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## 0.01a Technical Data 55% LFG H2 Blend (at Genset)

			100%	75%	50%
Power input	[2]	MBTU/hr	9,835	8,173	6,512
Gas volume	*)	SCFH	25,479	21,174	16,870
Mechanical output	[1]	bhp	1,598	1,290	983
Electrical output	[4]	kW el.	1,160	935	709
<b>Heat to be dissipated (calculated with Glykol 37%)</b>					
~ Intercooler 1st stage (Engine jacket water cooling circuit)	[9]	MBTU/hr	464	217	37
~ Intercooler 2nd stage (Low Temperature circuit)		MBTU/hr	361	306	241
~ Lube oil (Engine jacket water cooling circuit)		MBTU/hr	705	649	570
~ Jacket water		MBTU/hr	1,123	1,006	862
~ Surface heat	ca. [7]	MBTU/hr	383	~	~
<b>Spec. fuel consumption of engine electric</b>					
Spec. fuel consumption of engine electric	[2]	BTU/kWel.hr	8,484	8,743	9,182
Spec. fuel consumption of engine	[2]	BTU/bhp.hr	6,155	6,336	6,625
Lube oil consumption	ca. [3]	gal/hr	0.09	~	~
Electrical efficiency			40.2%	39.0%	37.2%
Fuel gas LHV		BTU/scft	386		

\*) 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; ...).

## 0.01b Technical Data on LFG (at Genset)

			100%	75%	50%
Power input	[2]	MBTU/hr	11,923	9,331	6,612
Gas volume	*)	SCFH	30,889	24,174	17,130
Mechanical output	[1]	bhp	1,966	1,475	983
Electrical output	[4]	kW el.	1,429	1,070	709
<b>Heat to be dissipated (calculated with Glykol 37%)</b>					
~ Intercooler 1st stage (Engine jacket water cooling circuit)	[9]	MBTU/hr	873	417	101
~ Intercooler 2nd stage (Low Temperature circuit)		MBTU/hr	195	191	119
~ Lube oil (Engine jacket water cooling circuit)		MBTU/hr	833	785	669
~ Jacket water		MBTU/hr	1,339	1,167	912
~ Surface heat	ca. [7]	MBTU/hr	405	~	~
<b>Spec. fuel consumption of engine electric</b>					
Spec. fuel consumption of engine electric	[2]	BTU/kWel.hr	8,355	8,722	9,323
Spec. fuel consumption of engine	[2]	BTU/bhp.hr	6,065	6,326	6,727
Lube oil consumption	ca. [3]	gal/hr	0.09	~	~
Electrical efficiency			40.8%	39.1%	36.6%
Fuel gas LHV		BTU/scft	386		

\*) 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	in	~ 280
Width	in	~ 80
Height	in	~ 90
Weight empty	lbs	~ 33,330
Weight filled	lbs	~ 34,870

## Connections

Jacket water inlet and outlet	in/lbs	3"/145
Exhaust gas outlet [C]	in/lbs	12"/145
Fuel Gas (at genset) [D]	in/lbs	5"/232
Water drain ISO 228	G	½"
Condensate drain	in	~
Safety valve - jacket water ISO 228 [G]	in/lbs	2x1½"/2.5
Lube oil replenishing (pipe) [I]	in	1.1
Lube oil drain (pipe) [J]	in	1.1
Jacket water - filling (flex pipe) [L]	in	0.5
Intercooler water-Inlet/Outlet 1st stage	in/lbs	3"/145
Intercooler water-Inlet/Outlet 2nd stage [M/N]	in/lbs	~

## Output / fuel consumption

ISO standard fuel stop power ICFN	bhp	1,598   1,966
Mean effe. press. at stand. power and nom. speed	psi	189   232
Fuel gas type		H2 Blend   Landfill Gas
Based on methane number   Min. methane number	MN	123   145 d)
Compression ratio	Epsilon	12.5
Min./Max. fuel gas pressure at inlet to gas train	psi	1.16 - 2.9 c)
Max. rate of gas pressure fluctuation	psi/sec	0.145
Maximum Intercooler 2nd stage inlet water temperature	°F	104
Spec. fuel consumption of engine	BTU/bhp.hr	6,155   6,065
Specific lube oil consumption	g/bhp.hr	0.15
Max. Oil temperature	°F	~ 185
Jacket-water temperature max.	°F	~ 203
Filling capacity lube oil (refill)	gal	~ 115

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 420 GS-B823
Working principle		4-Stroke
Configuration		V 70°
No. of cylinders		20
Bore	in	5.71
Stroke	in	7.28
Piston displacement	cu.in	3,728
Nominal speed	rpm	1,800
Mean piston speed	in/s	437
Length	in	148
Width	in	62
Height	in	80
Weight dry	lbs	15,873
Weight filled	lbs	17,417
Moment of inertia	lbs-ft <sup>2</sup>	276.26
Direction of rotation (from flywheel view)		left
Radio interference level to VDE 0875		N
Starter motor output	kW	13
Starter motor voltage	V	24

### Thermal energy balance (H2 Blend | LFG)

Power input	MBTU/hr	9,835   11,923
Intercooler	MBTU/hr	825   1,068
Lube oil	MBTU/hr	705   833
Jacket water	MBTU/hr	1,123   1,339
Exhaust gas cooled to 356 °F	MBTU/hr	2,001   2,263
Exhaust gas cooled to 212 °F	MBTU/hr	2,507   2,907
Surface heat	MBTU/hr	240   235

### Exhaust gas data on H2 Blend

Exhaust gas temperature at (100% / 75% / 50%) load	[8]	°F	1,006 / 1,039 / 1,070
Exhaust gas mass flow rate, wet		lbs/hr	13,698 / 11,245 / 8,834
Exhaust gas mass flow rate, dry		lbs/hr	12,773 / 10,476 / 8,222
Exhaust gas volume, wet		SCFH	169,881 / 139,462 / 109,563
Exhaust gas volume, dry		SCFH	151,442 / 124,140 / 97,354
Max.admissible exhaust back pressure after engine		psi	0.870

### Combustion air data on H2 Blend

Combustion air mass flow rate		lbs/hr	12,384 / 10,153 / 7,964
Combustion air volume		SCFM	2,558 / 2,097 / 1,645
Max. admissible pressure drop at air-intake filter		psi	0.145

base for exhaust gas data: natural gas: 100% CH<sub>4</sub>; biogas 65% CH<sub>4</sub>, 35% CO<sub>2</sub>

## Exhaust gas data on LFG

Exhaust gas temperature at (100% / 75% / 50%) load	[8]	°F	913 / 970 / 1024
Exhaust gas mass flow rate, wet		lbs/hr	17,379 / 13,227 / 9,053
Exhaust gas mass flow rate, dry		lbs/hr	16,176 / 12,286 / 8,386
Exhaust gas volume, wet		SCFH	216,271 / 164,624 / 112,695
Exhaust gas volume, dry		SCFH	192,301 / 145,864 / 99,403
Max.admissible exhaust back pressure after engine		psi	0.870

## Combustion air data on LFG

Combustion air mass flow rate		lbs/hr	15,690 / 11,905 / 8,117
Combustion air volume		SCFM	3,241 / 2,459 / 1,677
Max. admissible pressure drop at air-intake filter		psi	0.145

**base for exhaust gas data: natural gas: 100% CH<sub>4</sub>; biogas 65% CH<sub>4</sub>, 35% CO<sub>2</sub>**

## Sound pressure level

Aggregate a)		dB(A) re 20μPa	100
31,5	Hz	dB	82
63	Hz	dB	90
125	Hz	dB	101
250	Hz	dB	98
500	Hz	dB	94
1000	Hz	dB	89
2000	Hz	dB	91
4000	Hz	dB	95
8000	Hz	dB	92
Exhaust gas b)		dB(A) re 20μPa	115
31,5	Hz	dB	95
63	Hz	dB	117
125	Hz	dB	115
250	Hz	dB	113
500	Hz	dB	108
1000	Hz	dB	105
2000	Hz	dB	108
4000	Hz	dB	109
8000	Hz	dB	107

## Sound power level

Aggregate	dB(A) re 1pW	120
Measurement surface	ft <sup>2</sup>	1,184
Exhaust gas	dB(A) re 1pW	123
Measurement surface	ft <sup>2</sup>	67.60

a) average sound pressure level on measurement surface in a distance of 3.28ft (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 3.28ft according to DIN 45635 and ISO 3744, precision class 2.

The spectra are valid for aggregates up to bmep=232.060384 psi. (for higher bmep add safety margin of 1dB to all values per increase of 15 PSI pressure).

Engine tolerance ± 3 dB

## \*0.03 Technical data of generator

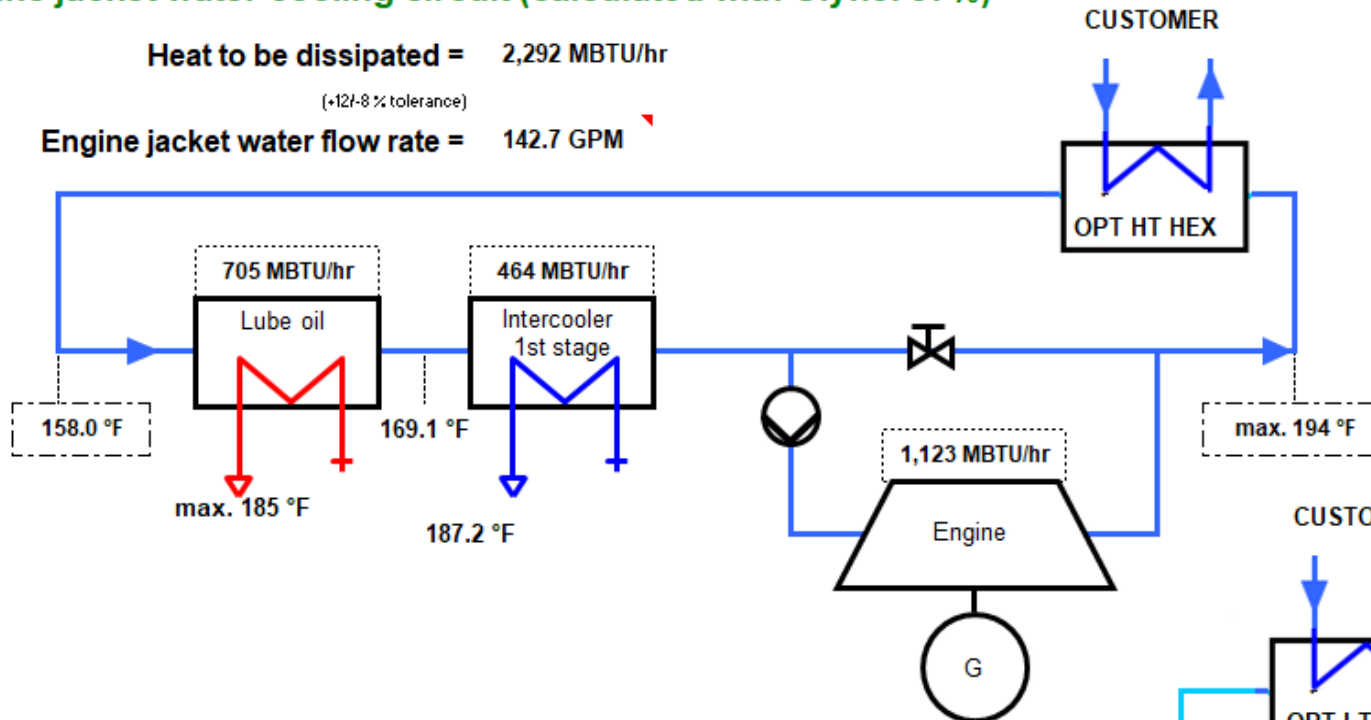
Manufacturer		STAMFORD e)
Type		S7L1D-F4 e)
Type rating	kVA	2,112
Driving power	bhp	1,598   1,966
Ratings at p.f.= 1.0	kW	1,159   1,427
Ratings at p.f. = 0.8	kW	1,150   1,416
Rated output at p.f. = 0.8	kVA	1,437   1,770
Rated reactive power at p.f. = 0.8	kVAr	862   1,062
Rated current at p.f. = 0.8	A	1,729   2,129
Frequency	Hz	60
Voltage	V	480
Speed	rpm	1,800
Permissible overspeed	rpm	2,250
Power factor (lagging - leading) (UN)		0,8 - 1,0
Efficiency at p.f.= 1.0		97.3%
Efficiency at p.f. = 0.8		96.5%
Moment of inertia	lbs-ft <sup>2</sup>	951.26
Mass	lbs	7,196
Radio interference level to EN 55011 Class A (EN 61000-6-4)		N
Cable outlet		Left
I <sub>k</sub> " Initial symmetrical short-circuit current	kA	20.03
I <sub>s</sub> Peak current	kA	50.99
Insulation class		H
Temperature rise (at driving power)		F
Maximum ambient temperature	°F	104

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

x <sub>d</sub> direct axis synchronous reactance	p.u.	1.615   1.937
x <sub>d</sub> ' direct axis transient reactance	p.u.	0.120   0.148
x <sub>d</sub> " direct axis sub transient reactance	p.u.	0.085   0.105
x <sub>2</sub> negative sequence reactance	p.u.	0.102   0.126
T <sub>d</sub> " sub transient reactance time constant	ms	20
T <sub>a</sub> Time constant direct-current	ms	30
T <sub>do</sub> ' open circuit field time constant	s	4.29

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.

