

07/2020

Technical Description

Cogeneration Unit-Container

JMC 616 GS-N.L

dyn. GC Profile 1 (150ms/30%)

Carbon Force



Electrical output	2676	kW el.
Thermal output	1521	kW

Emission values

NOx < 250 mg/Nm³ (5% O₂) | < 95 mg/Nm³ (15% O₂)

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0.01 Technical Data (container)

			100%	75%	50%
Power input	[2]	kW	6,075	4,659	3,243
Gas volume	*)	Nm³/h	639	490	341
Mechanical output	[1]	kW	2,745	2,058	1,372
Electrical output	[4]	kW el.	2,676	1,998	1,319
Recoverable thermal output (calculated with Glykol 37%)					
~ Intercooler 1st stage	[9]	kW	814	448	178
~ Lube oil		kW	282	238	205
~ Jacket water		kW	425	369	309
~ Exhaust gas cooled to 362 °C		kW	~	~	~
Total recoverable thermal output	[5]	kW	1,521	1,055	692
Total output generated		kW total	4,197	3,053	2,011
Heat to be dissipated (calculated with Glykol 37%)					
~ Intercooler 2nd stage		kW	177	136	86
~ Lube oil		kW	~	~	~
~ Surface heat	ca. [7]	kW	185	~	~
Spec. fuel consumption of engine electric	[2]	kWh/kWel.h	2.27	2.33	2.46
Spec. fuel consumption of engine	[2]	kWh/kWh	2.21	2.26	2.36
Lube oil consumption	ca. [3]	kg/h	0.55	~	~
Electrical efficiency			44.0%	42.9%	40.7%
Thermal efficiency			25.0%	22.6%	21.3%
Total efficiency	[6]		69.1%	65.5%	62.0%
Hot water circuit:					
Forward temperature		°C	90.0	83.9	79.1
Return temperature		°C	70.0	70.0	70.0
Hot water flow rate		m³/h	73.2	73.2	73.2
Fuel gas LHV		kWh/Nm³	9.5		

*) 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; ...). In the specifications in addition to the general tolerance of ±8 % on the thermal output a further reserve of +5 % is recommended for the dimensioning of the cooling requirements.

Main dimensions and weights (container)

Length	mm	xxx
Width	mm	xxx
Height	mm	xxx

Engine - Container

Weight empty	kg	xxx
Weight filled	kg	xxx

Infra - Container

Weight empty	kg	xxx
Weight filled	kg	xxx

Ventilation - Container

Weight empty	kg	xxx
Weight filled	kg	xxx

Connections

Hot water inlet and outlet [A/B]	DN/PN	100/10
Exhaust gas outlet [C]	DN/PN	600/10
Fuel gas connection (container) [D]	mm	100/16
Fresh oil connection	G	28x2"
Waste oil connection	G	28x2"
Cable outlet	mm	800x400
Condensate drain	mm	~

Output / fuel consumption

ISO standard fuel stop power ICFN	kW	2,745
Mean effe. press. at stand. power and nom. speed	bar	22.00
Fuel gas type		Natural gas
Based on methane number Min. methane number	MZ	70 70 d)
Compression ratio	Epsilon	11.5
Min. fuel gas pressure for the pre chamber	bar	4.29
Min./Max. fuel gas pressure at inlet to gas train	bar	4.1 - 8 c)
Max. rate of gas pressure fluctuation	mbar/sec	10
Maximum Intercooler 2nd stage inlet water temperature	°C	45
Spec. fuel consumption of engine	kWh/kWh	2.21
Specific lube oil consumption	g/kWh	0.20
Max. Oil temperature	°C	80
Jacket-water temperature max.	°C	95
Filling capacity lube oil (refill)	lit	~ 648

