

CONDITION 19 DISCHARGE NOTE

This document has been prepared by Hodkinson Consultancy, a specialist energy and environmental consultancy for planning and development to discharge Condition 19 of the planning application ref 585/APP/2017/2819.

Condition 19

“Condition 19: No development shall commence until a quantified low emission strategy has been submitted to and approved in writing by the Local Planning Authority. The Low Emission Strategy shall have targets for emission reduction and time-scales, with pollution savings quantified. At the end of each calendar year an implementation plan shall be submitted for approval in writing by the local planning authority, which on approval shall be fully implemented in accordance with the details and measures so approved. The measures in the agreed scheme shall be maintained throughout the life of the development”.

Low emission strategy

Targets

The targets set out for the Low Emission Strategy are the same as those made in the Air Quality Assessment (AQA) produced by Fichtner Consulting Engineers Limited (v2, 29/03/2018) which, in relation to heat generating plant, are the following:

Item	NO _x emissions
Gas-boilers	<38mg/kWh
CHP	<95mg/Nm ³

Table 1 – Air Quality Assessment NO_x emission assumptions

The excess oxygen percentage (%O₂) is not stated, however it is assumed to be 0%O₂.

Plant Selection

The following plant has been selected:

Item	Manufacturer	Model	Stated NO _x emissions
Gas-boilers	Hoval	UltraGas 2D 2200	41mg/kWh
CHP	2G	Aura 412 EG	65.7mg/Nm ³

Table 2 – Selected plant and associated stated NO_x emissions

The datasheets for the boilers and CHP are provided in Appendix B.

Although gas-boiler NO_x emissions are higher than those set out in the AQA, this impact is more than offset by the significantly lower emissions from the CHP. This point is discussed further in the following section.

Implementation Plan

Operational Strategy

The CHP shall be the lead source of heat, with gas boilers acting as top-up during high demand periods. The approved Sustainability and Energy Strategy allowed for 61%/39% CHP/gas-boiler contribution, respectively. However, these figures were due to be refined, which they were to 85.2%/14.8%, respectively.

This means that the bulk of the heat is expected to be generated by the CHP. This lowers NO_x emissions further still due to the lower emission levels generated by the CHP (in comparison to the target).

As per the AQA NO_x emissions and the approved Energy Strategy, the average weighted NO_x emission expected from the system would be 65.65mg/kWh. Due to the enhanced performance achieved by the selected CHP and the refined CHP/gas-boiler contribution targets, the actual average weighted NO_x emission level expected is 54.06mg/kWh.

This represents a pollution saving of 11.60mg/kWh. The calculations are provided in Appendix A.

Commissioning

Both gas-boilers and the CHP will be commissioned by their respective manufacturers. As part of the standard commissioning procedures NO_x emission measurements will be taken and adjustments will be made accordingly to ensure stated values are met.

Operation

Metropolitan (the appointed ESCo) will be carrying out Preventative Planned Maintenance. As part of this, NO_x emission measurements will be taken periodically, and adjustments will be made accordingly should the readings exceed the stated values.

Summary

As described in this note, the design is compliant with the requirements of the condition. The expected NO_x emissions are below the emission levels stated in the Air Quality Assessment. Furthermore, the appointed ESCo will ensure the preservation of this performance.