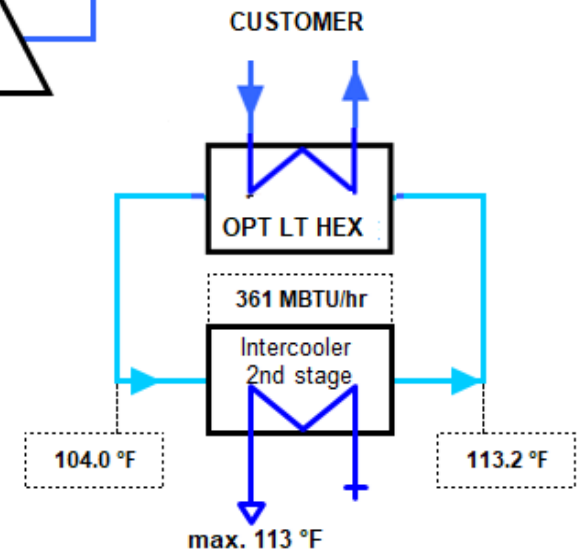
### Engine jacket water cooling circuit (calculated with Glykol 37%)



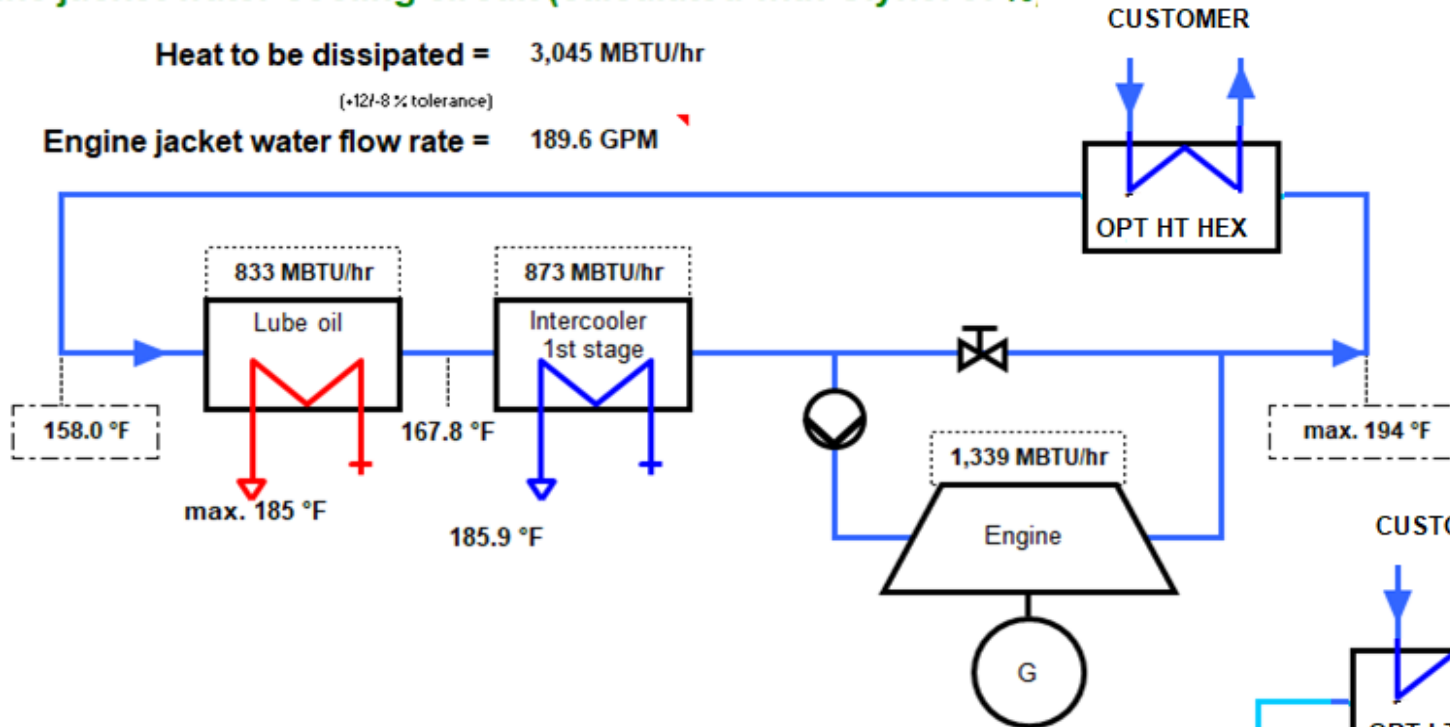
### Low Temperature circuit (calculated with Glykol 37%)

Heat to be dissipated = 361 MBTU/hr  
(+12/-8 % tolerance)

Cooling water flow rate = 88.1 GPM



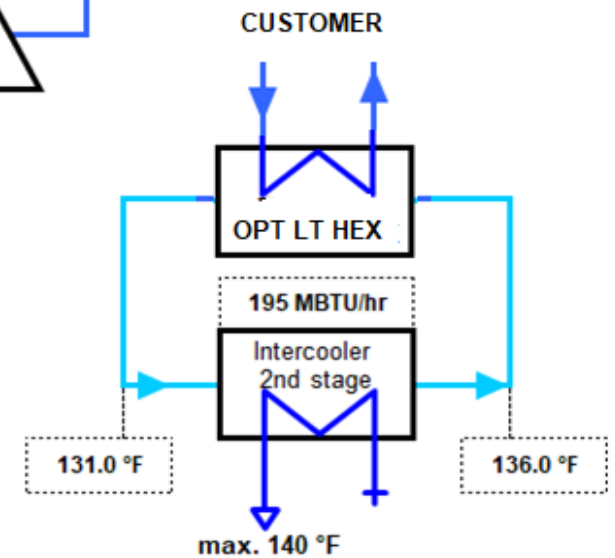
### Engine jacket water cooling circuit (calculated with Glykol 37%)



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

Heat to be dissipated = 195 MBTU/hr  
(+12/-8 % tolerance)

Cooling water flow rate = 88.1 GPM



## 0.05 Cooling water circuit

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

Nominal output	MBTU/hr	705   833
Max. Oil temperature	°F	185
Loss of nominal pressure of engine jacket water	psi	7.25
Safety valve - max press. set point	psi	36.26

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

Nominal output	MBTU/hr	1,123   1,339
Max. engine jacket water temperature (outlet engine)	°F	194
Engine jacket water flow rate	GPM	142.7
Safety valve - max press. set point	psi	36.26

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

Nominal output	MBTU/hr	464   873
Max. inlet cooling water temp. (intercooler)	°F	169.1
Design pressure of cooling water / (max. operating pressure)	lbs	145
Loss of nominal pressure of engine jacket water	psi	4.35
Safety valve - max press. set point	psi	36.26

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

Nominal output	MBTU/hr	361   195
Max. inlet cooling water temp. (intercooler)	°F	104   131
Aftercooler water flow rate	GPM	88.1
Design pressure of cooling water / (max. operating pressure)	lbs	145
Intercooler water pressure drop	psi	11.60
Safety valve - max press. set point	psi	36.26

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

The following “Technical Instruction (TA) of JENBACHER” form an integral part of the contract and must be strictly observed:

**TA 1000-0004 - Preservation of Jenbacher modules**

**TA 1100-0110 – Boundary Conditions for Jenbacher Gas Engines**

**TA 1100-0111 – General Conditions – Operation and Maintenance**

**TA 1100-0112 – Installation of Jenbacher Units**

These Technical Instructions reference other guides and instructions which can be provided upon request. These instructions should be carefully reviewed by all personnel involved with the application, installation design, installation construction, and overall maintenance of any Jenbacher gas engine.

All data in the technical specification are based on engine full load (unless stated otherwise) at specified temperatures as well as the methane number and subject to technical development and modifications. For isolated operation an output reduction may apply according to the block load diagram. Before being able to provide exact output numbers, a detailed site load profile needs to be provided (motor starting curves, etc.).

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

[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 optimized operating mode to minimize 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] Intercooler heat on:

\* **standard conditions** - If the turbocharger design is done for air intake temperature > 86°F w/o de-rating, the intercooler heat of the 1st stage need to be increased by 2%/K starting from 77°F. Deviations between 77 – 86°F will be covered with the standard tolerance.

\* **Hot Country application (V1xx)** - If the turbocharger design is done for air intake temperature > 104°F w/o de-rating, the intercooler heat of the 1st stage need to be increased by 2%/K starting from 95°F. Deviations between 95 – 104°F will be covered with the standard tolerance.

## 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: 14.5 psi (1000 mbar) or 328 ft (100 m) above sea level

Air temperature: 77°F (25°C) or 298 K

Relative humidity: 30 %

- Volume values at standard conditions (fuel gas, combustion air, exhaust gas)

Pressure: 1 atmosphere (1013.25 mbar)

Temperature: 32°F (0°C)

## 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.

H<sub>2</sub> 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-H<sub>2</sub> mixture according to the specification. For reliable compliance with required NO<sub>x</sub> emissions, the JENBACHER LEANOX<sup>plus</sup> control is recommended (measurement of NO<sub>x</sub> emissions and correction of the LEANOX controller). Higher H<sub>2</sub> addition rates into the natural gas network must be assessed on a project-specific basis.

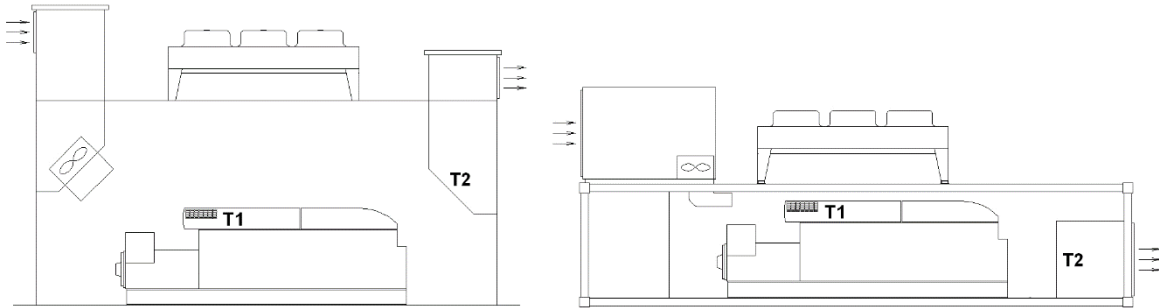
### b) Performance reduction due to voltage and frequency limits

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

The ratings in the specification are valid for full load operation at a site installation of 46 ft (14 m) and an air intake temperature of T<sub>1</sub> < 95F (35 C). At T<sub>1</sub> > 95F (35C), an output derating of 0.67%/F (1.2%/C) will occur up to an air intake temperature of T<sub>1</sub> < 104F (40 C). At T<sub>1</sub> > 104F (40 C), and output derating of (1.11%/F) (2.0%/C) will occur.

Engine room outlet temperature: **122°F (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  $C_{min}= 50h^{-1}$  for JENBACHER modules.

### Parameters for the operation of JENBACHER gas engines

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

The following "Technical Instruction of JENBACHER" 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.

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

Relative humidity 50% by maximum temperature of 104°F.

Altitude up to 2000m above the sea level.

### Parameters for using a gas compressor

The gas quantity indicated under the technical data refers to standard conditions with the given calorific value. The actual volume flow (under operating conditions) has to be considered for dimensioning the gas compressor and each gas feeding component – it will be affected by:

- Actual gas temperature (limiting temperature according to TA 1000-0300)
- Gas humidity (limiting value according to TA 1000-0300)
- Gas Pressure
- Calorific value variations (can be equated with methane (CH<sub>4</sub>) variations in the case of biogas)
- The gas compressor is designed for a max. relative under pressure of 15 mbar(g) (0.22 psi) and a inlet temperature of 40°C (104°F) , if within scope of supply JENBACHER.

## 0.20 Mode of Operation

### Grid Parallel Mode

The genset is running in parallel to the utility. The unit load can be adjusted via its power control set point or designated option.

Procedure in the event of mains failure:

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 generator breaker. The module is shut down without any cool-down run.

Island operation is not available in this case!

The module can be restarted following the restoration of mains power after a 5-minute mains stabilization period.