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 616 GS-J12
Working principle		4-Stroke
Configuration		V 60°
No. of cylinders		16
Bore	mm	190
Stroke	mm	220
Piston displacement	lit	99.80
Nominal speed	rpm	1,500
Mean piston speed	m/s	11.00
Length	mm	4,894
Width	mm	1,886
Height	mm	2,503
Weight dry	kg	12,500
Weight filled	kg	13,500
Moment of inertia	kgm ²	64.96
Direction of rotation (from flywheel view)		left
Radio interference level to VDE 0875		N
Starter motor output	kW	20
Starter motor voltage	V	24

Thermal energy balance

Power input	kW	6,075
Intercooler	kW	991
Lube oil	kW	282
Jacket water	kW	425
Exhaust gas cooled to 180 °C	kW	855
Exhaust gas cooled to 100 °C	kW	1,222
Surface heat	kW	97

Exhaust gas data

Exhaust gas temperature at full load	[8] °C	362
Exhaust gas temperature at bmep= 16.5 [bar]	°C	~ 405
Exhaust gas temperature at bmep= 11 [bar]	°C	~ 459
Exhaust gas mass flow rate, wet	kg/h	15,396
Exhaust gas mass flow rate, dry	kg/h	14,488
Exhaust gas volume, wet	Nm ³ /h	12,149
Exhaust gas volume, dry	Nm ³ /h	11,019
Max.admissible exhaust back pressure after y-pipe	mbar	50

Combustion air data

Combustion air mass flow rate	kg/h	14,958
Combustion air volume	Nm ³ /h	11,575
Max. admissible pressure drop at air-intake filter	mbar	10

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

Sound pressure level

Aggregate a)		dB(A) re 20µPa	102
31,5	Hz	dB	83
63	Hz	dB	90
125	Hz	dB	96
250	Hz	dB	98
500	Hz	dB	97
1000	Hz	dB	95
2000	Hz	dB	94
4000	Hz	dB	94
8000	Hz	dB	92
Exhaust gas b)		dB(A) re 20µPa	119
31,5	Hz	dB	109
63	Hz	dB	119
125	Hz	dB	128
250	Hz	dB	117
500	Hz	dB	115
1000	Hz	dB	114
2000	Hz	dB	111
4000	Hz	dB	106
8000	Hz	dB	91

Sound power level

Aggregate	dB(A) re 1pW	124
Measurement surface	m²	149
Exhaust gas	dB(A) re 1pW	127
Measurement surface	m²	6.28

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

b) average sound pressure level on measurement surface in a distance of 1m according to DIN 45635, precision class 2.

The spectra are valid for aggregates up to bmep=20 bar. (for higher bmep add safety margin of 1dB to all values per increase of 1 bar pressure).

Engine tolerance ± 3 dB

0.03 Technical data of generator

Manufacturer		Leroy-Somer(-0,925cap) e)
Type		LSA 54 ZL105 e)
Type rating	kVA	3,785
Driving power	kW	2,745
Ratings at p.f. = 1,0	kW	2,676
Ratings at p.f. = 0.8	kW	2,657
Rated output at p.f. = 0.8	kVA	3,321
Rated reactive power at p.f. = 0.8	kVar	1,993
Rated current at p.f. = 0.8	A	174
Frequency	Hz	50
Voltage	kV	11
Speed	rpm	1,500
Permissible overspeed	rpm	1,800
Power factor (lagging - leading) (UN)		0,8 - 0,95
Efficiency at p.f. = 1,0		97.5%
Efficiency at p.f. = 0.8		96.8%
Moment of inertia	kgm ²	149.40
Mass	kg	9,950
Radio interference level to EN 55011 Class A (EN 61000-6-4)		N
Cable outlet		~
I _k " Initial symmetrical short-circuit current	kA	2.08
I _s Peak current	kA	5.29
Insulation class		H
Temperature (rise at driving power)		F
Maximum ambient temperature	°C	40

Reactance and time constants (saturated) at rated output

x _d direct axis synchronous reactance	p.u.	1.814
x _d ' direct axis transient reactance	p.u.	0.163
x _d " direct axis sub transient reactance	p.u.	0.083
x ₂ negative sequence reactance	p.u.	0.082
T _d " sub transient reactance time constant	ms	10
T _a Time constant direct-current	ms	30
T _{do} ' open circuit field time constant	s	1.76

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.

