouse or touch and monitor (min. resolution 1024*768)
- Operating system Windows 7, Windows 8, Windows 10
- DirectX 9.0 c compatible or newer 3D display adapter with 64 MB or higher memory

**2.) myPlant™**

myPlant* is the remote data transfer and diagnostics solution from JENBACHER

| | BASIC | CARE | PROFESSIONAL |
|---|---|---|---|
| **basic / advanced monitoring** | | | |
| Live operating status | ✓ | ✓ | ✓ |
| Historic and live data trending | | ✓ | ✓ |
| Alarm management and notification | Alarm management only | ✓ | ✓ |
| Access to all engine documents | ✓ | ✓ | ✓ |
| Mobile app | ✓ | ✓ | ✓ |
| Daily status logbooks | ✓ | ✓ | ✓ |
| Remote access to engine controller | | ✓ | ✓ |
| Fleet management | | ✓ | ✓ |
| Engine status notifications (SMS/Email) | | ✓ | ✓ |
| **increased productivity / strong performance** | | | |
| Recommended maintenance[1] (coming soon) | ✓ | ✓ | ✓ |
| Support case management[1] | ✓ | ✓ | ✓ |
| Predictive maintenance for spark plugs, oil and air filters[2] | Spark plugs lifetime prediction only | ✓ | ✓ |
| Oil & coolant quality monitoring[3] | | ✓ | ✓ |
| Fleet emission monitoring[4] | Engine emission monitoring only | ✓ | ✓ |
| **artificial intelligence & predictive analytics** | | | |
| Operator analytics package | | | ✓ |

| | | | |
|---|---|---|---|
| Historic performance analysis | | | ✓ |
| User-defined monitoring | | | ✓ |
| On demand: Access to myPlant data via API (Application Programming Interface) service[5] | | | ✓ |

[1] Available soon for JENBACHER direct markets only
[2] Spark plugs, oil and air filters data might not always be available and is depending on the engine version/type ant the sensors installed
[3] Oil and coolant reports are available in myPlant for the following laboratories: Spectro, JetCare, Polaris, MIC GSM
[4] May require additional hardware installation for emission monitoring (available as upgrade)
[5] Might require development work on customer/service provider side and includes 70 API calls per engine per month

**Scope of supply**

- Access to myPlant™
- Integration of the plant in the myPlant™ system
- Access to Basic and Care level as per new installation contract
- Access to Professional level via separate contract