## 0.30 General information for connection to the public mains

Technical Instruction TA 1530-0188 describes the - possibly optional - functions and parameters for complying with the boundary conditions defined in the country-specific "Grid Codes".

**Network operator-dependent requirements must always be coordinated with JENBACHER.**

### 0.30.10 Generator operating range in mains parallel operation

#### Frequency:

Normal operation  $f_n \pm 2\%$  - without power output reduction

Extended operation:  $f_n \pm 4\text{--}6\%$  - with power output reduction between 2 – 10%/Hz

Frequency-measurement resolution:  $\leq 10\text{mHz}$  (resolution)

Generator - voltage range:  $\pm 10\%$  of generator  $U_n$

Generator power factor  $\cos \phi$  at the generator terminals: as specified in "0.03 Generator technical data"

FRT (Fault Ride Through) – capability: at mains connection point

Profile 1: 150ms/30% $U_n$  (applies to natural gas and biogas)

Profile 2 (150ms/5% $U_n$ ) and Profile 3 (250ms/5% $U_n$ ) upon request.

#### Requirement:

- mains short-circuit power must be at least 5 x  $S_{rE}$  or 50MVA
- FRT capability of the onsite auxiliaries

**Extended project requirements and country-specific design are optionally possible after consultation and approval with JENBACHER.**

### 0.30.20 Possible mains operator requests

To protect the generating unit in mains parallel operation, appropriate mains protection monitoring functions are necessary to disconnect the generator from the mains in case of a mains fault.

The mains operator-dependent specifications such as e.g.: voltage and frequency range, active power limitation, load ramps, reactive power limitation and control, protection concept, necessary certification or declarations, process data and interfaces are to be specified in project enquiries and must be agreed with JENBACHER before conclusion of the contract.

- The mains operator questionnaire must be sent to JENBACHER. Check at what time the document must be available! On conclusion of the contract. Requirements must be clear!
- Project-specific requirements of the mains operator to be checked for feasibility
- Required verifications, confirmations and declarations of conformity: on-site by the system operator
- Selectivity assessment, protection tests and recurring tests: on-site by the system operator
- Control power provision via pool operator: on request e.g. primary, secondary, tertiary
- Black start capability and countering in own use: on request
- Power generation system (EZA) controller or central control: on-site or possible on request
- Process data scope / remote control:
  - System data must be provided by the connectee for the mains operator.
  - Remote control interface to the mains operator: on-site
  - Interface specification!

Billing measurements - installation, operation, maintenance and remote data transmission: on-site.

Models of genset and generator: simplified models executed as effective value models for mains parallel operation optionally available.

Model formats: Powerfactory, or PSS/E (as of PP23)

Validated genset models in Powerfactory according to FGW TR3, TR4 and TR8 by a body accredited for this purpose according to DIN EN ISO/IEC 17065

#### **Functional scope of the models in mains parallel operation:**

- static voltage stability
- dynamic mains support
- Provision of reactive power
- Behaviour at active power setpoint
- Active power adjustment in the event of overfrequency and underfrequency (LFSM-O, LFSM-U)
- Protective devices and settings

## **0.30.20.01 Active power adjustment in the event of overfrequency and underfrequency**

#### **The following functions are available:**

- LFSM-U: Limited Frequency Sensitive Mode - Underfrequency
- LFSM-O: Limited Frequency Sensitive Mode - Overfrequency
- FSM

#### **Reduced power output at overfrequency: (LFSM-O function)**

The frequency threshold is freely adjustable from  $f_n + (200 - 500\text{MHz})$  and the static from 2% to 12%. Unless the relevant mains operator specifies otherwise for the LFSM-O mode, a threshold of  $f_n + 200\text{MHz}$  and a static of 5% is set.

## **Power increase in the event of underfrequency (LFSM-U function) – (OPTIONAL as of XT4.5)**

activated according to the mains operator's specifications

The frequency-sensitive active power feed-in has the effect that the generating plant also moves permanently up and down on the frequency characteristic curve ("driving on the characteristic curve") in the frequency range between  $f_n - 200\text{MHz}$  (unless otherwise specified by the mains) and  $f_n - 2.5\text{Hz}$  with regard to its maximum possible active power feed-in.

The prerequisite for this is a corresponding power setpoint.

## **Reduced power output at underfrequency:**

below 98% of  $f_n$ , reduction by standard 10% of maximum capacity per Hz. Reduction up to maximum  $f_n - 6\%$ .

Lower reduction ramps of 2 - 10%/Hz on request

The FSM function is available as an option

The power generation system is capable of continuing to operate at this minimum power when the minimum power for controllable operation is reached.

## **1.00 Scope of supply - Module**

### **Design:**

The module is built as a compact package. The engine and generator are mounted on a common base when a low voltage generator is specified ( $<1000\text{ V}$ ). In case of a medium voltage generator the engine base is bolted to the generator base.

The Engine output shafting is connected through a coupling to the generator. To provide the best possible isolation from the transmission of vibrations, the engine rests on the engine base-frame by means of anti-vibration mounts. The remaining vibrations are eliminated by mounting the complete module on isolating

pads (e.g. Sylomer). This, in principle, allows for placing of the module to be 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 of light metal alloy (Two-part steel piston), 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: sputter 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 and valve guides and spark plug sleeves individually replaceable; exhaust and inlet valve 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 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:** Automatically, cylinder selective registration and control of the current needed ignition voltage.

## **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

## **1.01.03 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.

### **1.02 Generator-Low Voltage**

The 2 bearing generator consists of the main generator (built as rotating field machine), the exciter machine (built as rotating armature machine) and the digital excitation system.

The digital regulator is powered by an auxiliary winding at the main stator or a PMG system

#### **Main components**

- Enclosure of welded steel construction
- Stator core consist of thin insulated electrical sheet metal with integrated cooling channels.
- Stator winding with 2/3 Pitch
- Rotor consists of shaft with shrunken laminated poles, Exciter rotor, PMG (depending on Type) and fan.
- Damper cage
- Excitation unit with rotating rectifier diodes and overvoltage protection
- Dynamically balanced as per ISO 1940, Balance quality G2,5
- Drive end bracket with re-greaseable antifriction bearing
- Non-drive end bracket with re grease antifriction bearing
- Cooling IC01 - open ventilated, air entry at non-drive end, air outlet at the drive end side
- Main terminal box includes main terminals for power cables
- Regulator terminal box with auxiliary terminals for thermistor connection and regulator.
- Anti-condensation heater
- 3 PT100 for winding temperature monitoring+3 PT100 Spare
- 2 PT100 for bearing temperature monitoring

Option:

Current transformer for protection and measuring in the star point

xx/1A, 5P10 15VA, xx/1A, 1FS5, 15VA

## Electrical data and features

- Standards: IEC 60034, EN 60034, ISO 8528-3, ISO 8528-9
- Voltage adjustment range: +/- 10 % of rated voltage (continuous)
- Frequency: -6/+4% of rated frequency
- Overload capacity: 10% for one hour within 6 hours, 50% for 30 seconds
- Asymmetric load: max. 8% I<sub>2</sub> continuous, in case of fault I<sub>2</sub> x t=20
- Altitude: < 1000m
- Max permitted generator intake air temperature: 5°C - 40°C
- Max. relative air humidity: 90%
- Voltage curve THD Ph-Ph: <3,5% at idle operation and <5% at full load operation with linear symmetrical load
- Generator suitable for parallel operating with the grid and other generators
- Sustained short circuit current at 3-pole terminal short circuit: minimum 3 times rated current for 5 seconds.
- Over speed test with 1.2 times of rated speed for 2 minutes according to IEC 60034

## Digital Excitation system ABB Unitrol 1010 mounted within the AVR Terminal box with following features:

- Compact and robust Digital Excitation system for Continuous output current up to 10 A (20A Overload current 10s)
- Fast AVR response combined with high excitation voltage improves the transient stability during LVRT events.
- The system has free configurable measurement and analog or digital I/Os. The configuration is done via the local human machine interface or CMT1000
- Power Terminals
  - 3 phase excitation power input from PMG or auxiliary windings
  - Auxiliary power input 24VDC
- Excitation output
- Measurement terminals: 3 phase machine voltage, 1 phase network voltage, 1 phase machine current
- Analog I/Os: 2 outputs / 3 inputs (configurable), +10 V / -10 V
- Digital I/O: 4 inputs only (configurable), 8 inputs / outputs (configurable)
- Serial fieldbus: RS485 for Modbus RTU or VDC (Reactive power load sharing for up to 31 JENBACHER engines in island operation), CAN-Bus for dual channel communication
- Regulator Control modes: Bump less transfer between all modes
  - Automatic Voltage Regulator (AVR) accuracy 0,1% at 25°C ambient temperature
  - Field Current Regulator (FCR)
  - Power Factor Regulator (PF)
  - Reactive Power Regulator (VAR)
- Limiters: Keeping synchronous machines in a safe and stable operation area
  - Excitation current limiter (UEL min / OEL max)
  - PQ minimum limiter
  - Machine current limiter
  - V / Hz limiter
  - Machine voltage limiter
- Voltage matching during synchronization
- Rotating diode monitoring

- Dual channel / monitoring: Enables the dual channel operation based on self-diagnostics and setpoint follow up over CAN communication. As Option available
- Power System Stabilizer (PSS) is available as option. Compliant with the standard IEEE 421.5-2005 2A / 2B, the PSS improves the stability of the generator over the highest possible operation range.
- Computer representation for power system stability studies: ABB 3BHS354059 E01
- Certifications: CE, cUL certification according UL 508c (compliant with CSA), DNV Class B,
- **Commissioning and maintenance Tool CMT1000** (for trained commissioning/ maintenance personal)
- With this tool the technician can setup all parameters and tune the PID to guarantee stable operation. The CMT1000 software allows an extensive supervision of the system, which helps the user to identify and locate problems during commissioning on site. The CMT1000 is connected to the target over USB or Ethernet port, where Ethernet connection allows remote access over 100 m.
- Main window
  - Indication of access mode and device information.
  - Change of parameter is only possible in CONTROL access mode.
  - LED symbol indicates that all parameter are stored on none volatile memory.
- Setpoint adjust window
  - Overview of all control modes, generator status, active limiters status and alarms.
  - Adjust set point and apply steps for tuning of the PID.
- Oscilloscope
- 4 signals can be selected out of 20 recorded channels. The time resolution is 50ms. Save files to your PC for further investigation.
- Measurement
  - All measurements on one screen.

## Routine Test

Following routine tests will be carried out by the generator manufacturer

- Measuring of the DC-resistance of stator and rotor windings
- Check of the function of the fitted components (e.g. RTDs, space heater etc.)
- Insulation resistance of the following components
  - Stator winding, rotor winding
  - Stator winding RTDs
  - Bearing RTDs
  - Space heater
- No Load saturation characteristic (remanent voltage)
- Stator voltage unbalance
- Direction of rotation, phase sequence
- High voltage test of the stator windings ( $2 \times U_{nom} + 1000 \text{ V}$ ) and the rotor windings (min. 1500 V)

## 1.03 Module Accessories

### Base frame

Common Base Frame fabricated with welded structural steel. Frame to mount the engine, jacket water heat exchangers, pumps and engine auxiliaries, as well as generator.

### Coupling

Engine to Generator coupling is provided. The coupling isolates the major sub-harmonics of engine alternating torque from generator.

## **Coupling housing**

Provided for Coupling

## **Anti-vibration mounts**

2 sets of isolation, one is arranged between engine block assembly and base frame. The second is via insulating pads (SYLOMER) for placement between base frame and foundation, delivered loose.

## **Exhaust gas connection**

A flanged connection is provided that collects the exhaust gas turbocharger output flows, includes flexible pipe connections (compensators) to compensate for heat expansions and vibrations.

## **Combustion air filter**

A Dry type air filter with replaceable filter cartridges is fitted. The assembly includes flexible connections to the fuel mixer/carburetor and service indicator.

## **Interface panel (M1 cabinet)**

Totally enclosed sheet steel cubicle with hinged doors, pre-wired to terminals, ready to operate. All Cable entry will be via bottom mounted cable gland plates.

Painting: RAL 7035

Protection: External NEMA 3 (IP 54), Internal IP 20 (protection against direct contact with live parts)

Cabinet design is according to IEC 439-1 (EN 60 439-1/1990) and DIN VDE 0660 part 500, respectively. Ambient temperature 41 - 104 °F (5 - 40 °C), Relative humidity 70%

Dimensions:

- Height: 1200 mm (47 in)
- Width: 1200 mm (47 in)
- Depth: 400 mm (16 in)

Control Power Source: The starter batteries and the cabinet mounted battery chargers will provide the power source for this enclosure.