Appendix A - St Andrews LEOMB

Inputs						Outputs		
Parameter			Value	Units		Parameter	Value	Units
B	Gas-boiler annual heat demand contribution (refined)		14.8%	-	$J=E * F$	CHP stated emissions (@0% O2)	65.72	mg/Nm3
C	CHP annual heat demand contribution (refined)		85.2%	-	$K=J * G$	CHP stated emissions (@0% O2)	56.32	mg/kWh
						$L=B * D+C * K$	Average weighted emissions(plant)	54.06 mg/kWh
D	Gas-boiler stated emissions (@0% O2)		41.00	mg/kWh				
E	CHP stated emissions (@5% O2)		50.00	mg/Nm3	$M=G * I$	CHP stated emissions (@0% O2)	81.42	mg/kWh
F	5% to 0%O2 correction factor		1.31					
G	Conversion factor mg/m3 to mg/kWh		0.86		$N=O * D+P * M$	Average weighted emissions(AQA)	65.65	mg/kWh
H	Gas-boiler AQA emissions (@0% O2)		41.00	mg/kWh				
I	CHP AQA emissions (@0% O2)		95.00	mg/Nm3			11.60	
O	Gas-boiler annual heat demand contribution (AQA)		39.0%	-				
P	CHP annual heat demand contribution (AQA)		61.0%	-				

Hoval UltraGas® 2 D (2000-3100)

Type		D (2000)	D (2200)	D (2600)	D (3100)
• Nominal heat output at 80/60 °C, natural gas ¹⁾	kW	185-1852	203-2076	241-2460	297-2894
• Nominal heat output at 50/30 °C, natural gas ¹⁾	kW	205-1998	229-2224	269-2640	324-3100
• Nominal heat output at 80/60 °C, propane ²⁾	kW	245-1852	299-2067	362-2455	427-2877
• Nominal heat output at 50/30 °C, propane ²⁾	kW	264-1998	316-2224	385-2640	453-3100
• Nominal heat input with natural gas ³⁾	kW	187-1886	206-2114	247-2502	297-2938
• Nominal heat input with propane ²⁾	kW	248-1886	306-2114	371-2502	437-2938
• Operating pressure heating min./max. (PMS)	bar	1/6	1/6	1/6	1/6
• Operating temperature max. (T _{max})	°C	95	95	95	95
• Boiler water content (V _(H2O))	l	2 x 756	2 x 718	2 x 1211	2 x 1118
• Flow resistance boiler		see diagram			
• Minimum circulation water quantity	l/h	-	-	-	-
• Boiler weight (without water capacity, incl. cladding)	kg	2 x 1540	2 x 1600	2 x 2130	2 x 2300
• Boiler efficiency at 80/60 °C in full-load operation (NCV/GCV) ⁴⁾	%	98.2/88.5	98.2/88.5	98.2/88.5	98.2/88.5
• Boiler efficiency at 30 % partial load (NCV/GCV) ⁴⁾	%	109.0/98.2	108.6-97.8	108.7/97.9	108.5/97.7
• Room heating energy efficiency					
- without control	ηs %	-	-	-	-
- with control	ηs %	-	-	-	-
- with control and room sensor	ηs %	-	-	-	-
- annual energy consumption	Q _{HE} GJ	-	-	-	-
• NOx class (EN 15502)		6	6	6	6
• Nitrogen oxide emissions (EN 15502) (GCV)	NOx mg/kWh	36	41	37	35
• Carbon monoxide emissions at 50/30 °C (related to 3 % of O ₂)	CO mg/Nm ³	25	26	23	23
• O ₂ content in flue gas min./max. output	%	6.0/5.9	6.0/5.9	6.0/5.9	6.0/6.0
• Heat loss in standby mode	Watt	2400	2400	3200	3200
• Dimensions		see dimensional drawing			
• Gas flow pressure min./max.					
- Natural gas E/LL	mbar	17.4-300	17.4-300	17.4-300	17.4-300
- Propane	mbar	37-57	37-57	37-57	37-57
• Gas inlet pressure max. (idle pressure)	mbar	300	300	300	300
• Gas connection values at 15 °C/1013 mbar:					
- Natural gas E (Wo = 15.0 kWh/m ³) NCV = 9.7 kWh/m ³	m ³ /h	19.3-194.4	21.2-217.9	25.5-257.9	30.6-302.9
- Natural gas LL (G25) - (Wo = 12.4 kWh/m ³) NCV = 8.13 kWh/m ³	m ³ /h	23.0-232.0	25.3-260.0	30.4-307.7	36.5-361.4
- Propane (G31) NCV = 24.4 kWh/m ³ ²⁾	m ³ /h	10.2-77.3	12.6-86.6	15.2-102.5	17.9-120.4
• Operating voltage	V/Hz	1 x 230/50 3 x 400/50	1 x 230/50 3 x 400/50	1 x 230/50 3 x 400/50	1 x 230/50 3 x 400/50
• Electrical power consumption min./max.	Watt	203/3746	203/3866	271/8222	301/8282
• Standby	Watt	7	7	5	7
• Type of protection	IP	20	20	20	20
• Permitted ambient temperature during operation	°C	5-40	5-40	5-40	5-40
• Sound power level					
- Heating noise (EN 15036 part 1) (room air dependent)	dB(A)	86	85	89	88
- Flue gas noise radiated from the mouth (DIN 45635 part 47) (room air dependent/independent of room air)	dB(A)	-	-	-	-
• Condensate quantity (natural gas) at 50/30 °C	l/h	136	144	200	276
• pH value of the condensate (approx.)	pH	4.2	4.2	4.2	4.2
• Construction		B23, B23P, C53, C63			
• Flue gas system					
- Temperature class		T120	T120	T120	T120
- Flue gas mass flow at max. nominal heat input (dry)	kg/h	2976	3338	3950	4460
- Flue gas mass flow at min. nominal heat input (dry)	kg/h	295	325	390	450
- Flue gas temperature at max. nominal heat output and 80/60 °C	°C	69	70	66	68
- Flue gas temperature at max. nominal heat output and 50/30 °C	°C	47	49	45	46
- Flue gas temperature at min. nominal heat output and 50/30 °C	°C	28	29	29	28
- Max. permissible temperature of the combustion air	°C	48	48	48	48
- Volume flow of combustion air	Nm ³ /h	2438	2732	3234	3660
- Maximum supply pressure for combustion air supply and flue gas line	Pa	60	60	60	60
- Maximum draught/underpressure at flue gas outlet	Pa	-50	-50	-50	-50