0.04 Technical data of heat recovery

General data - Hot water circuit

Total recoverable thermal output	kW	1,521
Return temperature	°C	70.0
Forward temperature	°C	90.0
Hot water flow rate	m³/h	73.2
Nominal pressure of hot water	PN	10
min. operating pressure	bar	3.5
max. operating pressure	bar	9.0
Pressure drop hot water circuit	bar	1.20
Maximum Variation in return temperature	°C	+0/-5
Max. rate of return temperature fluctuation	°C/min	10

General data - Cooling water circuit

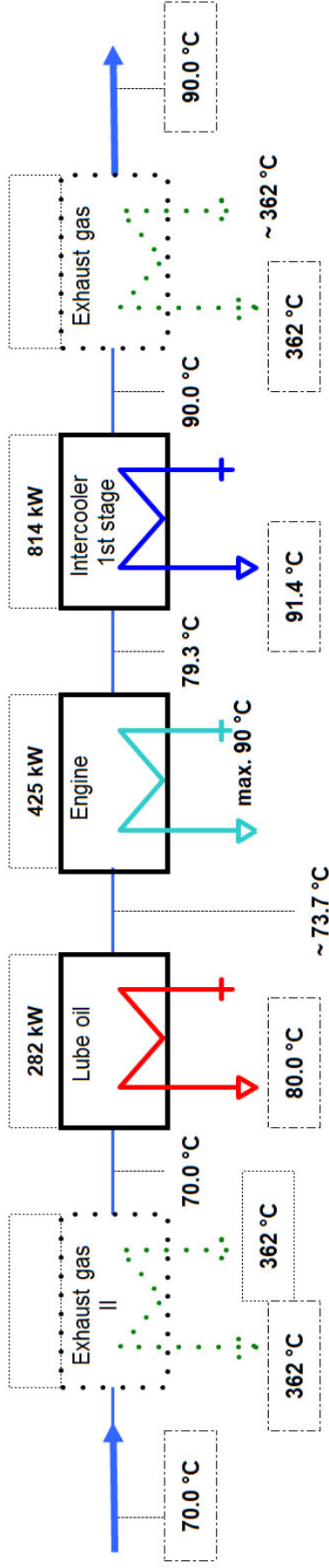
Heat to be dissipated (calculated with Glykol 37%)	kW	177
Return temperature	°C	45
Cooling water flow rate	m³/h	35
Nominal pressure of cooling water	PN	10
min. operating pressure	bar	0.5
max. operating pressure	bar	5.0
Loss of nominal pressure of cooling water	bar	~
Maximum Variation in return temperature	°C	+0/-5
Max. rate of return temperature fluctuation	°C/min	10

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

Hot water circuit (calculated with Glykol 37%)

Recoverable thermal output = 1,521 kW
(±8 % tolerance +5 % reserve for cooling requirements)

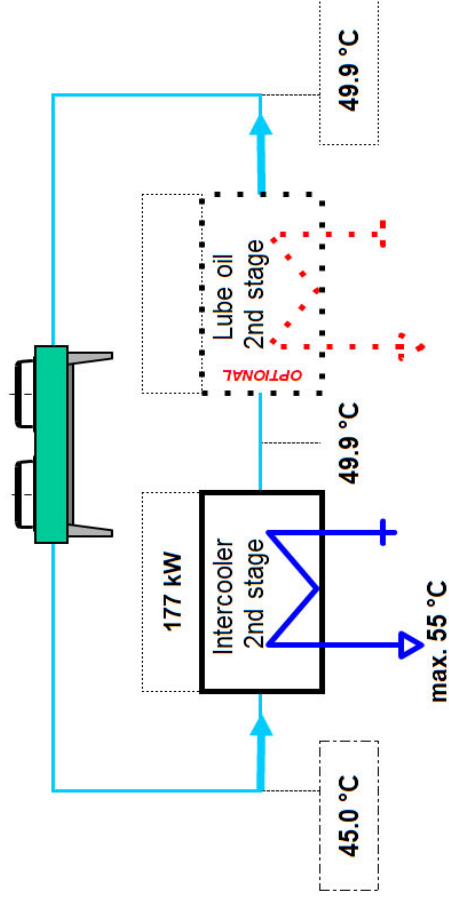
Hot water flow rate = 73.2 m³/h



Low temperature circuit (calculated with Glykol 37%)