## **Interface Panel contents and control functions:**

- The cabinet houses the unit Battery Charger and primary 24VDC Control Power Distribution (breakers, fuses, and terminals) from the unit Batteries
- Distributed PLC Input and Output cards, located in the cabinet, gather all Engine and Generator Control I/O. These cards transmit data via data bus interface to the central engine control of the module control panel located in the A1 cabinet. Data bus is via CAN and B&R Proprietary Data Highway (Data Cables provided by JENBACHER)

- Speed monitoring relays for protection are provided.
- Gas Train I/O Collection, including interface relays and terminals for gas train shutoff valves.
- Transducer for generator functions, such as excitation voltage.
- Door Mounted Emergency Stop Switch with associated Emergency Stop Loop interface relays.
- Miscellaneous control relays, contacts, fuses, etc. for additional control valves, and auxiliaries.
- Interface Terminal Strips

Skid Mounted 3 Phase Devices are Powered by 3 x 480/277 V, 60 Hz, 50 A

AC Power for engine mounted auxiliaries (heater, pumps, etc.) are routed through a separate J-box mounted on the side M1 cabinet (Box E1). This is done to maintain signal segregation (AC from control)

**NOTE: Generator Current Transformer wiring is connected directly to the Generator and does NOT pass through the M1 cabinet.**

## 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
- Electrical jacket water pump, including check valve
- Jacket water preheat device

## 1.03.02 Automatic lube oil replenishing system incl. extension tank

### **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

## **Oil sump extension tank 79.3 gal**

To increase the time between oil changes

## **Pre-lubrication- and aftercooling oil pump:**

Mounted on the module base frame; it is used for pre-lubrication and aftercooling of the turbochargers.

Period of operation:      Pre-lubrication: 1 minute  
   Aftercooling: 15 minutes from engine stop

Consisting of:

- 1 piece oil pump 1500 W, 24 V
- All necessary vents
- Necessary pipework

## **1.03.04 SCR Catalytic converter**

## 1. Introduction

### 1.1. General

The development, production, engineering and sale of emission control systems is the core business of Hug Engineering AG. For more than 30 years, we realize standard solutions as well as customized solutions for diesel and gas engines in stationary and mobile applications.

### 1.2. Important project notes

#### 1.2.1 Exhaust gas temperature

The engine exhaust temperature at full load was indicated in your inquiry and is reported in this offer under section 2.3, however as gas engines usually have their highest exhaust gas temperature at a lower load it is recommended to check the actual operating load and relevant exhaust temperature profile before placing an order for any catalytic after treatment system.

The maximum allowed exhaust gas temperature for the catalysts is specified section 8.1.5.2  
The minimum catalyst temperature for the correct operation of the system is 270°C.

#### 1.2.2 Arrangement of catalyst, heat exchanger and further equipment along the exhaust piping.

The catalytic system must be the first piece of equipment along the exhaust line, so immediately downstream the engine outlet. Any other equipment such as economizers, scrubbers, mufflers or similar must be installed downstream the catalytic system.

#### 1.2.3 Thermal expansion

The housing of the catalyst and the connected exhaust tubes must be placed and fixed with enough free movement to allow for thermal expansion. During the project execution phase Hug Engineering will provide engineering instructions for the proper installation of its equipment.

#### 1.2.4 Temperature tolerance

Please refer to product specification sheets for standard temperature tolerances. Unless otherwise specified, measures to winterize and/or cooler systems are not included. These can be added with price addition. If ammonia water is being used, all component dealing with ammonia water must be protected from direct sunlight to avoid gasification of the liquid. Minimum temperature for these components is 0°C

## 2. Project - data

### 2.1. Project specific

1. The offer is based on engine technical data and reduction requirements per customer's provision.

### 2.2. Source of exhaust gas

Engine Quantity Power Output @ 100% load Fuel Pollutants in Fuel	Jenbacher JGC420 B823 3 Units 1966 bhp/1598 bhp Landfill gas/Blended Gas In acc. to C.00374
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### 2.3. Raw gas emissions

#### 2.3.1 The design and performance guarantee of this offer relies on the following exhaust gas data.

		Blended Gas	Landfill Gas
Exhaust gas temperature	@ 100% load	977* °F (525 °C)	977* °F (525 °C)
Mass flow rate	@ 100% load	13,698 lb/hr (wet)	17,379 lb/hr (wet)
Residual oxygen in exhaust	@ 100% load	7.8 %	8.1 %
NOx Nitrogen oxides (as NO <sub>2</sub> )	@ 100% load	1.10 grams/bhp-hr	1.10 grams/bhp-hr
CO	@ 100% load	293 ppm (0.329 g/bhp-hr)	10 ppm (0.014 g/bhp-hr)

\* It is recommended that maximum, continuous exhaust temperatures be kept below 977 °F at all loads. See section 8.1.5.2 of the warranty for guidance.

### 2.4. Performance guarantee

#### 2.4.1 Guarantee period for catalytic performance

SCR running time	16,000 operating hours
or max. 24 months after the day the exhaust gas has passed through the catalyst for the first time (whichever occurs sooner) and/or max. 36 months after the delivery EXW of the equipment.	
The performance guaranty strictly follows our poison list C.00374.	

#### 2.4.2 Catalytic performance during guaranteed period

Pollutants measured downstream the catalytic system @ 100% load:

NOx Nitrogen oxides (as NO <sub>2</sub> )	< 0.15 g/bhp-hr
CO	< 0.89 g/bhp-hr
VOC	unknown

\* CO reduction not required based on baseline estimates.

\* Oxidation layer included. VOC reduction unknown. Contingent upon determination of incoming VOC's.

### 2.5. Design parameter

#### 2.5.1 Designed pressure drop

ΔP	measured across the catalytic system at commissioning (at new and clean condition)	Blended Gas ≤ 19.5 mbar	Landfill Gas ≤ 24.8 mbar
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## 4. Exhaust Purification System

### 4.1. CombiKat™ exhaust gas purification system

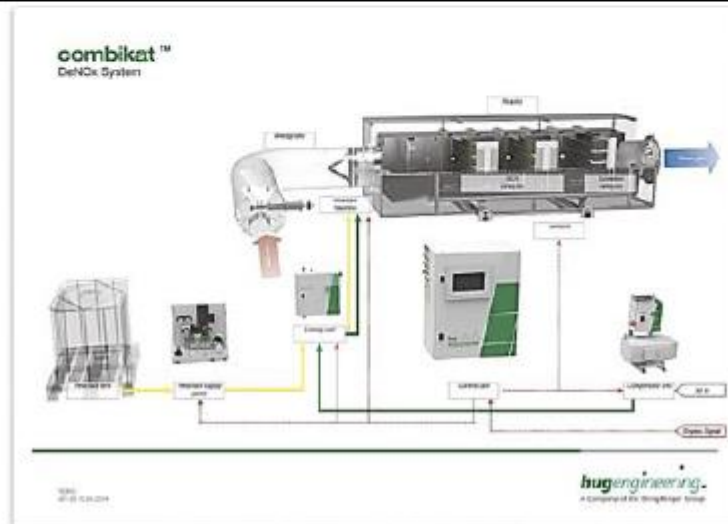
CombiKat™ is an integrated system for the catalytic abatement of polluting emissions released by endothermic engines running on every type of gaseous and liquid fuels.

Following the concept of modular design of the catalytic elements and the proper urea dosing technology, available both in open loop and as feed-back loop controlled by the measured emissions after the catalyst, CombiKat is capable to reduce emissions down to level compliant with the strictest regulations worldwide.

CombiKat applications are reliably running at single digit concentrations of NO<sub>x</sub>, NH<sub>3</sub> and CO as for instance in the demanding field of CO<sub>2</sub> fertilization of greenhouses using the trade name of CodiNO<sub>x</sub>™.

Every CombiKat element is designed and manufactured in order to secure simple installation, trouble-free operation and minimal maintenance, consequently each single component is pre-assembled, cabled and tested in house during the pre-commissioning phase set as standard procedure in Hug's quality policy.

The following scheme effectively portrays the simplicity and linearity of the CombiKat architecture.

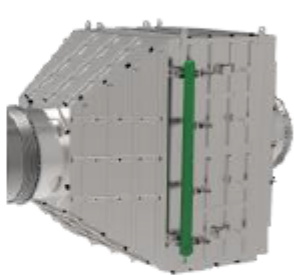


## 4.2. Project Component List


Bid	Option Bid		
Equipment	Type	Total # Project Combined Components	Datasheet
SCR/OXI Reactor Housing	EMH42.90 ss	3	
SCR Catalysts	RFV D4	84 x 3 = 252	
OXI Catalysts	OCT I5	42 x 3 = 126	
Urea Injection Piping	ES500 - 19.7" dia. x 7'3"	3	C.02056
- Injection port	E265	3	
- Dosing Mixer	DM500	3	
- Mixer	M500	6	
- Bypass Probe	NP400	3	
Controller SNQ (Closed Loop)	SNQ200 w/HMI Touch panel 12"	3	C.02253
- Sample Gas Lines	.02mg2	6	
- router/local network	.gat1	3	
- Air condition unit	.02acu	3	
Dosing Box SEV	SEV006	3	C.02150
Reactant Injector	DEN20	3	C.01016
Air Compressor	CA20	3	C.00986
Reactant Supply Pump	VNR095	1	C.02184
Pulsation Damper	PD0.14.02	1	
Sampling Probe	LS400.02	6	C.00983
Temperature Sensor	TEA330	3	C.00981
Differential Pressure Sensor	PEA100.03	3	C.01290
Hug Connect	SIM-card	1	
Packing for shipment		Included	
Technical documentation	As electronic file	included	

## 4.3. Converter CombiKat® EMH120.90.50.50




<b>Inlet</b>	axial, Ø800x4mm		
<b>Outlet</b>	axial, Ø800x4mm		
<b>Access</b>	from top		
<b>Material</b>	16Mo3		
<b>Insulation</b>	No		
<b>Flange</b>	Standard		
<b>Connections</b>	4 measuring ports 1/2" at in- and outlet pipes, one measuring port per service access door		
<b>Pressure</b>	max 200 mbar		
<b>Configuration:</b>			
Layer	1	SCR	300 mm
Layer	2	SCR	300 mm
Layer	3	OXI	100 mm
<i>Note: converter to be delivered empty – catalyst will be installed during commissioning</i>			
<i>Welding universal tolerance EN ISO 13920-BF</i>			
<i>Weld quality EN ISO 5817-C</i>			
<i>General tolerances ISO 2768-mK</i>			
<i>Image may vary from final product</i>			
<b>Project-remark:</b> Assembly contains all, gaskets, supports sheets for the entire catalyst installation.			




## 4.4. CombiKat™ mixing pipe

<p><i>Straight mixing pipe for Urea injection, hydrolysis and mixing.</i></p> <p><i>Hug Engineering's scope of supply includes the mixer's internal elements such as injection port, dosing mixer and static mixers. Piping and construction work not included.</i></p> <p><i>Certain dimensions on the drawing are the minimal required, longer lengths are acceptable. Piping between the dosing mixer and static mixer must be straight, downstream the first static mixer piping can be curved if needed.</i></p>		
1x	<p><b>Dosing – Mixer DM</b></p> <p>Material      DIN 1.4301</p> <p>Diameter      ∅     500   mm</p> <p>Max-temp      550   °C</p> <p>Weight         5     kg</p>	
1x	<p><b>Mixer M</b></p> <p>Material      DIN 1.4301</p> <p>Diameter      ∅     500   mm</p> <p>Max-temp      550   °C</p> <p>Weight         5     kg</p>	
1x	<p><b>Injector port – E</b></p> <p>Material      DIN 1.4301</p> <p>Length         265   mm</p> <p>Max-temp      550   °C</p> <p>Weight         3     kg</p>	
<p><i>Project-remark:</i>  <i>in case of a bend upstream of the mixing-sections baffle-plates to be to be installed inside the bend (according to HUG-guidance)</i></p>		