¹⁾ In relation to natural gas G20 (100 % methane). With a hydrogen content (H₂) of up to 20 % in accordance with DVGW ZP3100 (D), an output reduction of up to 7 % is possible.

²⁾ Data related to NCV, conditional data

³⁾ Data related to NCV. The boiler series is tested for EE/H setting. With a factory setting to a Wobbe value of 15.0 kWh/m³, operation in the Wobbe value range from 12.0 to 15.7 kWh/m³ is possible without resetting.

⁴⁾ Conversion acc. to EN 15502-1, Appendix J

Technical specification

aura 412 EG | bt70-1



Design:

420 kW el.
400 V / 50 Hz
natural gas
Hi = 10,25 kWh/Nm³
NOx 0,05 g/Nm³
Exhaust cooling to 100 °C

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Subject to technical changes!

Note: Figure on cover page may differ

1 Genset

1.1 General power data

	50 %	75 %	100 %	Load
Electrical power	210	315	420	kW ⁽⁵⁾
Recoverable thermal output	374	496	605	kW ⁽²⁾
Energy input	628	856	1089	kW ⁽¹⁾
Efficiencies electrical	33,4	36,8	38,6	% ⁽¹⁾
Efficiencies thermal	59,6	57,9	55,5	% ^{(1), (2)}
Efficiencies total (el. + th.)	93,1	94,7	94,1	% ^{(1), (2)}
CHP coefficient	0,56	0,64	0,69	^{(1), (2)}

1.2 Emissions exhaust * gas & sound

	with catalytic converter	w/o exhaust aftertreatment	
NOx	< 0,05	< 6,50	g/Nm ³ ^{(4), (6)}
CO	< 0,25	< 6,5	g/Nm ³ ^{(4), (6)}
HCHO	< 5	k.A	mg/Nm ³ ^{(4), (6)}
THC (as total carbon)	< 0,30	k.A.	g/Nm ³ ^{(4), (6)}
Engine surface noise** (without / with sound encapsulation) (optional) **:	105 / 83		dB(A) ⁽⁷⁾
Exhaust outlet noise **	117		dB ⁽⁷⁾