Heat to be dissipated = 177 kW
(±8 % tolerance +5 % reserve for cooling requirements)

Cooling water flow rate = 35.0 m³/h



0.10 Technical parameters

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

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

[1] At nominal speed and standard reference conditions ICFN according to ISO 3046-1, respectively

[2] According to ISO 3046-1, respectively, with a tolerance of **+5 %**.

Efficiency performance is based on a new unit (immediately upon commissioning). Effects of degradation during normal operation can be mitigated through regular service and maintenance work.

[3] Average value between oil change intervals according to maintenance schedule, without oil change amount

[4] At p. f. = 1.0 according to VDE 0530 REM / IEC 34.1 with relative tolerances, all direct driven pumps are included

[5] Total output with a tolerance of $\pm 8 \%$

[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 $\pm 8 \%$

[9] Intercooler heat on:

* **standard conditions** - If the turbocharger design is done for air intake temperature $> 30^{\circ}\text{C}$ w/o de-rating, the intercooler heat of the 1st stage need to be increased by $2\%/^{\circ}\text{C}$ starting from 25°C .

Deviations between $25 - 30^{\circ}\text{C}$ will be covered with the standard tolerance.

* **Hot Country application (V1xx)** - If the turbocharger design is done for air intake temperature $> 40^{\circ}\text{C}$ w/o de-rating, the intercooler heat of the 1st stage need to be increased by $2\%/^{\circ}\text{C}$ starting from 35°C . Deviations between $35 - 40^{\circ}\text{C}$ 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:

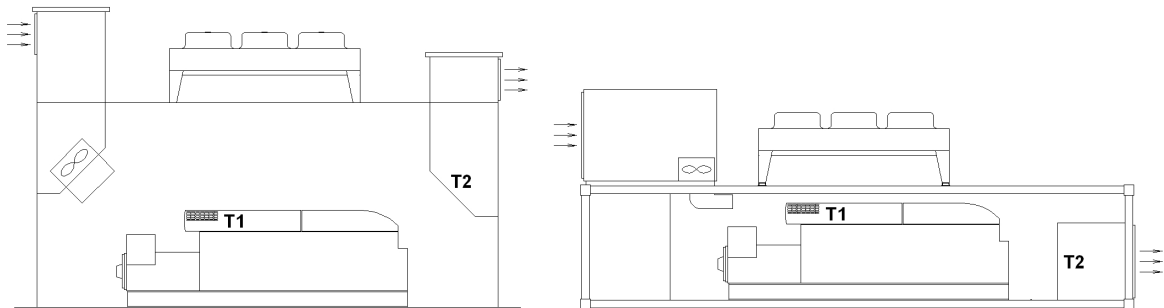
Barometric pressure:	1000 mbar (14.5 psi) or 100 m (328 ft) above sea level
Air temperature:	25°C (77°F) or 298 K
Relative humidity:	30 %

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

Output adjustment for turbo charged engines

Standard rating of the engines is for an installation at an altitude ≤ 500 m and combustion air temperature $\leq 30^\circ\text{C}$ (T1)

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



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

If the actual methane number is lower than the specified, the knock control responds. First the ignition timing is changed at full rated power. Secondly the rated power is reduced. These functions are carried out by the engine management system.

Exceedance of the voltage and frequency limits for generators according to IEC 60034-1 Zone A will lead to a derate in output.

Parameters for the operation of JENBACHER gas engines

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

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

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

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

Parameters for the operation of control unit and the electrical equipment

Relative humidity 50% by maximum temperature of 40°C .

