H1 Assessment to Support a Permit Application for Three Maids Anaerobic Digestion Plant (AD), Three Maids Farm, Three Maids Hill, Winchester, SO21 2QG

Acorn Bioenergy Operations Limited

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Abbreviations

AEL	Associated Emissions Level
AD	Anaerobic Digester
AQIA	Air Quality Impact Assessment
AW	Ancient Woodland
BAT	Best Available Techniques
BG	Biogas
BUU	Biogas upgrading unit
CH_4	Methane
CHP	Combined heat and power (engine)
CO_2	Carbon dioxide
EA	Environment Agency
EAL	Environmental Assessment Level
ELV	Emission Limit Value
EPR	Environmental Permitting Regulations
ETL	Earthcare Technical Ltd
H1	Environment Agency Horizontal Guidance Note H1
H_2S	Hydrogen sulphide
kWe	Kilowatts electrical output
kWthi	Kilowatts thermal input
LWS	Local wildlife site
MCP	Medium Combustion Plant
MCPD	Medium Combustion Plant Directive
MWth	Megawatts thermal input
n/a	Not applicable
N	Nitrogen
NG	Natural Gas
NGR	National Grid Reference
O_2	Oxygen
PC	Process Contribution
PEC	Predicted environmental concentration
PVRV	Pressure and vacuum relief valve
SO_2	Sulphur dioxide
SAC	Special Area of Conservation
TVOC	Total gaseous and vaporous organic substances, expressed as total organic carbon
VOC	Volatile organic compounds

Executive Summary

Earthcare Technical Ltd (ETL) have screened the potential air quality impact associated with the proposed application for the operation of an anaerobic digestion (AD) plant at Three Maids, Three Maids Farm, Three Maids Hill, Winchester, SO21 2QG.

The Environment Agency's H1 Assessment Tool has been used for quantitative assessment of the proposed point source emissions to air including the 2No. CHPs, emergency flare, emergency boiler, emergency generator, Manure reception building emissions abatement stack, Digestate off-take bay emission abatement vent, 3No. digestate storage bag vents, and an underground leachate tank vent.

The process contribution of emissions to air and background concentrations have been compared with relevant environmental standards for the protection of health and ecosystems and Environment Agency (EA) significance criteria.

Emission rates of pollutants were based on Medium Combustion Plant (MCP) Emission Limit Values, Best Available Techniques (BAT) Associated Emissions Levels (AELs) and relevant guidance.

The H1 assessment has determined that the pollutant-EALs which require further assessment using detailed modelling are all EALs for human health:

- Nitrogen Dioxide (Annual and 1 Hour Mean)
- Nitrogen Dioxide (Ecological - Daily Mean)
- Ammonia (Ecological - Sensitive Lichens)
- Carbon monoxide (8h mean)
- Benzene (Annual and 24 Hour mean)
- Sulphur Dioxide (15 Min Mean)
- Sulphur Dioxide (1 Hour Mean)
- Sulphur Dioxide (24 Hour Mean)
- Sulphur Dioxide (Ecological - Sensitive Lichens)

1 Introduction

This H1 Assessment (H1) has been prepared by Earthcare Technical Ltd (ETL) on behalf of Acorn Bioenergy Operations Limited, hereafter referred to as 'the Client,' to support an application for a new bespoke installation permit application for an anaerobic digestion (AD) plant including the use of resultant biogas , biogas upgrader, with carbon dioxide capture and liquefaction at Three Maids AD Plant, Three Maids Farm, Three Maids Hill, Winchester, SO21 2QG (the Site).

The plant will be operated by Acorn Bioenergy Operations Limited (the Operator). The plant has been designed by Agraferm Ltd (Agraferm) who will also be responsible for construction, key equipment supplies and commissioning. Bright Renewables UK will supply and commission the biogas upgrade unit (BUU) and carbon dioxide recovery equipment.

An H1 risk assessment using the H1 tool, which is a conservative tool, is used to screen out the pollutants from the proposed emission sources that do not require further assessment. Pollutants that do not screen out would need to be considered in an Air Quality Impact Assessment (AQIA) which would use detailed dispersion modelling.

1.1 Site location

The site sits within the northwest section of the intersection between the A34 dual carriageway and the A272. The site's gradient slopes in a north easterly direction towards the A34 from approximately 93.5m AOD to approximately 87.8m AOD. The site is located approximately 4km north northwest of the city of Winchester.

The surrounding area is used principally for arable farming and grassland with pockets of protected Ancient Woodland. Other land uses within 1km of the site include: a solar farm, an area used for muck-away, recycling and aggregates processing, and a pig farm. The nearest residential premises, Three Maids Bungalow, is situated approximately 250m southwest of the Site. The village of Littleton lies over 1km southwest of the proposed site.

On the 18 December 2023, Winchester County Council granted planning permission (reference: 23/01594/FUL) for the development of an Electric Vehicle Charging Station (EVCS) with associated ancillary restaurant, outdoor seating and play area on land directly adjacent to the southern site boundary. At the time of writing construction had not started.