## 4.5. CombiKat™ control system

<p><b>Reactant dosing unit SNQ</b> Control system closed loop</p> <p><i>Pre-commissioned control cubicle including all governing functions for:</i></p> <ul style="list-style-type: none"> <li>• urea dosing</li> <li>• temperature and pressure drop monitoring</li> <li>• bi-phase injector and driver</li> <li>• compressed air system</li> <li>• Automation safety chain management</li> <li>• bypass valves with control mechanism (option)</li> <li>• dust-blowing control system (option)</li> </ul> <p><i>Material</i>                      <i>Steel 1.0037 powder coated RAL 7035, structured</i></p> <p><i>Weight</i>                         <i>60 kg</i></p> <p><i>Dimensions</i>                 <i>600x760x250mm</i> <i>WxHxD</i></p> <p><i>Power supply</i>                <i>230V 50/60Hz</i> <i>Protection</i>                    <i>IP54</i> <i>Conformity</i>                   <i>CE-conformity</i></p> <p><i>Options:</i></p> <table border="0"> <tr> <td><i>Cable-labelling</i></td> <td><i>.lab</i></td> <td><i>included</i></td> </tr> <tr> <td><i>HMI touch-panel</i></td> <td><i>.ops</i></td> <td><i>included</i></td> </tr> <tr> <td><i>Gateway</i></td> <td><i>.gat</i></td> <td><i>included</i></td> </tr> <tr> <td><i>Modem for remote access</i></td> <td><i>.mod</i></td> <td><i>not included</i></td> </tr> <tr> <td><i>UL-conformity</i></td> <td><i>.UL</i></td> <td><i>included</i></td> </tr> <tr> <td><i>door-switch (CIP-Standard)</i></td> <td><i>.cdm</i></td> <td><i>not included</i></td> </tr> <tr> <td><i>key-lock (CIP-Standard)</i></td> <td><i>.key</i></td> <td><i>not included</i></td> </tr> <tr> <td><i>Air conditioning unit</i></td> <td><i>.acu</i></td> <td><i>included</i></td> </tr> <tr> <td><i>Sampling Gas Lines (2)</i></td> <td><i>.mg2</i></td> <td><i>included</i></td> </tr> </table> <p><i>For further details note datasheet C.02253</i></p>	<i>Cable-labelling</i>	<i>.lab</i>	<i>included</i>	<i>HMI touch-panel</i>	<i>.ops</i>	<i>included</i>	<i>Gateway</i>	<i>.gat</i>	<i>included</i>	<i>Modem for remote access</i>	<i>.mod</i>	<i>not included</i>	<i>UL-conformity</i>	<i>.UL</i>	<i>included</i>	<i>door-switch (CIP-Standard)</i>	<i>.cdm</i>	<i>not included</i>	<i>key-lock (CIP-Standard)</i>	<i>.key</i>	<i>not included</i>	<i>Air conditioning unit</i>	<i>.acu</i>	<i>included</i>	<i>Sampling Gas Lines (2)</i>	<i>.mg2</i>	<i>included</i>	 <p><i>Image may vary from final product</i></p>
<i>Cable-labelling</i>	<i>.lab</i>	<i>included</i>																										
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<i>Sampling Gas Lines (2)</i>	<i>.mg2</i>	<i>included</i>																										
<p><b>SCR dosing unit SEV006</b></p> <p><i>Cabinet including Urea flowmeter, dosing valve, intercepting and instrumentation equipment for automation safety chain, local gauges.</i></p> <p><b>1x</b></p> <p><i>Dimensions</i>                 <i>500x500x157mm</i></p> <p><i>Max-flow</i>                     <i>6 l/h</i></p> <p><i>For further details note datasheet C. 02150</i></p>	 <p><i>Image may vary from final product</i></p>																											
<p><b>Reactant injection unit DEN20.500.02</b> <i>Reactant injector ≤20l/h reactant</i></p> <p><b>1x</b></p> <p><i>Material</i>                        <i>Stainless steel 1.4307, 1.4435 or similar</i></p> <p><i>Max-flow</i>                     <i>20 l/h</i></p> <p><i>Temperature</i>                 <i>exhaust: ≤ +550°C</i> <i>media: -10...+55°C</i></p> <p><i>For further details note datasheet C.01016</i></p>	 <p><i>Image may vary from final product</i></p>																											

## 4.6. CombiKat™ reactant pump system

1x	<p>reactant supply pump. Pump can be supply 1:1 (one pump per dosing system) or up to 1:4 (one pump per 4x dosing-systems=</p> <ul style="list-style-type: none"> <li>• Centralized pump unit – to be activated by main Dosing-unit</li> <li>• Maximum flow 115 l/h</li> </ul>	
----	--	---

## 4.7. CombiKat™ Air-supply

<p><b>Option Air-Compressor</b></p> <p>Compressor unit with integrated Power-Supply-unit</p> <p><i>Material</i> Steel 1.0037 powder coated RAL 7035, structured</p> <p><i>Ambient temperature</i> 0...+40°C</p> <p><i>Protection</i> IP55</p> <p><i>Conformity</i> CE-conformity</p> <p><i>Weight</i></p> <table style="margin-left: 20px;"> <tr> <td>CA 20:</td> <td>20</td> <td>kg</td> </tr> <tr> <td>CA 75:</td> <td>38</td> <td>kg</td> </tr> <tr> <td>CA 115:</td> <td>46</td> <td>kg</td> </tr> </table> <p><i>Dimension: WxHxD</i></p> <table style="margin-left: 20px;"> <tr> <td>CA 250</td> <td>x</td> <td>680</td> <td>x</td> <td>400</td> <td>mm</td> </tr> <tr> <td>545</td> <td>x</td> <td>680</td> <td>x</td> <td>400</td> <td>mm</td> </tr> <tr> <td>625</td> <td>x</td> <td>680</td> <td>x</td> <td>400</td> <td>mm</td> </tr> </table> <p style="text-align: right;"><i>For further details note datasheet C. 00986</i></p>		CA 20:	20	kg	CA 75:	38	kg	CA 115:	46	kg	CA 250	x	680	x	400	mm	545	x	680	x	400	mm	625	x	680	x	400	mm	 <p style="text-align: center; font-size: small;">Image may vary from final product</p>
CA 20:	20	kg																											
CA 75:	38	kg																											
CA 115:	46	kg																											
CA 250	x	680	x	400	mm																								
545	x	680	x	400	mm																								
625	x	680	x	400	mm																								

## 4.8. Scope of supply per site (can be shared if more than 1 engine is present at one site) CombiKat™ Visualisation and communication

1x	<p><b>Touch screen HMI</b></p> <p>Operating panel to supervise and interact with the controllers SNV by setting the operating parameters of the SCR systems and pumping station.</p> <p>Visualization of all activities of the SCR system including:</p> <ul style="list-style-type: none"> <li>• Process variables (temperatures, pressure drop, flowrates, etc.)</li> <li>• Status of the equipment (pumps, valves, etc.)</li> <li>• Safety chain signals</li> <li>• Diagnostic indications</li> <li>• Alarms and alarms records</li> <li>• Trends and logbook</li> </ul>
1x	<p><b>Gateway (mounted into Main SCR-System – SNQ No1)</b></p> <p>For communication integration into customer-network per MOD-TCP</p> <p>Includes Hardware only - Software modification will be charged at actual costs according to section 7.2.1</p>

## 5. Documentation

Manual for erection, installation, commissioning and maintenance - in English language - as file	3 set
Interconnection diagrams (PFDs, P&Is, electric schemes, etc.) and datasheets - as file	3 set
Installation drawings (converter with weights, main equipment) - as file	3 set
Commissioning report - as file	3 set

## 6. Consumptions

### 6.1. Reactant consumptions

Urea 32.5 %, SOR at operating conditions acc. to 2.3

Expected Cons. @ 100% load	Blended Gas 3.4 l/h	Landfill Gas 4.0 l/h
Max. Cons. @ 100% load	4.4 l/h	5.2 l/h

Urea consumption might vary in case of different process conditions from those reported above.

### 6.2. Compressed air consumption for injecting

Number of injectors per system	1
Compressed air consumption per system (Continuously while engine is running)	8 Nm <sup>3</sup> /h / system is operated around 1bar, g
Max. consumption if the injection system is off. (During 15 min after the shutdown of engine)	10 Nm <sup>3</sup> /h

### Not included in the scope of supply:

- Tank farm for urea (exchangeable tanks are recommended)
- Commissioning by the supplier

### NOTE:

SCR inlet temperature must be limited to 977 F (525 C) for continuous operations to maximize life of the catalysts. Spikes of up to 550 C are allowed, but < 525 C is expected.

## 1.05.01 Gas train <500mbar (7.3 psi) (NPFA 37)

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

### Consisting of:

- Manual shut off valve
- Gas filter, filter fineness <3 µm
- Pressure gauge with push button valve
- Gas admission pressure regulator
- Solenoid valves
- Leakage detector
- Gas pressure switch (min.)
- TEC JET
- Gas flow meter (option)
- p/t compensation (option)

The gas train complies with DIN - DVGW regulations.

Maximum distance from TEC JET outlet to gas entry on engine, including flexible connections, is 39,37 in (1 m).

## 1.07 Painting

- Quality: Oil resistant prime layer  
Synthetic resin varnish finishing coat
- Color: 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: 91 in (including 8 in pedestal \*)
- Width: 32 -48 in \*
- Depth: 24 in \*

### Protection class:

- external IP42
- Internal IP 20 (protection against 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:

### Standard: 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.

### Option: TN-C (L1/2/3, PEN)

- 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: TT (L1/2/3, N)**

- Power supply via the module control cabinet via connection terminals or directly at the 4-pole mains disconnection unit. Protection against electric shock by automatic disconnection through integrated differential current monitoring (RCD) type A.
- Downstream outputs for auxiliary equipment with neutral conductors are fused using 2 or 4 poles.
- Additional protection for sockets with fault current breaker (RCD) type A, 30 mA
- Option:
  - When using frequency converters, an additional differential current monitoring device (RCD) type B is mounted.

**Option: IT (L1/2/3, N, PE)**

- Power supply via the module control cabinet via connection terminals or directly at the 4-pole mains disconnection unit. Protection against electric shock by automatic disconnection through integrated differential current monitoring (RCD) type A. Insulation monitoring is part of customer's scope of supply. Preparations have already been made for the transfer of error messages to the module control cabinet and alarm signaling via DIA.NE.
- Downstream outputs for auxiliary equipment with neutral conductors are fused using 2 or 4 poles.
- Additional protection for sockets with fault current breaker (RCD) type A, 30 mA
- Option:
  - When using frequency converters, an additional differential current monitoring device (RCD) type B is mounted.
- Option:
  - An insulation monitoring device connected to the auxiliary power supply with automatic disconnection in case of insulation faults. Alarm signaling via DIA.NE.
- Option:
  - Overvoltage protection for auxiliary equipment, protection module with integrated remote signaling.
  - SPD in conformity with EN 61643-11 type 2
  - Nominal voltage Un 230/400V

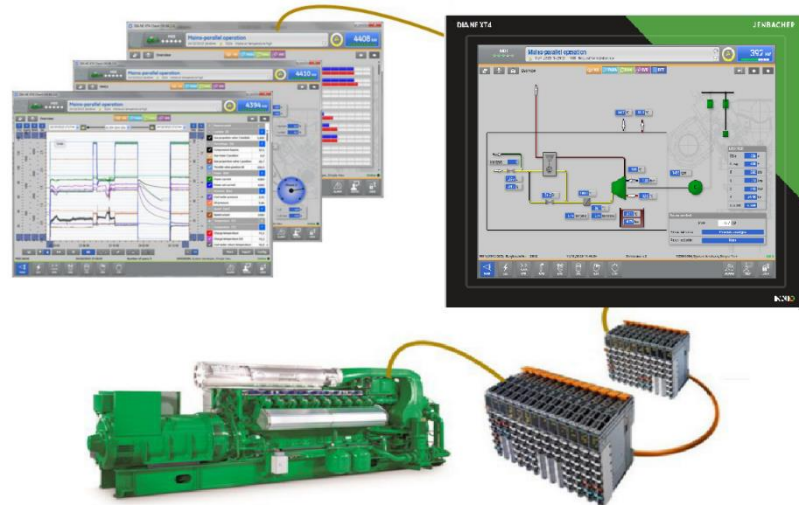
3 x **480/277 V**, **60 Hz**

**Consisting of:**

- Motor - Management - System DIA.NE

## Setup:

- a) Touch display visualization
- b) 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.

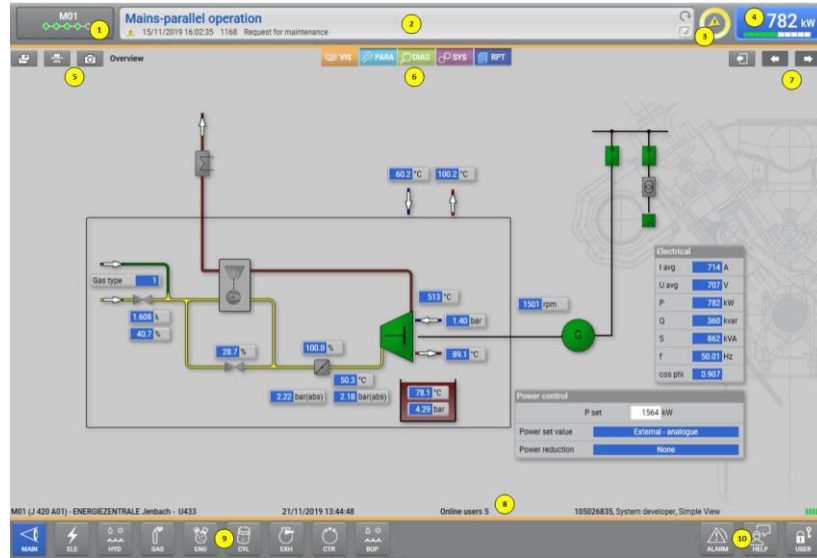
Operation is via the screen buttons on the touch screen

Numeric entries (set point values, parameters...) are entered on the touch numeric pad or via a scroll bar.