Altitude up to 2000m above the sea level.

0.11 Additional technical parameters

- Syngas gasification processes may create substances which may be hazardous or harmful to health. The relevant Health & Safety instructions and precautions need to be considered when dealing with the potential substances in the gas, deposits or condensates.
- Island operation (without grid) is not allowed.

- The engine room ventilation must be designed as a forced system (with intake fans), so that there is always a slight overpressure in the engine room. This ensures that any unburned exhaust gas will be forced out of the exhaust system and cannot leak back into the engine room.
- The engine room ventilation must be designed so that in case of leaks no ignitable amounts of gas can form.
- It must be insured that during any operational mode no ignitable gas mixture is evident at any of JENBACHER delivered components. See TA 1100-0110.
- An emergency shut off valve that can be controlled by JENBACHER shall be installed outside of the engine room.
- The gas warning system must be designed according to TA 1100-0110.
- All persons in the immediate vicinity of the site must be equipped with a suitable wearable gas warning sensor. Relevant warning and security notification boards for CO, H₂ and other poisonous and flammable gases/substances must be visible positioned and in a manner that informs and motivates personal correctly.
- The gas, according to TA 1000-0300 and at the given parameters must be free of condensate and/or sublimates
- The measurement at the central test bench is carried out with natural gas and can only partially simulate the operation with special gas (gas mixtures with hydrogen, CO, etc.). In particular, the measured gas consumption does not correspond to the expected value with the real gas due to the different gas composition and the resulting different combustion properties of hydrogen mixtures.

0.20 Mode of Operation

Grid Parallel Mode

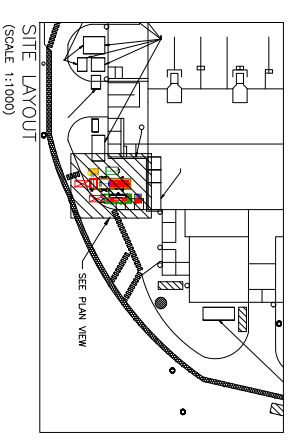
The genset is running in parallel to the utility. The unit load can be adjusted via its power control set point or designated option.

Procedure in the event of mains failure:

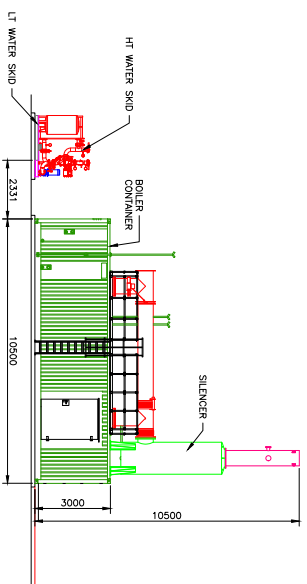
When the mains monitor relay (protective relay ANSI No. 27, 59, 81, 78- provided either by JENBACHER or the customer) is activated due to a mains failure, the engine is isolated from the mains by opening the generator breaker. The module is shut down without any cool-down run.

Island operation is not available in this case!

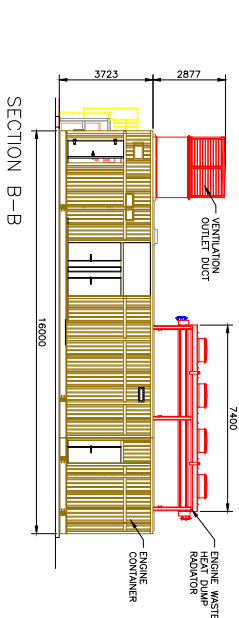
The module can be restarted following the restoration of mains power after a 5-minute mains stabilization period.