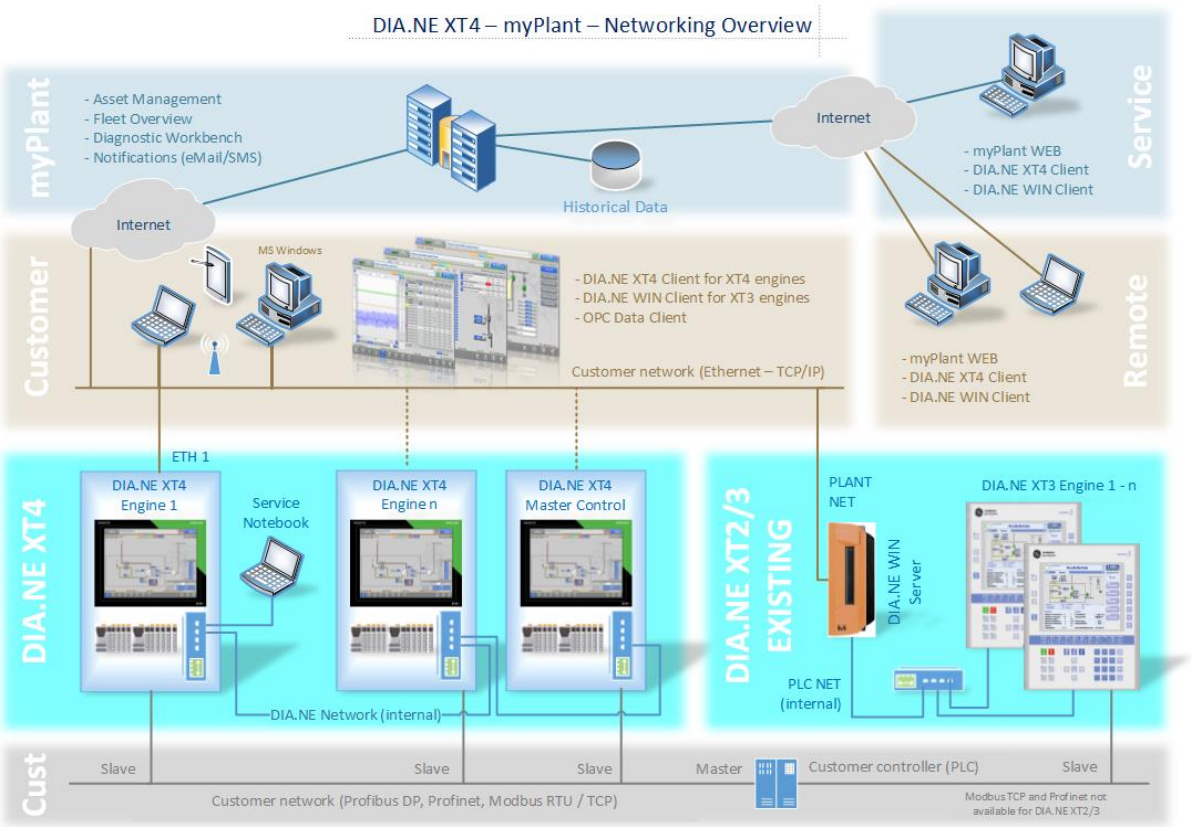
**Equipment to be provided by the customer**

- Permanent Internet connection (wired or wireless) (see also option 4)
- Technical requirements as per TA 2300-0008
- Outward data connection (from the plant server to the Internet) - INWARD connections are NOT PERMITTED!

CAUTION: The customer must take technical precautions to ensure that direct access to the plant server from the Internet is prevented (e.g. by means of a firewall):
This security measure CANNOT be assumed and guaranteed by JENBACHER

### 3.) Network overview

For information only!




## 1.11.13 Out-of-step protection / pole slip protection (integrated in DIA.NE XT4)

**ANSI Function Code 78**

- 3-phase monitoring, integrated in DIA.NE XT4 controller
- Uses voltage measurement at the generator and engine speed measurement (supplied by JENBACHER).
- Allows real-time calculation of rotor angle during dynamic operations
- Allows safe detection of a pole slip risk and allows operation up to the maximum limit value
- Acting on generator circuit breaker and generator de-excitation.
- Alarm message on the DIA.NE screen.
- Active in Grid and Island parallel operation

OPTIONAL on special release:
separate digital protection relay (ATTENTION: different detection as generator and mains voltage are evaluated. Tripping only possible if pole slip has occurred)

Following monitoring are integrated in the DIA.NE generator protection package

- Load angle / pole slip monitoring
- Exciter failure monitoring [ANSI 40]

## 1.11.31 Interfaces to customer's Master synchronization (Synchronization of grid CB)

**Scope:**
Interfaces from/to each module control panel and customer Master panel with potential free contacts.
Further project specific interfaces must be checked during project phase

The engines can run in island mode according to technical instruction TA 2108-0031 based on the condition that island mode function of the control system is properly designed, supplied, installed and commissioned by the customer in accordance with JENBACHER requirements.

**Request to customer master synchronization:**

**Manual synchronization**
For manual synchronization a "synchronizing check relay" is necessary.

**Signal monitoring**
The synchronizing panel has to have monitoring to detect un-logical signals and operations (such as trip errors) to ensure safe operation.