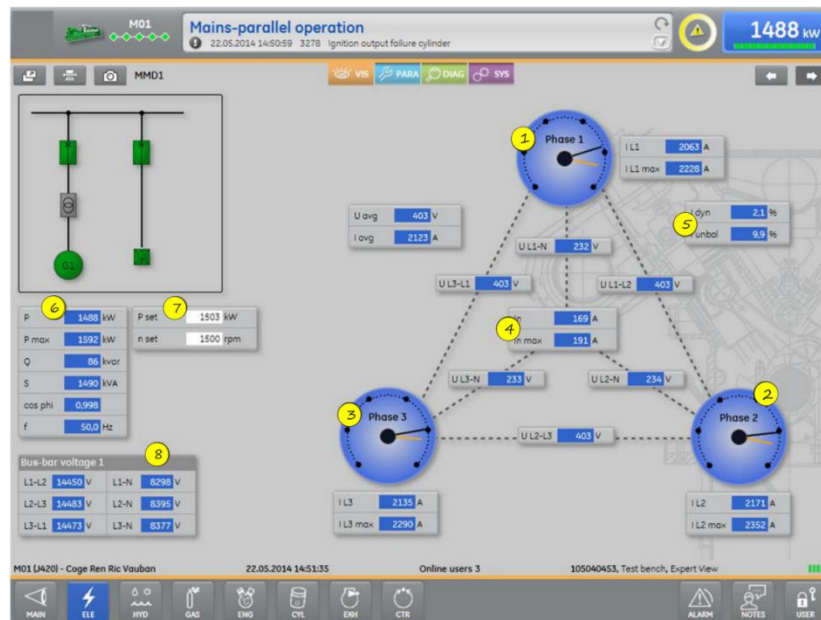
Determination of the operation mode and the method of synchronization via a permanently displayed button panel on the touch screen.

## Main screens (examples):

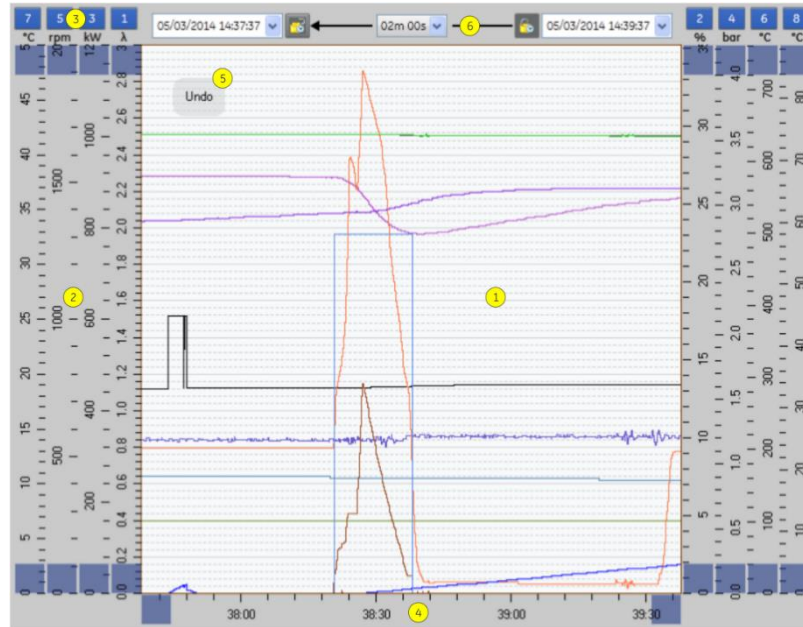
Main: Display of the overview, auxiliaries' status, engine start and operating data.



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: 3 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 (OPTION)

- MODBUS-RTU Slave
- MODBUS-TCP Slave,
- PROFIBUS-DP Slave (120 words),
- PROFIBUS-DP Slave (190 words),
- ProfiNet Slave
- OPC DA Server

## 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“)
- override external demand („ON“)

#### **Malfunction Notice list:**

##### **Shut down functions e.g.:**

- Low lube oil pressure
- Low lube oil level
- High lube oil level
- High lube oil temperature
- Low jacket water pressure
- High jacket water pressure
- High jacket water temperature
- Overspeed
- Emergency stop/safety loop
- Gas train failure
- Start failure
- Stop failure
- Engine start blocked
- Engine operation blocked
- Misfiring
- High mixture temperature
- Measuring signal failure
- Overload/output signal failure
- Generator overload/short circuit
- Generator over/undervoltage
- Generator over/underfrequency
- Generator asymmetric voltage
- Generator unbalanced load

- Generator reverse power
- High generator winding temperature
- Synchronizing failure
- Cylinder selective Knocking failure

## Warning functions e.g.:

- Cooling water temperature min.
- Cooling water pressure min.
- Generator winding temperature max.

## Remote signals:

(volt free contacts)

1NO = 1 normally open

1NC = 1 normally closed

1COC = 1 change over contact

- |   |     |
|---|-----|
| • 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 1 NO
- Generator circuit breaker OPEN 1 NO
- Generator circuit breaker READY TO CLOSE 1 NO
- Mains circuit breaker CLOSED 1 NO
- Mains circuit breaker OPEN 1 NO

Mains voltage 3 x **480/277V** or 3x 110V/v3 other measurement voltages available on requestBus bar voltage 3 x **480/277 V** or 3x 110V/v3 – other measurement voltages available on requestGenerator voltage 3 x **480 V** or 3x 110V/v3 – other measurement voltages available on request

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: 99ft

Maximum distance between module control panel and power panel: 164ft

Maximum distance between module control panel and master control panel: 164ft

Maximum distance between alternator and generator circuit breaker: 99ft

## 1.11.01 Remote messaging over MODBUS-TCP

Data transfer from the JENBACHER module control system to the customer's on-site central control system via MODBUS TCP using the ETHERNET 10 BASE-T/100BASE-TX protocol TCP/IP.

The JENBACHER module control system operates as a SLAVE unit.  
The data transfer via the customer's MASTER must be carried out in cycles.

### 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 supply:

RJ45 socket at the interface module in the module control cabinet

## 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.

### Option - Remote demand/blocking

If the service selectors switch at the module control panel is in position "Automatic" and the demand-selector switch in position "Remote", it is possible to enable (demanded) or disable (demand off) the module with a control button at the DIA.NE XT4 HMI

Note:

With this option, it makes no sense to have an additional clients demand (via hardware or data bus) or a self-guided operation (via JENBACHER master control, grid import /export etc.).

## Option - Remote - reset (see TA-No. 1100-0111 chapter 1.7 and 1.9)

### 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
<b>basic / advanced monitoring</b>			
Liver 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)		✓	✓
<b>increased productivity / strong performance</b>			
Recommended maintenance <sup>1</sup> (coming soon)	✓	✓	✓
Support case management <sup>1</sup>	✓	✓	✓
Predictive maintenance for spark plugs, oil and air filters <sup>2</sup>	Spark plugs lifetime prediction only	✓	✓
Oil & coolant quality monitoring <sup>3</sup>		✓	✓
Fleet emission monitoring <sup>4</sup>	Engine emission monitoring only	✓	✓
<b>artificial intelligence &amp; predictive analytics</b>			
Operator analytics package			✓
Historic performance analysis			✓
User-defined monitoring			✓
On demand: Access to myPlant data via API (Application Programming Interface) service <sup>5</sup>			✓

<sup>1</sup> Available soon for JENBACHER direct markets only

<sup>2</sup> Spark plugs, oil and air filters data might not always be available and is depending on the engine version/type and the sensors installed

<sup>3</sup> Oil and coolant reports are available in myPlant for the following laboratories: Spectro, JetCare, Polaris, MIC GSM

<sup>4</sup> May require additional hardware installation for emission monitoring (available as upgrade)

<sup>5</sup> 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.) Mobile Internet (OPTION)

Connection Plant - Customer via secured Internet - connection

See also technical instruction **TA 2300 - 0006**

#### Scope of delivery

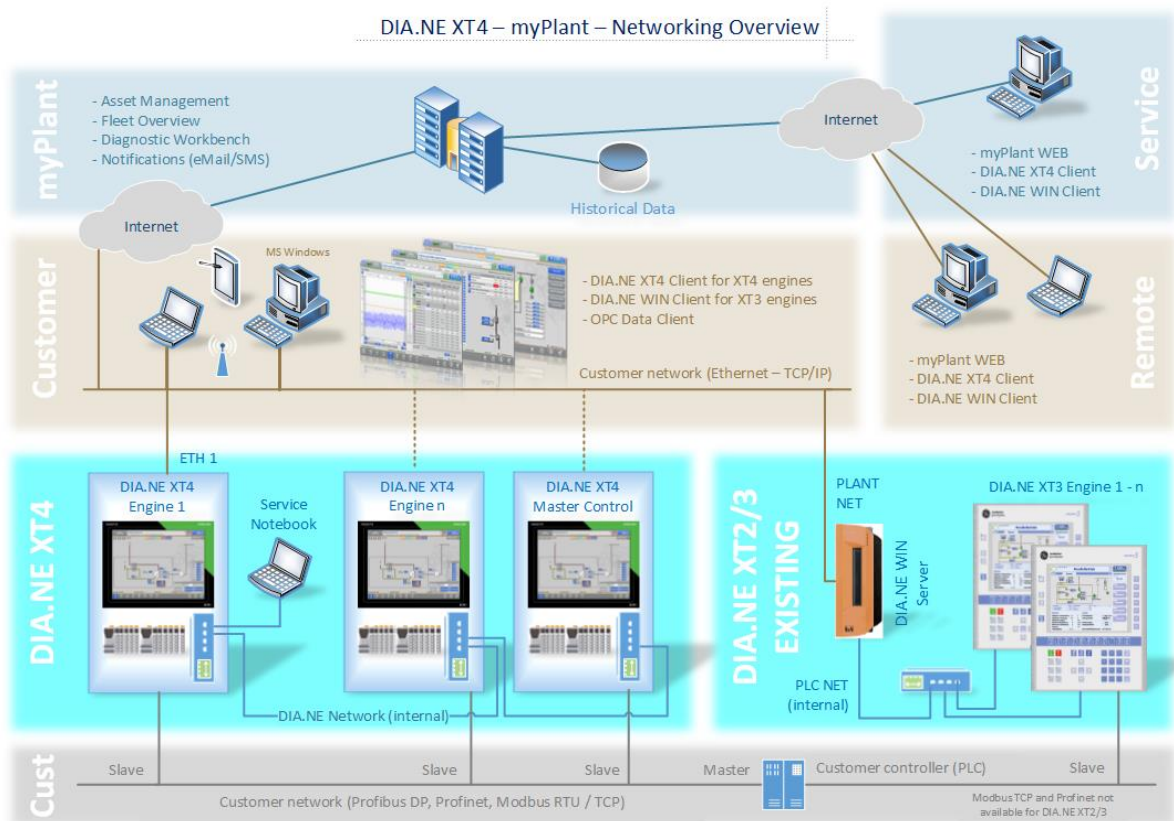
- Mobile Internet router with antenna to connect to the DIA.NE Server XT4

#### Customer requirements

- SIM card for 3G / 4G

### 4.) Network overview

- For information only!



## 1.11.10 Active power limitation, Reactive power control per module

### Active power limitation:

The module can be operated with a reduced power output if the network operator requires a temporary limitation on feed-in power. Power logging is carried out at the generator terminals.

### The customer has the option to engage in module control using the following signals:

- 0/4 - 20mA for the continuous limitation of generator active power from 100 % - 50(PMin) %
  - 1 potential-free contact for blocking the module (without RESET function)
- or
- 4 potential-free contacts for the limitation of generator active power from 100 % - 50(PMin) %
  - 1 potential-free contact for blocking the module (without RESET function)

### Reactive power control:

The reactive power/power factor control point is at the generator terminals

The module is designed for the process of reactive power control described below.

- Set point setting via the customer using the following signals:
- 0/4 - 20mA for the continuous cos phi set point setting in the range of xx overexcited to xx under-excited

•—

### The following signal is provided to the customer by JENBACHER:

- 0/4 - 20mA for the actual value of generator reactive power
- 0/4 - 20mA for the actual value of generator active power

Further interfaces upon request!

## 1.11.25 Control Strategy and Options

### Customer Fuel Blending System:

The customer provided engine fuel system will initially start with Landfill gas (LFG) as the primary fuel. Once the engine is online, breaker closed and accepting load, a customer hydrogen generation system will start. The hydrogen generation system will slowly begin to produce H<sub>2</sub>, which will then be blended into the site Landfill gas and sent to the engine for use as fuel. Based on customer analysis, the fuels available for the engines are either 100% Landfill Gas or a Blend of 55% Landfill Gas with a balance of Hydrogen. There will be a transition from 100% Landfill Gas to the 55% Blend which will also need to occur while the engine is online.