Within 2km of the proposed site, there are nine locally designated conservation sites, the closest of which is Worthy Copse an area designated as Ancient Woodland, a Local Wildlife Site (LWS) and Site of Importance for Nature Conservation (SINC) located 157m northwest of the site. The additional eight sites include: South Worthy Grove (AW, SINC), Worthy Grove (LWS, AW, SINC), The Gallops, Worthy Down (LWS, SINC), Long Wood (AW, SINC), Northwood Park Woods (Cradle Copse) (LWS, SINC), Flowerdown, Littleton (LWS, SINC), Worthy Camp Grassland (LWS, SINC), and Worthy Down Railway Halt (LWS). There is one statutory designation within 10km; the River Itchen Special Area of Conservation (SAC) located at its nearest point approximately 3.6 km southeast of site.

1.2 The operation

Figure 1 shows the proposed green line permit boundary for the AD Plant and the proposed locations of the point source emissions to air.

With specific regard to emissions to air, supporting infrastructure includes the following, where numbering A1-A23 refer to point source emissions, as shown on the emission point plan (Figure 1):

- 2 No. CHP engines with 7 m stacks (TEDOM Quanto 1200 1.2 MWe) (**A1, A2**)
- Emergency flare – 8.7 m stack height (**A3**)
- 1 No. 550 kW emergency biogas boiler (**A4**)
- 1 No. diesel emergency generator (770 kVA) (**A5**)
- Manure reception building incorporating: air handling and emissions abatement system ('Centri-Air AB') (**A6**)
- Biogas upgrade unit (BUU) PRV (**A7**)
- BUU Carbon dioxide (CO_2) vent (**A8**)
- 2No. CO_2 recovery plant PRVs (**A9, A10**)
- 2No. Compressor PRVs (**A11, A12**)
- 1 No. underground leachate tank with vent (1 x 50 m^3) (**A13**)
- 5 No. digesters: 2No. Primary digesters PVRVs (**A14, A15**), 2No. Secondary digesters PVRVs (**A16, A17**), 1 No. Tertiary digester PVRV (**A18**)
- 1 No. Digestate storage bag with leak detection (3No. vents **A19 – A21**)
- 1 No. Digestate off-take bay with sump (3 m^3) and carbon filter abatement system on liquid digestate tanker dispatch point (**A22**)

The plant will treat around 94,000 TPA of liquid and solid feedstock comprising: livestock waste (poultry and farmyard manures and slurry); energy crops and crop residues; and dirty water. All solid manure feedstock is received and processed within an enclosed Manure reception building which benefits from the continuous operation of an air extraction and emissions abatement system (emission point **A6**).

There will be five digesters (two primary (PD1 & PD2), two secondary (SD1 & SD2) and one tertiary or 'post' digester (TD1). Each digester will have a Pressure and vacuum relief valve (PVRV) (emission points **A14** to **A18**) to emit biogas or take in air if there is an over-pressure or under-pressure event respectively. PVRVs will not operate during normal operation, over-pressure is managed by operation of the flare (emission point **A3**) before the PVRVs. The operation of the digester PVRVs is therefore not considered within the H1 assessment.

Emissions will be released from the combustion of biogas (BG) in CHP1 (SO_2, TVOC, NOx and CO) and natural gas (NG) in CHP2 (TVOC, NOx and CO) from 7m stacks (emission points **A1** and **A2**). The 2No. 1,200kWe CHPs are required to meet the Medium Combustion Plant (MCP) Directive Emission Limit Values (ELVs) for sulphur dioxide (SO_2) and nitrogen oxides (NOx) for new plant.[1] The emissions and monitoring standards that apply to total volatile organic

[1] DIRECTIVE (EU) 2015/2193 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants

compounds (TVOC) and carbon monoxide (CO) from biogas fuelled engines are the same as those applied to landfill gas engines.[2]

- 107 mg/Nm^3 for SO_2 (5% O_2), MCP ELV
- 500 mg/Nm^3 for NOx (5% O_2), MCP ELV (for biogas)
- 250 mg/Nm^3 for NOx (5% O_2), MCP ELV (for natural gas)
- 1,000 mg/Nm^3 for TVOC (5% O_2), LFTGN08
- 1,400 mg/Nm^3 for CO (5% O_2), LFTGN08

Biogas may be burnt under abnormal operating conditions such as during extended periods of maintenance of the CHPs and/or malfunction of the BUU by the emergency flare (emission point **A3**). The flare should operate for a limited number of hours per year (<10% or <876 hours) as it is only used under abnormal operating conditions. Guidance for monitoring enclosed landfill gas flares (LFTGN 05[3]) sets out the emission standards for enclosed gas flares:

- 150 mg/Nm^3 for NOx (3% O_2), LFTGN 05
- 50 mg/Nm^3 for CO (3% O_2), LFTGN 05
- 10 mg/Nm^3 for TVOC (3% O_2), LFTGN 05

The emergency biogas boiler (emission point **A4**) will be used to generate heat for the AD plant when the CHPs are unavailable and/or cannot provide sufficient heat to the AD Plant, for instance in the event of extreme cold weather, CHP breakdown or prolonged unscheduled maintenance. It has been conservatively assumed in this H1 assessment that the emergency boiler could potentially operate approximately 15% of the time (i.e. for approximately two months) but it is expected it will in practice operate less than 5% of the time. The emergency boiler will not be used in normal operation.