1.3 Engine

Engine manufacturer	2G	
Engine type	aura 412 EG bt70	
Type / No. of cylinders	V engine / 12	
Operating method	4-stroke	
Combustion process	$\lambda = 1$	
Engine displacement	25007	ccm
Bore / Stroke	130 / 157	mm
RPM	1500	1/min
ISO standard power (mech.)	435	kW
compression ratio	12,5 : 1	
average effective pressure	13,9	bar
average piston speed	7,9	m/s
body of balance wheel	SAE 1	
Direction of rotation (based on balance wheel)	left	
tooth rim with number of teeth	137	
Engine dead weight	2150	kg
Mixture cooling to	80	°C

* With appropriate catalyst configuration!

** Total sound power level at full engine load in accordance with DIN EN ISO 3746

*** Average sound pressure level under open area conditions at distance of 1 m in accordance with DIN 45635

An increased noise load must be taken into account with fresh air intake from the installation room.

1.4 Generator (utility planning data)

Manufacturer	Leroy Somer	
Type	LSA 47.3 L9 / 4p	
Generator type	Synchronous, directly coupled	
Voltage regulator (AVR)	D510C	
Rated speed	1500	1/min
Frequency	50	Hz
mechanical fuel shutoff	435	kW
Effective electrical power	420,0	kW
Apparent electrical power (cos φ 1.0 / cos φ 0.9)	420 / 466,7	kVA
Rated generator current (cos φ 1.0 / cos φ 0.9)	606 / 674	A
Rated generator voltage (± 10 %)	400	V
Subtransient reactance X"d	14,6	%
Short-circuit current I _k "3	8,12	kA
Power factor cos φ (inductive / capacitive)	0,9 / 0,9	
Generator circuit breaker	800	A
Efficiency (full load) at Cos φ = 1	96,6	%
Mass moment of inertia	8,46	kg · m ²
Ambient air temperature	40	°C
Stator circuit	star	
Protection class	IP 23	
Generator weight	1381	kg
Compensation	not available	
Engine startup	not available	

2 Mixture composition

2.1 Combustion air

Combustion air mass flow	1348	kg/h
Combustion air volume flow (25 °C, 1013 mbar)	1138	m ³ /h

2.2 Fuel

Fuel requirements in accordance with 'TA-004 Gas'

Reference methane number - minimum methane number	80 / 70	
Fuel mass flow	85,3	kg/h ⁽¹⁾
Fuel volume flow	106,2	Nm ³ /h ^{(6), (1)}
Min. gas pressure at nom. Output *	20	mbar
Max. gas pressure at nom. Output *	70	mbar
Gas regulation line safety pressure	500	mbar

* At the inlet to the gas regulation line

3 Integrated heat extraction

3.1 Heating circuit

Heating water requirements in accordance with 'TA-002 Heating circuit'

Heating water volume flow ($\Delta t = 20 \text{ K}$)	26,0	m ³ /h
Heating water return temperature (max) *	70	°C
Heating water flow temperature (max) **	90	°C ⁽⁸⁾
Safety valve	6	bar
Operating pressure (min.)	1	bar
Internal pressure loss in heating circuit (approx.) *	400	mbar
Pressure reserve ca. *	500	mbar

3.2 Engine circuit

Coolant requirements in accordance with 'TA-001 Coolant'