**Grid protection device (supplied locally):**
Protections and settings must be according to JENBACHER requirements

Max. distance between customer Master synchronization panel and JENBACHER Module control panel: 50m

**Scope of supply:**
Terminals at each module control panel.

## 1.20.03 Starting system

**Starter battery:**
2 piece 12 V AGM battery, 125 Ah (according to DIN 72311).

**Battery voltage monitoring:**
Monitoring by PLC.

**Battery charging equipment:**
Capable for charging the starter battery with I/U characteristic and for the supply of all connected D.C. consumers.
Charging device is mounted inside of the module interface panel or module control panel.

- **General data:**
  - Power supply — **3 x 320 - 575 V, 47 - 63 Hz**
  - max. power consumption — 1040 W / 1550 W (5 sec)
  - Nominal D.C. voltage — 24 V(+/-1%)
  - Voltage setting range — 24V to 28V ( adjustable)
  - Nominal current (max.) — 40 A
  - Degree of protection — IP20 to IEC 60529
  - Operating temperature — 0 °C - 70 °C
  - Protection class — 1
  - Humidity class — 3K3, no condensation.
  - Natural air convection
  - Standards — EN60950,EN50178
    UL/cUL (UL508 / UL 60950-1)

**Signalling:**
Green Led: Output voltage > 21,6V

**Control accumulator:**
- Pb battery 24 VDC/18 Ah

## 1.20.05 Electric jacket water preheating

Installed in the jacket water cooling circuit, consisting of:
- Heating elements
- Water circulating pump

The jacket water temperature of a stopped engine is maintained between 56°C (133 °F) and 60°C (140°F), to allow for immediate loading after engine start.

## 1.20.08 Flexible connections

Following flexible connections per module are included in the JENBACHER -scope of supply:

| No. Connection | Unit | Dimension | Material |
|---|---|---|---|
| 2 Warm water in-/outlet | **DN/PN** | **80/10** | Stainless steel |
| 1 Exhaust gas outlet | **DN/PN** | **250/10** | Stainless steel |
| 1 Fuel gas inlet | **DN/PN** | **80/16** | Stainless steel |
| 2 Intercooler in-/outlet | **DN/PN** | **80/10** | Stainless steel |
| 2 Lube oil connection | **mm** | **28** | Hose |

Seals and flanges for all flexible connections are included.

## 2.00 Electrical Equipment

Totally enclosed floor mounted sheet steel cubicle with front door wired to terminals. Ready to operate, with cable entry at bottom. Naturally ventilated or with forced ventilation.

| | | |
|---|---|---|
| Protection: | IP 42 external<br>IP 20 internal (protection against direct contact with live parts) | |

Design according to EN 61439-2 / IEC 61439-2 and ISO 8528-4.
Ambient temperature 5 - 40 °C (41 - 104 °F), 70 % Relative humidity

| | | |
|---|---|---|
| Standard painting: | Panel: | RAL 7035 |
| | Pedestal: | RAL 7020 (Rittal TS8)<br>RAL 9005 (Rittal VX25) |

## 2.02 Grid monitoring device

Standard without static Grid Code - 50Hz alternator

**Function:**
For immediate disconnection of the generator from the grid in case of grid failures.

**Consisting of:**
- High/low voltage monitoring
- High/low frequency monitoring
- Specially adjustable independent time for voltage and frequency monitoring
- Vector jump monitoring or df/dt monitoring for immediate disconnection of the generator from the grid for example at short interruptions
- Indication of all reference dimensions for normal operation and at the case of disturbance over LCD and LED
- Adjusting authority through password protection against adjusting of strangers

**Scope of supply:**
Digital grid protection relay with storage of defect data, indication of reference dimensions as well as monitoring by itself.