The boiler will release emissions to air of NOx, SO_2 and CO from the 7m stack. The 647kWthi (thermal input) biogas-fired emergency standby boiler will meet the MCP Directive ELVs for new plant fired by biogas although it is not an MCP as its thermal input is less than 1MW. There are no BAT-AELs for TVOC and CO, emissions of which will be negligible from the emergency boiler:

- 100mg/Nm^3 for SO_2 (3% O_2), MCP ELV
- 200mg/Nm^3 for NOx (3% O_2), MCP ELV
- No limit set for CO (3% O_2)

An emergency standby diesel generator (770 kVA, 616kWe, 1,867kWthi) (emission point **A5**) will provide power when the CHPs are not operational and if power is not available from the grid. Therefore, it would be used only as an emergency backup operating typically less than 50 hours per year and operating less than 500 hours per year as a 3-year rolling average. It would be exempt from meeting MCPD ELVs and as such is not part of the H1 quantitative assessment.

[2] Environment Agency (2010) LFTGN08 v2 2010: guidance for monitoring landfill gas engine emissions (https://assets.publishing.service.gov.uk/media/5a7d87c140f0b64fe6c24434/LFTGN08.pdf)

[3] Environment Agency (2010) Guidance for monitoring enclosed landfill gas flares LFTGN05 v2 2010 (https://www.gov.uk/government/publications/monitoring-enclosed-landfill-gas-flares-lftgn-05)

Biogas (45 - 60% CH_4 by volume) will enter the BUU where it will be treated to create biomethane (97.5% CH_4 by volume) which leaves the BUU. Biogas from the gas holders will be pass through a series of gas treatment steps including cooling, filtration (2No. carbon filters to remove H_2S and 1 No. filter for VOCs, compression prior to three-stage membrane filtration which separates the biogas into methane (CH_4) and carbon dioxide (CO_2).

Biogas will be released from the Pressure Relief Valve (PRV) on the BUU in over-pressure scenarios only (emission point **A7**). In the event that the CO_2 recovery plant is not operational, during abnormal conditions, residual CO_2 emissions will be released from the BUU via a stack ('CO_2 vent', emissions point **A8**). The cleaned gas that is vented must comply with Gas Safety Management Regulations for hydrogen sulphide (H_2S) and total sulphur, and TVOC at minimal level of detection. The release of CO_2 due to the abnormal operation of the BUU PRV has therefore not been considered within the H1 assessment.

The BUU will be fitted with CO_2 recovery equipment so the remaining CO_2 output stream will not be released to air but captured prior to liquefaction of the CO_2. The CO_2 is compressed in a two-stage process compressor and passed through an automatic molecular sieve dryer to completely remove moisture. The CO_2 then passes through a fine filter to remove any remaining odorant compounds or impurities, as well as any remaining powders. The gas treatment technology is designed specifically to remove contaminants and ensure a high level of CO_2 purity.

The gas (99.9% v/v CO_2 purity) is sent to a CO_2 liquefier; traces of non-condensable gases still contained in the CO_2 gas remain gaseous when the CO_2 transforms to liquid in the liquefier. Any entrained non-condensables, such as oxygen, methane, and nitrogen are effectively removed in a stripping tower. These non-condensable gases are used for regeneration of the dryer; the pure liquid CO_2 flows to a storage tank. When both the BUU and CO_2 recovery plant are operational, cleaned gas may be released from the PRVs in over-pressure scenarios only (emission points A7, A9 and A10). Emissions from the CO_2 recovery plant have therefore not been assessed.

Silage leachate is produced from storage of silage. The leachate runs forwards from the clamps into drainage channels, then to an underground leachate storage tank, from where it is pumped into the Process water tanks and then used in the AD process. The leachate storage tank will be fitted with one vent (emissions point **A13**).

Whole digestate from the Tertiary digester will be screened and pasteurised before being cooled and pumped to the Suspension buffer tank (400m^3). Any displaced air during the pasteurisation process is recycled back to into the gas system. Separated liquor is pumped from the separator to either: the 7,344 m^3 Digestate storage bag where residual emissions are released via three vents (emission points **A19 to A21** inclusive); or the sealed 100m^3 Process water buffer tank. Tankers will be filled with liquid digestate at a tanker loading point fitted with a carbon filter emissions abatement system (emission point **A22**).

1.3 About this report

This report describes: the assessment methodology and source data (section 2); the calculated impact (section 3); and concludes in section 4. Appendix A shows the H1 input and output tables.

2 Assessment methodology

2.1 H1 Emissions to Air Screening Assessment

The H1 screening evaluation has been undertaken following H1 methodology, set out in Environment Agency (EA) guidance[4] and using the EA H1 Assessment Tool spreadsheet (v8).[5]

2.2 Assessment Criteria

2.2.1 Air Quality Standards and Critical Levels – Human Health

Table 2.1 sets out those Air quality strategy (AQS) objectives, Ambient Air Directive (AAD) Limit Values and Environmental Assessment Levels (EALs) for the protection of human health that are relevant to this assessment in determining receptor exposure. In the H1 Assessment Tool these are all referred to as EALs.