The power output rating of the engine is based on the fuel provided. The ratings are as stated

Landfill Gas (LFG)	1429 KWe
55% LFG Blended Gas	1159 KWe

Note that during the fuel blending transition, the rated output of the engine will necessarily need to reduce due to the fuel composition of the blend so that knocking conditions are avoided, thus the rated output of the engine will also need to be reduced from 1429 KWe to 1159 KWe during the fuel transition.

To facilitate this blending arrangement, each unit Diane XT4 system will be fitted with a 4-20mA analog input signal connected to the customer provided signals, representing the following 2 signals

- A customer provided CH<sub>4</sub> sensor will track the LFG quality prior to blending and allow for the engine to adjust for any changes.
- The customer provided blending ratio signal will control the load ramp between the pure LFG to the LFG/H<sub>2</sub> blend of 55%.

## 1.20.03 Starting system

### Starter battery:

4 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	<b>3 x 320 - 575 V, 47 - 63 Hz</b>
• 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	32 °F – 158 °F (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 133 °F (56°C) and 140°F (60°C), 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	<b>IN/LBS</b>	<b>4"/145</b>	Stainless steel
1 Exhaust gas outlet	<b>IN/LBS</b>	<b>12"/145</b>	Stainless steel
1 Fuel gas inlet	<b>IN/LBS</b>	<b>5"/232</b>	Stainless steel
2 Intercooler in-/outlet	<b>IN/LBS</b>	<b>4"/145</b>	Stainless steel
2 Lube oil connection	<b>IN</b>	<b>1.1</b>	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, NEMA 12  
IP 20 internal (protection against direct contact with live parts)

Design according to EN 61439-2 / IEC 61439-2 / UL 508 A and ISO 8528-4.  
Ambient temperature 41 - 104 °F (5 - 40 °C), 70 % Relative humidity

Standard painting: Panel: RAL 7035  
Pedestal: RAL 7020 (Rittal TS8)  
RAL 7020 (Rittal VX25)

## 2.02 Grid monitoring device Standard 60Hz Profile 1

Standard for generating plants connected to the medium voltage grid with dynamic Grid Code requirements.

### Function:

Monitoring device for immediate disconnection of the generator from the grid in case of grid failures.

### Consisting of

- Voltage monitoring with two-stage undervoltage and two-stage overvoltage limit function
- Frequency monitoring with underfrequency and over frequency function.
- Separately adjustable, independent times for voltage and frequency monitoring.
- Monitoring of the limit line of the low voltage profile ULVRT
- Display of all measured values for normal operation or malfunction via an alphanumeric display and LEDs.
- Setting authorization through password against unauthorized changes.

## Scope of supply:

- Digital grid protection relay with fault data storage, measured value display and self-monitoring.
- Rated input voltages: 100 V / 110 V /400V

## Out of standard scope of supply:

- all necessary instrument transformers,
- additional protection equipment acc. to utility operator's specifications and guidelines.
- Site-specific acceptance test done by approved testing institute

## Recommended setting value for Grid monitoring device:

The limit values need to be aligned site-specific with the utility operator!

Parameter	Parameter Limit	Time Delay	Comments
U>> [ANSI 59]	115 %U	0.2 s	Power capability reduction with 1 %Pn/%U above 105 %U
U> [ANSI 59]	111 %U	60 s	Power capability reduction with 1 %Pn/%U above 105 %U
U< [ANSI 27]	80 %U	1.5 s	Power capability reduction with 1 %Pn/%U below 95 %U
U<< [ANSI 27]	45 %U	0.2 s	Power capability reduction with 1 %Pn/%U below 95 %U
f> [ANSI 81O]	62 Hz	0.1 s	Power capability reduction with 10 %Pn/Hz above 61 Hz
f< [ANSI 81U]	57.0 Hz	0.1 s	Power capability reduction within the boundaries of 2 %Pn/Hz below 59 Hz; 10 %Pn/Hz below 59.5 Hz. Default: 10 %Pn/Hz below 59 Hz
Monitoring of the voltage profile U <sub>LVRT</sub> [ANSI 27T]	28 %U	0 s	For symmetrical faults
	68 %U	0.17 s	
	83 %U	1.6 s	

## 2.10.10 Master synchronization for 3 Modules

### Purpose:

The "Master synchronization" is assigned for control of the plant circuit breaker (CB), as well as the selection and the release of the individual modules via HMI for isolated operation and interlocking for black out start.

### Scope of supply:

The following essential components are included:

- Programmable controller
- Visualization
- Synchronizing device
- Necessary coupling relays
- Terminal strip for incoming and outgoing cables (scope of supply)

### Dimensions:

- Height 2200 mm (87 in) (including 200 mm [8 in] foundation)
- Width 1200 mm (47 in) (size can vary, also more cabinets possible depending on the options)
- Depth 600 mm (24 in)

Control power supply (by supplier of the control power supply unit) from the battery 24 V DC, 16 A (tolerance: min. 22 V, max. 30 V, including waviness  $U_{pp}$  3.6 V minus-grounded).

Auxiliary power supply (by the supplier of the auxiliary power supply unit):  
480/277 V, 60 Hz, 16 A.

### Assumptions:

- In every case of mains failure and transition from mains-parallel operation to island operation the customers load shedding equipment (preferably using relay control with direct contacts on the standby loads) has to limit the standby load within 50 mSec after the mains CB is opened to the standby rating of the module(s). There is no load shedding equipment supplied by Jenbacher. Load shedding have to be realized on-site.
- Jenbacher synchronizes and controls the generator CB's of the individual modules by module control panels
- The mains CB and section CB's are optional controlled by the master synchronization panel. (see following points 2.10.x)
- All other CB's of the plant have to be controlled/interlocked by the customer in this way, that there is ensured a safe operation in every operating mode of the plant.

### Function:

- Release of the gas engines for isolated operation  
Release of the gas engines for isolated operation is performed in accordance with the availability of the units and the settings at the visualization.
- Interlocking of module circuit breaker control for black out start  
For securing a safe operation for a black out start, an interlocking of the module circuit breaker control with feedback signals is going to take place at closing the generator circuit breaker, that it is prohibited to close two generator circuit breakers at the same time.
- Lockable selection by touch of 'Manual demand gas engines for isolated operation':

- "0" No isolated operation. There will be no module released for isolated operation.  
In case of mains failure the generator CB's of the running units will be opened.  
Running units will be stopped.
- "1" Manual selection "1" module released for isolated operation.  
In case of mains failure the mains CB of the plant will be opened.  
Surplus running units will be stopped.
- "2".."n" Manual selection "2".. "n" modules released for isolated operation.  
In case of mains failure, the mains CB of the plant will be opened.  
Surplus running units will be stopped.




- Lockable selection by touch 'Priority engine':  
An engine is selected as the priority engine, further unit sequencing is based upon availability.
- Mains stabilization time  
After restoration of the mains a waiting time elapses until the automatic "Mains breaker synchronization" command is given to synchronize the plant to the mains.
- Select synchronization type  
Lockable synchronization type selection by touch:  
MANUAL                      manually initiated automatic synchronization of mains CB  
OFF                              Synchronization of mains CB is locked  
AUTOMATIC                      automatic synchronization of mains CB without operator intervention.

#### Manually initiated automatic synchronization

Pressing the "MAINS CB x ON / SELECTION" button on the touch control panel initiates automatic synchronization.

#### Automatic synchronization

Fully automatic synchronization system with frequency controller and synchronizer with autonomous synchronization selection.

- Synchronization device - with frequency balance and following displays:
  -  Double voltmeter - for monitoring of bus bar and generator voltage
  -  Double frequency meter - for monitoring of bus bar and generator frequency
  -  Synchroscope - for monitoring of the synchronizing function during synchronization

#### **DIA.NE XT**

Components:

- DIA.NE plant management system

Design:

- a) Touch Display visual display unit
- b) Central plant control

#### **a) Touch Display visual display unit**

15" industrial color graphics display with resistive touch screen.

Protection class for DIA.NE XT Front: IP 65,

The VDU contains a clear and functional summary of the measured values. All values are presented graphically.

The system is operated by touching on-screen buttons.

Numeric inputs (set points, parameters, ...) are made on a touch numerical keypad or slider. The operating mode and synchronization type are selected on a touch button panel that can be pinned permanently on each screen.

Main screens:

- MAIN: Operating selection
- ELE: Circuit breakers
- ELE: Electrical plant overview, synchronization (Option)
- HYD: Hydraulic plant overview (Option)
- GAS: Gas plant overview (Option)
- CTR: Plant controllers (Option)
- CUST: Shows order-specific screens added at the customer's request.
- PANEL: The operating mode and synchronization types are selected on a touch button panel that can be pinned permanently on each screen.
- ALARM: Alarm management. Efficient diagnostic instrumentation listing all active fault messages of the master control both tabular and chronologically, with the recorded time.
- Help: Information for causes and corrective measures for malfunctions

Each screen allows the user to switch between the screen view, the associated parameters in table form, powerful measured value trend displays, and, if available, system information.

## **b) Central plant control:**

A real-time, modular industrial control system based on an industrial PC which handles all activities for the

- station control,
- mains breaker control,
- and isolated operation settings for the modules.

Interfaces:

- Ethernet (twisted pair) for remote maintenance access
- Ethernet (twisted pair) for interconnecting multiple engines
- Ethernet (twisted pair) for the Powerlink connection to the control inputs and outputs.
- USB interface for software updates

Connection to on-site control system as described in Jenbacher options list (MODBUS-RTU slave, PROFIBUS-DP slave, MODBUS-TCP slave, ProfiNet and OPC)

## **Monitoring / fault messages, displays / operational messages:**

- Monitoring / fault messages:
  - Bus bar voltage sensor failure
- Monitoring / fault messages for each CB:
  - CB status signal failure
  - CB 0-signal failure
  - CB 1-signal failure

- CB opening failure
- CB closing failure
- CB overload/short circuit
- Monitoring / fault messages for each mains:
  - Mains monitoring device failure
- Displays for each CB:
  - CB OPENED/CLOSED
  - CB synchronization selected
- Displays for each mains:
  - Mains OK / Mains fault
- Displays for each module:
  - Generator CB OPENED/CLOSED

## Required reference and status signals for Jenbacher synchronizing system:

- Status signals for each CB
  - circuit breaker CLOSED 1 NO
  - circuit breaker OPENED 1 NC
  - circuit breaker READY TO CLOSE 1 NO

Voltages need to be prepared before and after the CB

- voltage 3 x / V  
Voltage transformer at star-star connection with min. 50 VA and KI.0.5.
- voltage 3 x / V  
Voltage transformer at star-star connection with min. 50 VA and KI.0.5.

## Jenbacher interface-signals to be incorporated in switchgear:

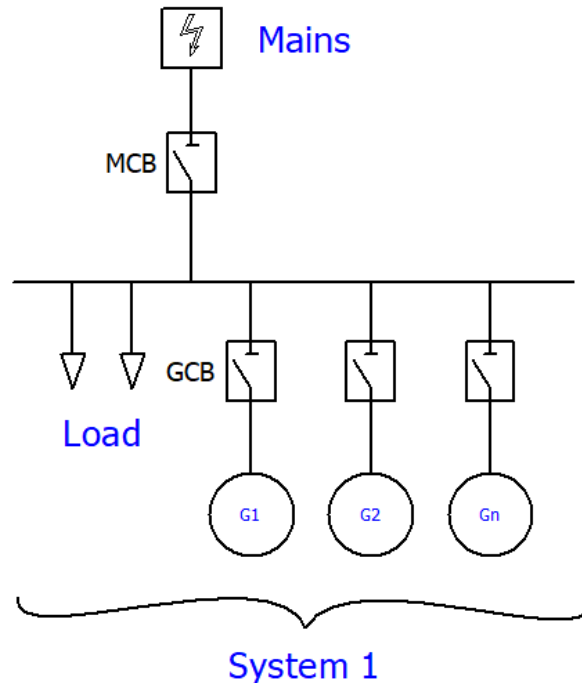
- circuit breaker CLOSING command 1 NO
- circuit breaker OPENING command 1 NO

The closing/opening command of the Jenbacher synchronization will be active until the opened/closed status signal from the switchgear is received.