**Grid protection values:**

| Parameter | Parameter limit | Max time delay[s] | **Comments** |
|---|---|---|---|
| 49-51Hz | | | Do work normal |
| f<[ANSI 81U] | 49Hz | 0,5 | Load reduction with 10% /HZ below 49Hz! |
| f<<[ANSI 81U] | 48.5Hz | 0,1 | |
| f>[ANSI 81O] | 51,5Hz | 0,1 | Load reduction with 30% /HZ higher 51Hz! |
| U<[ANSI 27] | 90% | 1 | Load reduction with 1%P /%U below 95% |

| | | | |
|---|---|---|---|
| U<<[ANSI 27] | 80% | 0,2 | Load reduction with 1%P /%U below 95% |
| U>[ANSI 59] | 110% | 30 | Load reduction with 1%P /%U above 105% |
| U>>[ANSI 59] | 115% | 0,2 | Load reduction with 1% P/%U above 105% |
| **Df/dt** [ANSI 81R]<br><br>**Or**<br><br>**Vector shift**<br><br>[ANSI 78] | 2Hz/s, 5 Periods<br><br>Or<br><br>8° -3pol | | Cos phi range:<br><br>0,8ind (overexcited)<br><br>- 1 |

# 4.00 Delivery, installation and commissioning

## 4.01 Carriage
According to contract.

## 4.02 Unloading
Unloading, moving of equipment to point of installation, mounting and adjustment of delivered equipment on intended foundations is not included in JENBACHER scope of supply.

## 4.03 Assembly and installation
Assembly and installation of all JENBACHER -components is not included in JENBACHER scope of supply.

## 4.04 Storage
The customer is responsible for secure and appropriate storage of all delivered equipment.

## 4.05 Start-up and commissioning
Start-up and commissioning with the JENBACHER start-up and commissioning checklist is included.
Plants with island operation require internet connection.

## 4.06 Trial run
After start-up and commissioning, the plant will be tested in an 8-hour trial run. The operating personnel will be introduced simultaneously to basic operating procedures.
Is included in JENBACHER scope of supply.

## 4.07 Emission measurement with exhaust gas analyser
Emission measurement by JENBACHER personnel, to verify that the guaranteed toxic agent emissions have been achieved (costs for measurement by an independent agency will be an extra charge).

# 5.01 Limits of delivery - Genset

**Electrical:**
- Genset:
  - At terminals of genset interface panel
  - At terminals of generator terminal box
    (screwed glands to be provided locally)
- Genset control panel:
  At terminal strips
- Auxiliaries:
  At terminals of equipment which is supplied separately

**Cooling water**
At inlet and outlet flanges on genset

**Exhaust gas**
At outlet flange of the genset

**Combustion air**
The air filters are set mounted

**Fuel gas**
At inlet and outlet flange of gas train (shipped loose)
At inlet flange of gas pipework on genset

**Lube oil**
At lube oil connections on genset

**Draining connections and pressure relief**
At genset

**Insulation**
Insulation of heat exchangers and pipework is not included in our scope of supply and must be provided locally.

**First filling**
The first filling of genset, (lube oil, engine jacket water, anti freeze-, anti corrosive agent) is not included in our scope of supply.

The composition and quality of the used consumables are to be strictly monitored in accordance with the "Technical Instructions" of JENBACHER.

Suitable bellows and flexible connections **must be provided locally** for all connections.
Cables from the genset must be flexible.

## 5.02 Factory tests and inspections

The individual module components shall undergo the following tests and inspections:

### 5.02.01 Engine tests
Carried out as combined Engine- and Module test based on ISO 3046-3 at JENBACHER test bench. The following tests are made at 100% load, and the results are reported in a test certificate:
- Engine output

- Fuel consumption
- Jacket water temperatures
- Lube oil pressure
- Lube oil temperatures
- Boost pressure
- Exhaust gas temperatures, for each cylinder

### 5.02.02 Generator tests

Carried out on test bench of the generator supplier.