Table 2. 1 Air Quality Standards for human health

Substance	Emission period	Limit (average)	Standard	Exceedances[1]
Ammonia	1 hour	2,500 µg/m^3	EAL	None
Ammonia	Annual	180 µg/m^3	EAL	None
Benzene	24 hour	30 µg/m^3	EAL	None
Benzene	Annual	5 µg/m^3	AAD Limit Value and AQS Objective	None
Carbon monoxide	8 hour running average across a 24-hour period	10,000 µg/m^3	AAD Limit Value	None
Hydrogen sulphide	24-hour	150 µg/m^3	EAL	None
Hydrogen sulphide	Annual	140 µg/m^3	EAL	None
Nitrogen dioxide	1 hour	200 µg/m^3	AAD Limit Value	Up to 18 1-hour periods
Nitrogen dioxide	Annual	40 µg/m^3	AAD Limit Value	None
Sulphur dioxide	15 minutes	266 µg/m^3	UK AQS Objective	Up to 35 15-minute periods
Sulphur dioxide	1 hour	350 µg/m^3	AAD Limit Value	Up to 24 1-hour periods
Sulphur dioxide	24 hour	125 µg/m^3	AAD Limit Value	Up to 3 24-hour periods

Notes: from https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit
[1]number of times a year that the limit may be exceeded
AQS: Air quality strategy; AAD: Ambient Air Directive; EAL: Environmental Assessment Level

[4] Environment Agency and Department for Environment, Food & Rural Affairs, Air emissions risk assessment for your environmental permit, Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit [Accessed 19 October 2023]
[5] Atmospheric Dispersion Modelling Liaison Committee, H1 Risk Assessment Tool, Available at: https://admlc.com/h1-tool/ [Accessed March 2024]

2.2.2 Environmental standards for protected conservation areas

The AQS objectives and AAD Limit Values for the protection of vegetation and ecosystems applicable to this assessment are presented in Table 2.2.

Table 2. 2 Environmental standards for protected conservation areas

Substance	Target	Emission period
Ammonia	1 µg/m^3 where lichens or bryophytes (including mosses, landworts and hornwarts) are present. 3 µg/m^3 where they are not present.	Annual
Sulphur dioxide[1]	10 µg/m^3 where lichens or bryophytes are present 20 µg/m^3 where they are not present	Annual
Nitrogen oxides (expressed as nitrogen dioxide)[2]	30 µg/m^3	Annual
Nitrogen oxides (expressed as nitrogen dioxide)	75 µg/m^3 200 µg/m^3 for detailed assessments where the ozone is below the AOT40[6] critical level and sulphur dioxide is below the lower critical level of 10 µg/m^3	Daily
Notes: from https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit [1]20 µg/m^3 is an AAD Limit Value if you have nature or conservation sites in the area; [2]30 µg/m^3 is an AAD Limit Value		

2.3 Environment Agency Risk Assessment Guidance

The current evaluation is based on EA risk assessment guidance[4] to determine the significance of the predicted impact. The guidance provides screening criteria for quantifying the environmental impacts of emissions to air. The criteria include long and short-term Environmental Assessment Levels (EALs).

The guidance considers initial H1 screening and then detailed modelling. At the initial screening stage, **Test 1**, long-term and short-term concentrations due to the sources entered, referred to as the Process Contribution (PC) can be screened out from further assessment if:

- the short-term PC is less than 10% of the short-term environmental standard, and
- the long-term PC is less than 1% of the long-term environmental standard.

The second stage of screening, **Test 2**, considers the background concentration as well as the PC.

[6] The sum of difference between hourly ozone concentration and 40ppb for each hour when the concentration exceeds 40ppb during a relevant growing season (May to July) averaged over five years Available at: AOT40 — European Environment Agency (europa.eu) [Accessed 18 October 2023]

Defra provides maps of 2024 background concentrations of NOx and NO_2 that have been projected from a base year of 2018; benzene projected to 2010 from a base year of 2001 and SO_2 and CO for 2001. Factors are provided to project the concentrations of benzene, CO and SO_2 to future years.[7] The maps and factors have been used to determine 2024 background concentrations, which are shown in Table A5.

Background concentrations of NH_3 are not part of the Defra mapped data and have been obtained from APIS.[8] Background concentrations of NOx, SO_2 all the ecological receptors have also been obtained from APIS maps which provide the data on a 1km grid cell basis.

The Predicted Environmental Concentration (PEC) is the sum of the PC and background concentration. A further assessment is not needed if:

- for human receptors only, the short-term PC is less than 20% of the short-term environmental standards minus twice the long-term background concentration i.e., less than 20% of the 'Headroom', and
- the long-term PEC is less than 70% of the long-term environmental standards.

In accordance with the guidance, it is not necessary to calculate PEC for short-term targets. For an ecological receptor, if the short-term PC exceeds 10% of the EAL, detailed modelling is required.

If the PC cannot be screened out on that basis, the guidance outlines further steps, including detailed modelling, which may lead to a requirement to carry out a cost-benefit analysis.

2.4 H1 Inputs – Process Emissions

Table 2.3 details the H1 input parameters for the point source emissions; the input data entered in the H1 Assessment Tool is shown in Appendix A, Tables A.1 and A.2. It has been assumed that the CHP will operate 100% of the time and, as a worst case, that the emergency boiler will operate for approximately 2 months (15% of the time) and the emergency flare for 10% of the time.

Emissions have been assumed to meet the MCP ELVs where applicable (section 1.2). For the boiler, emissions of TVOC and CO will be negligible.

The effective stack height has been calculated for each point source in accordance with EA guidance[9,10].

[7] Defra, Background Maps, Available at: https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html [Accessed 20 November 2023]
[8] Air Pollution Information System, Available at www.apis.ac.uk, [Accessed 20 November 2023]
[9] Gov.uk Air emissions risk assessment for your environmental permit: Effective height of release: impact of nearby buildings (https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit)
[10] Environment Agency (2023) H1 Software Tool User Guide, Version 8.0, October 2023.