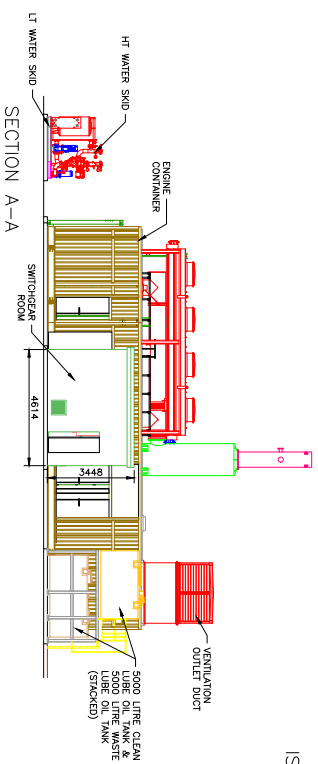
SITE LAYOUT
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SECTION C-C

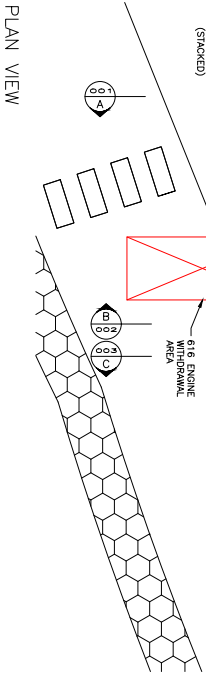
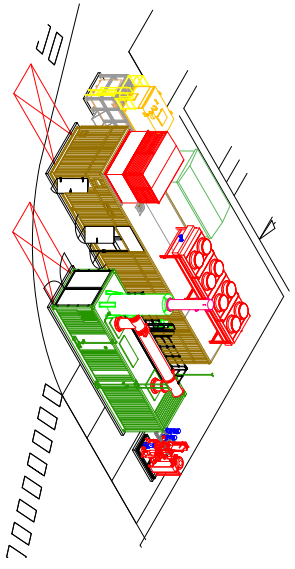


SECTION B-B

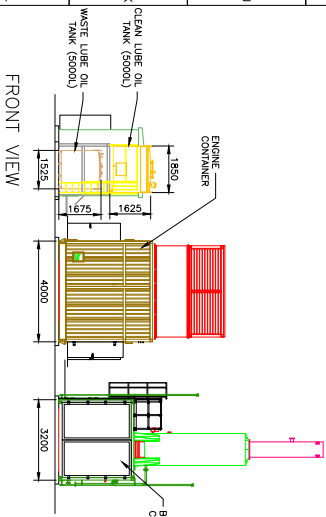


SECTION A-A

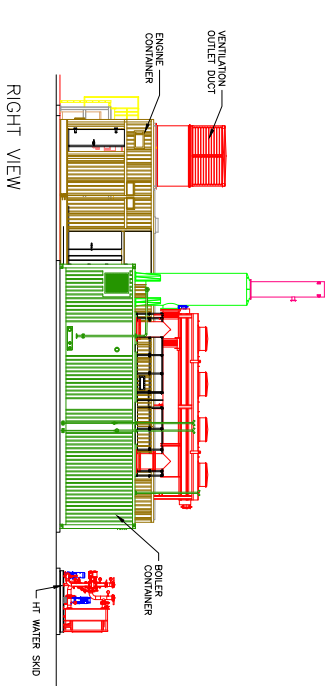
ISOMETRIC VIEW



PLAN VIEW



FRONT VIEW



RIGHT VIEW

TA	REVISION	DATE	BY	CHK	APP
1	TENDER ISSUE				
2	AMENDMENT				
3	REVISED LETTER OF AWARD				
4	REVISED LETTER OF AWARD				
5	REVISED LETTER OF AWARD				
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15	REVISED LETTER OF AWARD				
16	REVISED LETTER OF AWARD				



CLARKE ENERGY LIMITED, HEAD OFFICE, POWER HOUSE, SENIOR ROAD,
SOUTH BRIMLEY ROAD, WIMBORNE INDUSTRIAL PARK, 4446
WIMBORNE, SOUTH DORSET, BH20 4AA
TITLE: JMSB16 CSAL ENGINE & ASSOCIATED EQUIPMENT
CLIENT: CARBON FORCE
SITE: ST MERRYN FOODS
DRAWING No. T-50703
DATE: 24/07/20
SCALE: 1:100
REV: 1