Maximum distance between master synchronization and module control cabinet: 50m/164ft  
Maximum distance between master synchronization and power switch: 100m/328ft

## 2.10.11 Master Synchronization with one mains circuit breaker and one busbar

Example SLD



### Purpose:

- Control of one mains CB
- Transition from mains parallel to island operation and reverse for each system (load management in customer scope)

### Assumptions:

- only one system

### Function:

- Control one mains CB  
Mains circuit breaker 1 On /Off / Demand
- Island operation and black out start possibility with interlocking, of both systems (presupposed, the engines are prepared for black start. Number of engines for island operation can be manually selected)
- Resynchronization from island to mains parallel of running modules

### Scope of supply:

- Monitoring of breakers (see master synchronization for detailed description)
- Mains monitoring device for each mains connection
- Control and synchronizing of the mains CB
- Visualization

## 2.10.50 Master control for 3 modules

### Dimensions:

- Height 2200 mm (87 in) (including 200 mm (8 in) foundation)
- Width 1200 mm (47 in) (size can vary, also more cabinets possible depending on the options)
- Depth 600 mm (24 in)

Control power supply (by supplier of the control power supply unit) from the battery 24 V DC, 16 A (tolerance: min. 22 V, max. 30 V, including waviness  $U_{pp}$  3.6 V minus-grounded).

Auxiliary power supply (by the supplier of the auxiliary power supply unit):

**480/277 V, 60 Hz, 16 A.**

### Purpose:

The "Master control" is assigned for automatic starting/stopping of the individual modules, and for the unit control power default for mains parallel operation.

### Assumptions:

- The hydraulic integration of the units, the bypass of the surplus heat as well as the complete heater control must be finalized on-site, per JENBACHER-hydraulic diagram.
- Return temperature: the set value may not be exceeded. Permissible deviation  $-20^{\circ}\text{C}$  ( $-4^{\circ}\text{F}$ ). Permissible change in maximum velocity  $10^{\circ}\text{C}$  ( $50^{\circ}\text{F}$ )/minute.

### Scope of supply:

The following essential components are included:

- DIA.NE server
- Visualization
- Necessary coupling relays
- Terminal strip for incoming and outgoing cables (scope of supply)

### Demand of gas engines:

- Unit sequencing:  
The unit sequencing is based upon availability and according to lockable selection by touch:  
"AUT" sequence according to operating hours (the unit with the lowest operating hours will be requested first)  
"MAN", "1", "2", "3"..."n" Manual pre-selection of the leading unit with fixed sequence of the units.  
(Sequence: 1-2-3-n, 2-3-n-1, 3-n-1-2)
- Time intervals:  
Between two additions and shutdowns of the units, minimum (adjustable) dead time is observed.

### Function:

- Demand / shut down and power controls of the modules for mains parallel and island operation see following points 2.10.x
- Lockable service selection by touch:
  - "0", "1", "2"..."n" Manual selection of number of module demand. Module power default 50-100% according regulation.

- "AUT" Automatic Operation of the plant with module demand according the base procedure. Module power default 50-100% according regulation.
- Active power load sharing line for Jenbacher engines
- Reactive power load sharing line  
The reactive power regulation of the engines is carried out by a voltage droop characteristic set through the generator controller (same setting at all generators).

## DIA.NE XT

### Components:

- DIA.NE plant management system

### Design:

- a) Touch Display visual display unit
- b) Central plant control

#### **a) Touch Display visual display unit**

15" industrial color graphics display with resistive touch screen.

Protection class for DIA.NE XT Front: IP 65,

The VDU contains a clear and functional summary of the measured values. All values are presented graphically.

The system is operated by touching on-screen buttons.

Numeric inputs (set points, parameters, ...) are made on a touch numerical keypad or slider.

The operating mode and synchronization type are selected on a touch button panel that can be pinned permanently on each screen.

### Main screens:

- MAIN: Operating selection, counters (operating hours)
- ELE: Electrical plant overview, synchronization
- HYD: Hydraulic plant overview (Option)
- GAS: Gas plant overview (Option)
- CTR: Plant controllers (Option)
- CUST: Shows order-specific screens added at the customer's request.
- PANEL: The operating and synchronization mode are selected on a touch button panel that can be pinned permanently on each screen.
- ALARM: Alarm management. Efficient diagnostic instrumentation listing all active fault messages of the master control both tabular and chronologically, with the recorded time.
- Help: Information for causes and corrective measures for malfunctions

Each screen allows the use to switch between the screen view, the associated parameters in table form, powerful measured value trend displays, and, if available, system information.

#### **b) Central plant control:**

A real-time, modular industrial control system based on an industrial PC which handles all activities for the

- station control,

# JENBACHER

- mains breaker control,
- and isolated operation settings for the modules.

## Interfaces:

- Ethernet (twisted pair) for remote maintenance access
- Ethernet (twisted pair) for interconnecting a number of engines
- Ethernet (twisted pair) for the Powerlink connection to the control inputs and outputs.
- USB interface for software updates

Connection to on-site control system as described in JENBACHER options list (MODBUS-RTU slave, PROFIBUS-DP slave, MODBUS-TCP slave, ProfiNet and OPC)

## **Monitoring / fault messages, displays / operational messages:**

- Monitoring / fault messages
  - Measuring signal fault
  - CHP return temperature high (on-site sensor with potential free contact)
- Status messages of the plant
- Display of the actual operating mode of the plant in the status line e.g.:
  - Plant blocked
  - Mains failure
  - Emergency supply
  - Priority current - peak load
- Operational messages for each module:
  - Not ready / ready / demand by master control
  - Operation OFF/ON
  - Generator C.B. OFF/ON
- Displays for each module:
  - Operating hours (with possibility of adjust)
  - Electrical output - set value and actual value
- Operational conditions of the plant:
  - Mains C.B. OFF/ON
  - Mains o.k./mains fault
  - Mains power import/export - set value and actual value
  - Total power consumers
  - Generators total power set value

## **Remote control messages**

(potential free contacts):

- CPU fault master control
- Collect fault master control

## 2.10.53 Master control priority gas – gas capacity (Preliminary)

### Purpose:

The "Master control" is assigned for automatic starting/stopping of the individual gas engine units and the set power default for the unit controls, in accordance with the plant's waste gas production.

### Assumptions:

- Only for one system
- The requirements for gas quality must be in accordance with TA 1000-0300.
- The generated electric energy is fed into the main electric feeder, in net parallel operation with the grid.

### Function:

Signals from the gas processing system:

- Analogue:
 

O2-volume	(%)	Collect line	4 - 20 mA #)
CH4-volume	(%)	Collect line	4 - 20 mA #)
Gas pressure	(mbar)	Gas engine inlet	4 - 20 mA #)
Gas quantity Q[Gas]	(Nm <sup>3</sup> /h)	Collect line	4 - 20 mA #)
Gas quantity Q[Gas Mot]	(Nm <sup>3</sup> /h)	Gas engines	4 - 20 mA #)
- Digital:
 

Release for gas engines from gas compressor			#)
---	--	--	----

#) by on-site plant. Refer to technical diagram waste gas, E 10096, sheet 2.

The gas processing must be performed such that the gas volume that is not used by the gas engines is automatically and directly flared.

The compressor, flare control and the gas engine pressure control must be designed such that at the connection of the gas engine the gas pressure is kept in accordance with TA 1000-0300, especially if the gas engine or the flare is started or stopped.

(Refer to technical diagram waste gas, E 10096)

### Release conditions for gas engines:

- Within maximum O2 volume limits (limiting value 5%; programmed as a constant)
- Minimum CH4 volume met (calculated without air)
- Gas pressure O.K.
- Release from the compressor master O.K.

### Principal control-process:

- A) To find the available gas quantity for the gas engines Q[Gas Mot soll] through subtraction of the gas quantity Q[Gas F soll], which is determined from control engineering logic (compensation for variations of gas quantity and CH4 volume, control processes at the gas engine plant, necessary minimum quantity of the flare) for the flare. This value is adjustable over the visualization and must be optimized at start-up and commissioning.

$$Q[\text{Gas Mot soll}] = Q[\text{Gas}] - Q[\text{Gas F soll}]$$

- B) To find the available gas output for gas engines, P[gas engine]:

Gas quantity Q[Gas Mot soll] (Nm<sup>3</sup>/h): in existence as calculated value

CH4-volume (%) in existence as measured value  
 Heating power of CH4 (kWh/Nm<sup>3</sup>/h) programmed as constant (9,94 kWh/Nm<sup>3</sup>)

$$P[\text{Gas Mot}] \text{ (kW)} = Q[\text{Gas Mot soll}] \text{ (Nm}^3\text{/h)} \times \frac{\text{CH4 (\%)}}{100 \%} \times \text{Heating power of CH4}$$

C) Starting and stopping of gas engines:

The output is equally distributed throughout the available engines with a load range of 50 - 100 %. If gas is only available for one engine, and that engine is in a load range of 0-50%, the engine is stopped and the gas is lead to the flare.

D) Power adjustment:

The power adjustment is performed in this way that the consumed gas quantity Q[Gas Mot] of the gas engines will be limited by the available gas quantity Q[Gas Mot soll]. The running units perform within the load range of 50 - 100 % nominal load, with equal load distribution between the units.

E) Unit sequencing:

The unit sequencing is based upon availability and according to lockable selection by touch:

- "AUT" sequence according to operating hours (the unit with the lowest operating hours will be requested first)
- "MAN", "1", "2", "3"..."n" Manual pre-selection of the leading unit with fixed sequence of the units. (Sequence: 1-2-3-n, 2-3-n-1, 3-n-1-2)
- Between two additions and shutdowns of the units, minimum (adjustable) dead time is observed.

F) Variation power regulation according the gas pressure

Lockable service selection by touch:

- "0", "1", "2"..."n" Manual selection of number of modules with limitation of the module power default according the gas pressure (gas engine inlet).
- "AUT" Automatic Operation of the plant according the base procedure (A-D) with module demand and module power default 50-100%.

**Scope of supply:**

- Hard wired interfaces for priority gas
- Automatic control of modules as described in the function

**Monitoring / fault messages, displays / operational messages:**

- Monitoring / fault messages
  - Measuring signal fault
  - CHP return temperature high (on-site sensor with potential free contact)
  - Maximum O<sub>2</sub> volume
  - Minimum CH<sub>4</sub> volume
  - Minimum gas pressure
  - No release from the compressor master
  - Status messages of the plant
    - Display of the actual operating mode of the plant in the status line e.g.:
- Priority gas

- Operational conditions of the plant:
  - O2-volume Collect line
  - CH4-volume Collect line
  - Gas pressure Gas engine inlet
  - Gas quantity Q[Gas] Collect line
  - Gas quantity Q[Gas Mot] Gas engines
  - Q[Gas F soll] with possibility to adjust
  - P[Gas Mot]

### 3.03.05 Exhaust Gas Blow-Off Valve

When the risk of backfires in the exhaust gas system exists an exhaust gas blow-off valve must be installed. The exhaust gas can be released to atmosphere in case of a backfire. The blow-off valve should be installed as close to the engine exhaust exit as possible.

Scope:

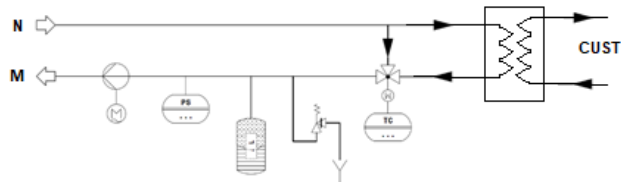
1. piece Exhaust gas blow-off valve (**Customer Scope**)

### 3.10.01 Cooling system - Low Temperature Circuit

A plate and frame heat exchanger is used to transfer heat from the intercooler circuit to the site cooling tower system.

**Consisting of (delivered loose):**

- Plate and Frame Heat Exchanger (Non ASME)
- Pump
- Short-circuit thermostat
- Safety valve
- Pressure switch
- Expansion tank

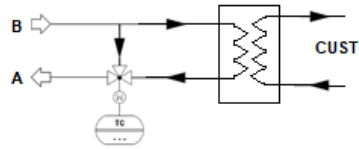


## 3.10.02 Cooling system - High Temperature Circuit

A plate and frame heat exchanger is used to transfer heat from the high temperature circuit to the site cooling tower system.

**Consisting of (delivered loose):**

- Plate and Frame Heat Exchanger (Non ASME)
- 3-way Valve



## 3.71 Vibration Switch

A structural Vibration Switch will be installed on the package base frame to detect excessive vibrations. A signal will be sent to the control panel to indicate an alarm condition.

## 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 not 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 not included in JENBACHER scope of supply.

### 4.07 Emission measurement with exhaust gas analyzer

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:

- Module:
  - At terminals of module interface panel
  - At terminals of generator terminal box, must use flexible cable (lugs and glands to be provided locally)
- Module control panel:
  - At terminal strips
- Auxiliaries:
  - At terminals of equipment which is supplied separately

### Mechanical

Suitable bellows and flexible connections **must be provided locally** for all connections.

### 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.

## **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 according to ISO 3046-3 at JENBACHER test bench. The following tests are made at 100%, 75% and 50% 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 the premises 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, according to 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%, 75% and 50% 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.

## 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.