Table 2. 3 CHP, emergency flare and emergency boiler emission parameters (A1, A2, A3, A4)

Parameter	Units	CHP A1 (BG) [1]	CHP A2 (NG) [2]	Emergency flare (A3) [3]	Emergency boiler (A4) [4]
Location	Easting, Northing	446014, 134088	446010, 134097	445988, 134142	445996, 134080
Fuel	-	Biogas	Natural gas	Biogas	Biogas/ Natural gas
Electrical output	kWe	1,200	1,200	-	-
Thermal output	kWtho	n/a	n/a	-	560
Stack height	m	7	7	8.7	7
Effective stack height	m	0	0	0	0
Internal diameter at exit	m	0.4	0.4	2.645	0.25
Volume flow rate (dry)	Nm^3/s	1.04	1.19	5.48	0.16
Volume flow rate (wet)	Am^3/s	2.21	2.51	63.19	0.33
Velocity	m/s	17.6	20.0	11.5	6.73
Temperature	°C	150	150	1,000	180
Exit concentration SO_2	mg/Nm^3	107 (ELV, 5% O_2)	n/a	n/a	100 (ELV, 3% O_2)
Exit concentration TVOC	mg/Nm^3	1,000 (ELV, 5% O_2)	1,000 (ELV, 5% O_2)	10 (ELV, 3% O_2)	n/a
Exit concentration NOx	mg/Nm^3	500 (Tech spec, 5% O_2)	250 (Tech spec, 5% O_2)	150 (ELV, 3% O_2)	200 (ELV, 3% O_2)
Exit concentration CO	mg/Nm^3	1,400 (ELV, 5% O_2)	1,400 (ELV, 5% O_2)	50 (ELV, 3% O_2)	n/a
Emission rate SO_2	g/s	0.11	-	-	0.016
Emission rate TVOC	g/s	1.04	1.19	0.05	-
Emission rate NOx	g/s	0.52	0.30	0.82	0.031
Emission rate CO	g/s	1.46	1.66	0.27	-

Notes:

[1] CHP1, TEDOM Quanto 1200 TCG2020V12, fuelled by biogas (Appendix B). ELVs are the MCP Directive values for new plant (Annex II, Part 2, Table 2: gaseous fuels other than natural gas). Flue gas diameter, and height were advised by ABL. The exhaust gas volume flow rate (wet) is from the manufacturer's datasheet; the oxygen (8%) and moisture content (10%) were estimated based on monitoring data from comparable engines.

[2] CHP2, TEDOM Quanto 1200 TCG2020V12, fuelled by natural gas (Appendix B). ELVs are the MCP Directive values for new plant (Annex II, Part 2, Table 2: natural gas). Flue gas diameter, and height were advised by ABL. The exhaust gas volume flow rate (wet) was taken from the manufacturer's datasheet; the oxygen (8%) and moisture content (10%) were estimated based on monitoring data from comparable engines.

[3] Based on Uniflare UF10-2500 High Temperature Enclosed Flare Stack (Appendix C) with maximum biogas flow rate of 2,500 Nm^3/h. Data on ELVs, temperature and volume flow rate were supplied by the manufacturer, Uniflare. Emission rates shown are for continuous operation; for long-term impact it has been assumed the flare will operate for a maximum of 10% of the time.

[4] Boiler parameters have been based on example specification for a 560 kW, Veissmann Vitoplex 200 (Appendix D). The ELVs for SO_2 and NOx are the MCP Directive values for new plant for the combustion of biogas (Annex II, Part 2, Table 1). The specification was used to reference volumetric flow rates; the oxygen (4.3%) and moisture (15.2%) content of the exhaust gas have are referenced from monitoring data from the same boiler at Wardley Biogas AD Facility (16 November 2020). Emission rates shown are for continuous operation; for long-term impact it has been assumed the emergency boiler will operate for a maximum of 15% of the time.

Table 5 Stack and emission parameters: A6, A13, A19- A21, and A22

Parameter	Units	(A6) OCU stack[1]	(A13) Leachate tank vent[2]	(A19 – A21) Digestate storage bag vents 1 - 3[3]	(A22) Liquid digestate dispatch point[4]
Location	NGR (X,Y) m	446049, 134061	446028, 133948	445960, 134129 445977, 134095 445968, 134112	446011, 134078
Stack height	m	15.5	0.1	0.5	2.5
Effective stack height	m	4.3	0	0	0
Internal diameter at stack exit	m	0.55	0.1	0.1	0.1
Volume flow rate (dry)	Nm^3/s	-	-	-	-
Volume flow rate (wet)	Am^3/s	5.14	0.009	0.001	0.02
Velocity	m/s	21.6	0.1	0.1	2.86
Temperature	°C	22.5	Modelled as 'Ambient'	Modelled as 'Ambient'	Modelled as 'Ambient'
Exit concentration NH_3	mg/Nm^3	3.5	17.9	(1,129) [5]	0.9 (0.04)[6]
Exit concentration Odour	ou_E/Nm^3	1,000	10,000	10,000 (500) [5]	10,000 (500)[6]
Emission rate NH_3	g/s	0.018	0.00016	(0.0009) [5]	0.00002 (0.000001)[6]
Emission rate Odour	ou_E/s	5,139	40.5	7.85 (0.39) [5]	225 (11.3) [6]

Notes:

[1] Emissions abatement system designed and supplied by Centri-Air AB. Data on the extraction system flow rates and design parameters taken from the data sheet (Appendix X). NH_3 concentrations (5ppm or $3.5mg/m^3$ at 22.5°C) based on technical specification; odour concentrations are based on BAT-AEL for channelled emissions (1,000 ou_E/Nm^3). The BAT-AEL for NH_3 and odour is not necessarily applicable where waste is derived principally from manure.