Coolant heat	366	kW ⁽²⁾
Engine inflow temperature (min.)	80	°C
Engine exit temperature (max.)	88	°C
Balance inflow / exit (max.)	9	K
Recirculated coolant quantity (min.)	43,9	m ³ /h
Total cooling water circulation volume	43,9	m ³ /h
Operating pressure (max.)	2	bar
Operating pressure (min.)	1	bar
Safety valve	3,0	bar
Emergency cooling circuit Pressure reserve ca. (optional) *	250	mbar
Safety temperature limiter	110	°C
Mixture heat high temperature circuit (HT)	29	kW ⁽²⁾
Mixture coolant, inflow temperature high temperature circuit (max.)	80	°C
Mixture coolant recirculated quantity high temperature circuit (min.)	14,7	m ³ /h

* Up to / from module interface

** depending on the design of the heating circuit pump group, information applies to design by 2G. Heating water supply temperature max., in partial load operation < 90 °C.

4. Exhaust system

Exhaust gas temperature downstream of engine	545	°C ⁽³⁾
Exhaust temperature after exhaust heat exchanger	100	°C ⁽³⁾
Exhaust gas heat	209	kW ⁽²⁾
exhaust gas volume flow wet	1141	Nm ³ /h ⁽⁶⁾
exhaust gas volume flow dry	940	Nm ³ /h ⁽⁶⁾
exhaust gas mass flow wet	1433	kg/h
exhaust gas mass flow dry	1261	kg/h
Exhaust back pressure downstream of engine	50	mbar
Pressure reserve approx. (with catalytic converter) *	32 (17)	mbar
Safety temperature limiter	-	°C

5 Ventilation

radiant heat of module (approx.)	54	kW
Supply air volume flow min. (at $\Delta t = 15$ K)	11986	m ³ /h

6 Operating fluids

Lubricating oil approvals, see 'TA-003 Lubricating oil'

Lubrication oil consumption (\emptyset / max.)	0,08 / 0,2	g/kWh
Filling capacity lubricant (max.)	90	l
Lubricating oil filling tank fill capacity (optional)	190	l
Lubricating oil volume auxiliary tank (optional)	190	l
Motor circuit coolant fill quantity approx. (module)	172	l
Mixture cooling circuit LT coolant fill quantity approx. (module)	-	l
Coolant approvals, see 'TA-001 Coolant'		

7 Electronics and software

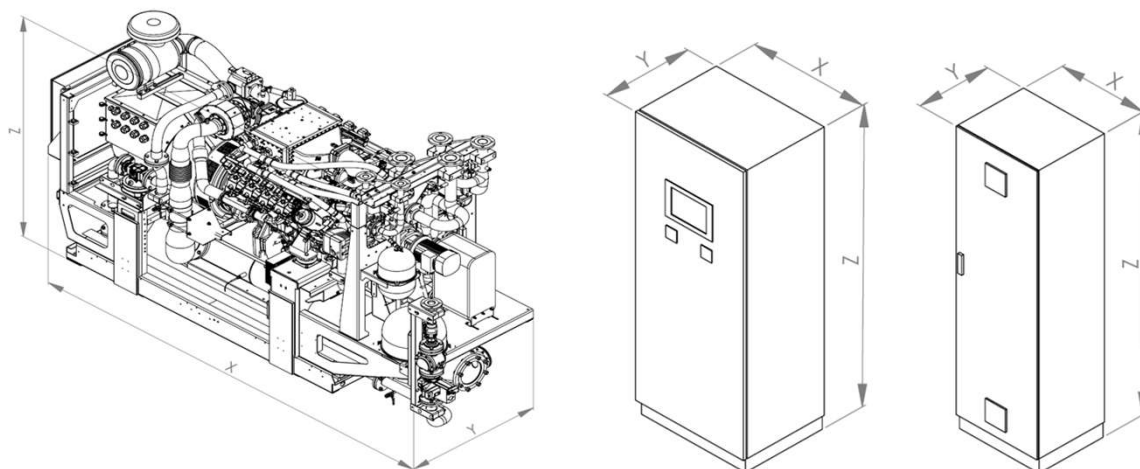
Grid protection device	Bachmann GSP	
Grid protection software status	> 13414	
Touchscreen display	10	"
Approval (depending on version)	VDE-AR-N 4105 / VDE-AR-N 4110	
Protection class Control cabinet	IP 54	
Protection class Power switch cabinet	IP 54	
Switch cabinet environmental temperature	0 - 35	°C
Switch cabinet relative air humidity (max.)	65	%