### 5.02.03 Module tests

The engine will be tested with natural gas (methane number 94). The performance data achieved at the test bench may therefore vary from the data as defined in the technical specification due to differences in fuel gas quality.
Carried out as combined Engine- and Module test commonly with module control panel at JENBACHER test bench, based on ISO 8528-6. The following tests are made, and the results are reported in a test certificate:
Visual inspection of scope of supply per specifications.

- Functional tests per technical specification of control system.
  - Starting in manual and automatic mode of operation
  - Power control in manual and automatic mode of operation
  - Function of all safety systems on module
- Measurements at 100% load:
  - Frequency
  - Voltage
  - Current
  - Generator output
  - Power factor
  - Fuel consumption
  - Lube oil pressure
  - Jacket water temperature
  - Boost pressure
  - Mixture temperature
  - Exhaust emission (NOx)

The module test will be carried out with the original generator, except if it is not possible because of the delivery date. Then a test generator will be used for the module test.
To prove characteristics of the above components, which are not tested on the test bench by JENBACHER, the manufacturers' certificate will be provided.
In the case of a container unit the above-mentioned test procedure for the module is performed in Jenbach. JENBACHER reserves the right to perform the functional test of the container in a facility elsewhere.

## 5.03 Documentation

**List of standard pre-documentation provided based on the technical status at the time of order receipt:**

- Module drawing **1)**
- Technical diagram **1)**
- Drawings of the cabinet views **3**

- Electrical interface list **2)**
- Technical specification of the control system **2)**

**Before delivery** (depending on progress in ordering the components, on request)
- Technical drawings for BoP components/accessories supplied separately (if included in scope of supply of INNIO Jenbacher GmbH & Co OG) **1)**

**Upon delivery**
- Circuit diagrams **3)**
- Cable list **3)**

**Delivered with the engine**
- Brief instructions (transport, erection, moving) **1)**

**For commissioning**
- Operation and maintenance instructions **4)**
- Spare parts catalogue **4)**
- Original supplier operation and maintenance instructions for any BoP components (installed in the INNIO Jenbacher GmbH & Co OG scope of supply) as Appendix **1)**

  All the components found in the INNIO Jenbacher GmbH & Co OG scope of supply are described in the operation and maintenance instructions, and in the spare parts catalogue.
  In addition, the manufacturer's original operation and maintenance instructions will be provided for every BoP component, in German and English as standard, as an Appendix for the operation and maintenance manual provided.

  Additional costs of producing or providing the required documents using the KKS (power station coding system) and/or integration in subcontractors' documentation, or additional approval, design and proof of testing documentation must be negotiated or ordered separately.

  **This standard offer does not include:**
  - Approval documentation
  - Design documentation
  - Proof of testing documentation
  - Printed copies and digital off-line versions (e.g. printed versions, CD, pdf, etc.) must be negotiated separately and ordered accordingly.

**Available languages (language codes as per ISO 639-1):**

| 4 | 3 | 2 | 1 | | |
|---|---|---|---|---|---|
| | | | | **de** | German |
| | | | | **en** | English |
| | | | | **fr** | French |
| | | | | **it** | Italian |
| | | | | **es** | Spanish |
| | | | | **nl** | Dutch |
| | | | | **hu** | Hungarian |
| | | | | **ru** | Russian |
| | | | | **pl** | Polish |
| | | | | **tr** | Turkish |
| | | | | **cs** | Czech |
| | | | | **pt** | Portuguese |
| | | | | **da** | Danish |
| | | | | **sk** | Slovakian |
| | | | | **sl** | Slovenian |
| | | | | **sr** | Serbian |
| | | | | **lv** | Latvian |
| | | | | **et** | Estonian |
| | | | | **ro** | Rumanian |
| | | | | **no** | Norwegian |
| | | | | **hr** | Croatian |
| | | | | **fi** | Finnish |
| | | | | **zh** | Chinese |
| | | | | **el** | Greek |
| | | | | **bg** | Bulgarian |
| | | | | **lt** | Lithuanian |
| | | | | **sv** | Swedish |