[2] Underground leachate tank vent: stack height, diameter and volume flow rates based on assumptions. Exit concentrations of NH_3 have been calculated based on the nitrogen content of fresh matter in the feedstock (7.1kg total N/tonne) derived from the feedstocks used within the process. Odour concentrations based on measured odour concentrations for a digestate storage bag (AS Modelling & Data, 2017[11]). A 55% reduction to emissions has been applied to account for dilution of the leachate by surface water run-off.

[3] 3No. Lagoon vents: stack height, diameter and volume flow rates based on assumptions. NH_3 concentrations have been calculated based on the nitrogen content of fresh matter in the feedstock (7.1kg total N/tonne) derived from the feedstocks used within the process. Odour concentrations based on measured odour concentrations for a digestate storage bag (AS Modelling & Data, 2017).

[4] Digestate off-take point with carbon filter abatement system. Stack height, diameter and volume flow rates from carbon filter based on assumptions. NH_3 and odour concentrations have been calculated based on the nitrogen content of fresh matter in the feedstock (7.1kg total N/tonne) derived from the feedstocks to be used within the process. Emission rates have been factored to account for intermittent tanker filling, assuming constant rate Monday to Sunday, 9 hours per day (3,285 hours/ year).

[5] Brackets indicate values used for modelling, factored to account for 95% reduction in emissions due to containment within a digestate storage bag.

[6] Brackets indicate values used for modelling, factored to account for 95% reduction in emissions through the carbon filter.

[11] A S Modelling & Data (2017) A Dispersion Modelling Study of the Impact of Odour from the Proposed Biofertilizer Storage Lagoon at land west of Hangman Stone Lane, near High Melton in South Yorkshire.

3 Impact assessment

Output tables from the H1 Assessment Tool are shown in Appendix A, Tables A.3 to A.7. Table A.3 shows the long-term and short-term PCs and EALs for each pollutant.

3.1 Air Impact Screening, Test 1

In Table A.4 the long-term and short-term PCs calculated by the H1 Assessment Tool are compared with the EAL. All pollutant-EAL combinations, with the exception of short-term impacts from ammonia on human receptors, 'fail' Test 1.

3.2 Air Impact Screening, Test 2

In Table A.5 the long-term PECs are compared with the EALs and the short-term PCs are compared with Headroom (EAL minus twice the long-term background concentration). All pollutant-EAL combinations, with the exception of long and short-term impacts from ammonia on human receptors, 'fail' Test 2.

3.3 Deposition to land

Table A.6 compares the long-term PC to the EAL to assess the significance of impacts due to deposition. The following pollutant-EALs are assessed as not insignificant:

- Nitrogen dioxide,
- Benzene (24h mean)[12]
- Ammonia to ecological receptors with sensitive lichens present; and
- Sulphur dioxide to ecological receptors with and without sensitive lichens present.

Deposition to land has been considered in the supporting AQIA[13] for potential impact on ecological receptors.

3.4 Summary

Table A.6 is the output table summarising which pollutant-EALs require further assessment using detailed modelling. Those requiring detailed modelling are given as:

- Nitrogen Dioxide (Annual and 1 Hour Mean)
- Nitrogen Dioxide (Ecological - Daily Mean)
- Ammonia (Ecological - Sensitive Lichens)
- Carbon monoxide (8h mean)
- Benzene (Annual and 24 Hour mean)

[12] The H1 tool has included benzene (24 hour) in the assessment of the significance of impacts due to deposition, however, there are no EALs relevant to the assessment of benzene on ecological receptors.

[13] Earthcare Technical Ltd (March 2024) Air Quality Impact Assessment to Support a Permit Application for Three Maids Anaerobic Digestion Plant (AD), Three Maids Farm, Three Maids Hill, Winchester, SO21 2QG. Doc Ref: ETL724_AQIA_V1.0_THRM_Mar24.

- Sulphur Dioxide (15 Min Mean)
- Sulphur Dioxide (1 Hour Mean)
- Sulphur Dioxide (24 Hour Mean)
- Sulphur Dioxide (Ecological - Sensitive Lichens)

Deposition to land will be considered for potential impact on ecological sites within relevant screening distance criteria.

4 Conclusion

This H1 Assessment has been completed to assess whether the air quality impact of point source emissions to air at the proposed AD plant at Three Maids, Three Maids Farm, Three Maids Hill, Winchester, SO21 2QG.

The H1 Assessment Tool spreadsheet v.8 has been used for quantitative assessment of combustion sources including the CHPs (A1, A2), emergency flare (A3) and emergency boiler (A4). The emergency generator (A5) would be used for less than 50 hours per year and as such has not been part of the quantitative screening assessment. Emissions were assumed to meet the MCP ELVs for NOx and SO_2, and, for the CHPs, EALs for CO and TVOC. The emergency backup boiler will meet the MCP Directive ELVs for new plant fired by biogas although it is not an MCP as its thermal input is less than 1MW. The emergency generator will be a new MCP operating less than 500 hours per year as a 3-year rolling average and exempt from meeting MCPD ELVs.