* From module interface (exhaust heat exchanger / catalytic converter in standard version and new condition)

8 Interfaces

8.1 Dimensions and weights

(Figures may differ)



Length Module *	X	4545	mm
Width Module *	Y	1310	mm
Height Module *	Z	2300	mm
Weight Module (without operating fluids)		6637	kg
Weight Module with sound encapsulation (optional)		8037	kg
Powder-coated CHP frame		RAL 6002	
Width Control cabinet	X	800	mm
Depth Control cabinet	Y	600	mm
Height Control cabinet	Z	2000	mm
Weight Control cabinet		200	kg
Control cabinet powder coated		RAL 7035	
Width Power switch cabinet	X	600	mm
Depth Power switch cabinet	Y	500	mm
Height Power switch cabinet	Z	2000	mm
Weight Power switch cabinet		150	kg
Power switch cabinet powder coated		RAL 7035	

*

8.2 Water / gas transfer points

Interfaces Gas	50 / 10	DN / PN
Interfaces Exhaust	250 / 10	DN / PN
Interfaces Heating circuit	80 / 16	DN / PN
Interfaces Emergency cooling circuit	80 / 16	DN / PN
Interfaces Mixture cooling circuit LT	-	DN / PN

8.3 Electrical connections / utility interface

Grid connection with pre-fuse (customer-provided)	400 V / 50 Hz	
Grid system	TN-S	
Short-circuit proof Icc (max.)	50	kA

8.4 Data interfaces

Remote maintenance access (optional) *	DSL / UMTS (SIM)
Interfaces / Data interfaces (optional):	<ul style="list-style-type: none"> - Profibus DP - Profinet IO - Modbus RTU - Modbus TCP - Ethernet IP - Hardware signals
Access virtual power plant (optional)	Possible after technical clarification (bus or hardware signals)

* Access for remote maintenance must be provided by the customer

9 Technical boundary conditions

Unless otherwise specified, all data is based on full engine load with the respective indicated media temperatures and subject to technical improvements. The generator output measured at the generator terminals serves as the basis for the delivered electrical power. All power and efficiency specifications are gross specifications. The fuel gas quality must conform to the specifications of 'TA-004 Gas'. The operating fluids and plant system layout must conform to the 'Technical instructions' of 2G.

- (1) Performance conditions in accordance with ISO 3046. Tolerance for specific fuel use amounts to + 5% of nominal performance. Efficiency specifications are based on an engine in new condition. An abatement in efficiency over the service life is reduced with observance of the maintenance requirements.
- (2) The tolerance for heat output is +/- 8 % under normal load.
- (3) Data according to new condition.
The tolerance for the exhaust temperature is +/- 8 %.
- (4) Corresponding to a residual oxygen concentration in the exhaust of 5 %
- (5) Electrical generator terminal power at $\cos \varphi = 1$.
- (6) Volume specifications for normal status:

Pressure	1013 mbar
Temperature	0 °C
- (7) Standard deviation of reproducibility 4 dB in accordance with DIN EN ISO 3746
- (8) The tolerance for the Heating water flow temperature is +/- 1 °C.

Power specifications in this document relate to standard reference conditions.

Standard reference conditions in accordance with ISO 3046-1:

Air pressure	1000 mbar
Air temperature	25 °C
Relative air humidity	30 %

Power reduction

Power reduction due to installation at altitude > 300 m a.s.l. and/or air suction temperature > 25 °C shall be determined specifically for each project according "TI-049 Load reduction".

(*) It is possible to retrofit the 2G plant onsite for operation with up to 100% hydrogen. Performance data and interfaces may change.