Additional point sources to air evaluated within the screening assessment included: the Manure reception building odour abatement system stack (A6), the underground leachate tank vent (A13), 3No. vents on the surface of the Digestate storage bag (A19 – A21), and emissions from the digestate off-take point carbon filter (A22).

Test 1 of the assessment compared the long-term and short-term PCs calculated by the H1 Assessment Tool with the relevant EALs; all pollutant-EAL combinations, with the exception of short-term impacts from ammonia on human receptors, were found to 'fail' Test 1.

Test 2 compared the long-term PECs are compared with the EALs and the short-term PCs with Headroom (EAL minus twice the long-term background concentration); all pollutant-EAL combinations, with the exception of long and short-term impacts from ammonia on human receptors, were found to 'fail' Test 2.

Three pollutants EALs for ecological receptors, including NO_2, NH_3 and SO_2 need to be considered further for the local and nationally designated ecological sites. Deposition to land will be considered for potential impact on these sites.

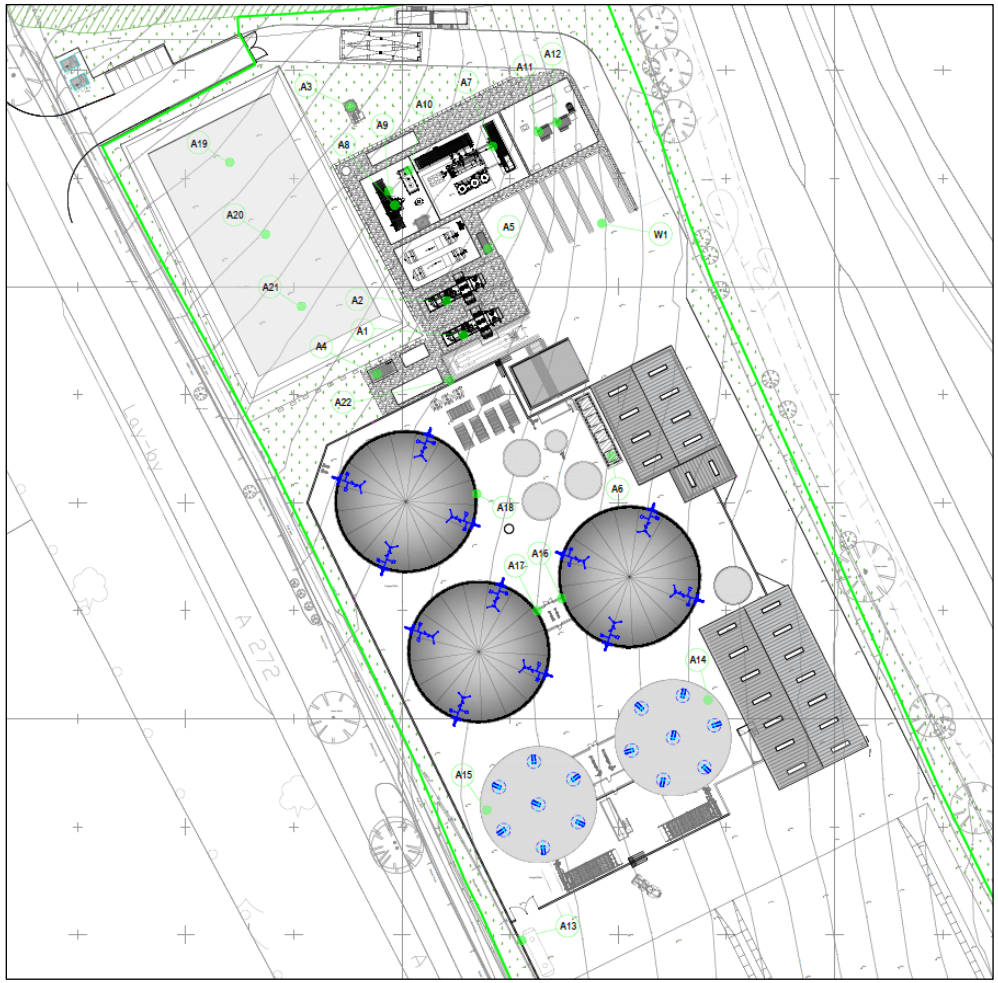
The pollutant-EALs which require further assessment using detailed modelling, within an air quality impact assessment include the following:

- Nitrogen Dioxide (Annual and 1 Hour Mean)
- Nitrogen Dioxide (Ecological - Daily Mean)
- Ammonia (Ecological - Sensitive Lichens)
- Carbon monoxide (8h mean)
- Benzene (Annual and 24 Hour mean)
- Sulphur Dioxide (15 Min Mean)
- Sulphur Dioxide (1 Hour Mean)
- Sulphur Dioxide (24 Hour Mean)
- Sulphur Dioxide (Ecological - Sensitive Lichens)

An air quality impact assessment has been prepared and submitted to support this application.

Figures

Figure 1 AD Plant permit boundary emission points



Reference Table	
A1	Combined heat and power engine stack 1
A2	Combined heat and power engine stack 2
A3	Emergency flare stack
A4	Emergency boiler stack
A5	Emergency generator stack
A6	Emissions abatement plant stack (manure reception building)
A7	Biogas upgrade unit PRV
A8	Biogas upgrade unit CO_2 vent
A9	Carbon dioxide recovery plant PRV 1
A10	Carbon dioxide recovery plant PRV 2
A11	Compressor PRV 1
A12	Compressor PRV 2
A13	Underground leachate tank vent
A14	PVRV on Primary digester 1
A15	PVRV on Primary digester 2
A16	PVRV on Secondary digester 1
A17	PVRV on Secondary digester 2
A18	PVRV on Tertiary digester
A19	Digestate storage bag vent 1
A20	Digestate storage bag vent 2
A21	Digestate storage bag vent 3
A22	Liquid Digestate off-take point
W1	Clean surface water from underground storage system

Base plan produced by GGP Reference: Acorn-29348-C-202-E Site Emissions Plan. Edited by Earthcare Technical Ltd March 2024.

Appendix A H1 Assessment Tool Input and Output

Table A.1 Input: Air release points

Release point code	Location or grid reference	Activity/Activities	Effective height (metres)	Dispersion factor (Long term)	Dispersion factor (short term)	Efflux velocity (m/s)	Total flow (m3/h)
A1	CHP 1 BG	Combustion	0	148	3900	17.6	3752
A2	CHP 2 NG	Combustion	0	148	3900	20.0	4268
A3	Emergency flare	Combustion	0	148	3900	11.5	19741
A4	Emergency boiler	Combustion	0	148	3900	6.73	564
A6	Emissions abatement plant stack	Abatement	4.3	98.1	2472	21.6	18500
A13	Leachate tank vent	Residual emissions release	0	148	3900	0.1	32.4
A19	Digestate storage bag vent 1	Residual emissions release	0	148	3900	0.1	2.83
A20	Digestate storage bag vent 2	Residual emissions release	0	148	3900	0.1	2.83
A21	Digestate storage bag vent 3	Residual emissions release	0	148	3900	0.1	2.83
A22	Digestate off-take vent	Abatement	0	148	3900	2.86	81.0
A13	Leachate tank vent	Residual emissions release	0	148	3900	0.1	32.4

Table A.2 Input: Emissions inventory

Release Point	Substance	Measurement method	Operating mode(%)	Long term conc (mg/m3)	Release rate g/s (long term)	Short term conc (mg/m3)	Release rate g/s (short term)	Annual rate (t/yr)	Long term PC (ug/m3)	Short term PC (ug/m3)	Total Flow
A1	Nitrogen Dioxide	Estimated	100%	500	0.521111	500	0.5211111	16.43	77.12	2032.33	3752.00
A1	Nitrogen Dioxide (Ecological - Daily Mean)	Estimated	100%	500	0.521111	500	0.5211111	16.43	77.12	1199.08	3752.00
A1	Sulphur Dioxide (15 Min Mean)	Estimated	100%	107	0.111518	107	0.1115178	3.52	16.50	582.79	3752.00
A1	Sulphur Dioxide (1 Hour Mean)	Estimated	100%	107	0.111518	107	0.1115178	3.52	16.50	434.92	3752.00
A1	Sulphur Dioxide (24 Hour Mean)	Estimated	100%	107	0.111518	107	0.1115178	3.52	16.50	256.60	3752.00
A1	Sulphur Dioxide (Ecological - Sensitive Lichens)	Estimated	100%	107	0.111518	107	0.1115178	3.52	16.50	434.92	3752.00
A1	Carbon monoxide (8h mean)	Estimated	100%	1400	1.459111	1400	1.4591111	46.01	215.95	3983.37	3752.00
A1	Benzene (24h mean)	Estimated	100%	1000	1.042222	1000	1.0422222	32.87	154.25	2398.15	3752.00
A2	Nitrogen Dioxide	Estimated	100%	250	0.296389	250	0.2963889	9.35	43.87	1155.92	4268.00
A2	Nitrogen Dioxide (Ecological - Daily Mean)	Estimated	100%	250	0.296389	250	0.2963889	9.35	43.87	681.99	4268.00
A2	Carbon monoxide (8h mean)	Estimated	100%	1400	1.659778	1400	1.6597778	52.34	245.65	4531.19	4268.00
A2	Benzene (24h mean)	Estimated	100%	1000	1.185556	1000	1.1855556	37.39	175.46	2727.96	4268.00
A3	Nitrogen Dioxide	Estimated	10%	150	0.822552	150	0.8225517	2.59	12.17	3207.95	19741.24
A3	Nitrogen Dioxide (Ecological - Daily Mean)	Estimated	10%	150	0.822552	150	0.8225517	2.59	12.17	1892.69	19741.24
A3	Carbon monoxide (8h mean)	Estimated	10%	50	0.274184	50	0.2741839	0.86	4.06	748.52	19741.24
A3	Benzene (24h mean)	Estimated	10%	10	0.054837	10	0.0548368	0.17	0.81	126.18	19741.24
A4	Nitrogen Dioxide	Estimated	15%	200	0.031333	200	0.0313333	0.15	0.70	122.20	564.00
A4	Nitrogen Dioxide (Ecological - Daily Mean)	Estimated	15%	200	0.031333	200	0.0313333	0.15	0.70	72.10	564.00
A4	Sulphur Dioxide (15 Min Mean)	Estimated	15%	100	0.015667	100	0.0156667	0.07	0.35	81.87	564.00
A4	Sulphur Dioxide (1 Hour Mean)	Estimated	15%	100	0.015667	100	0.0156667	0.07	0.35	61.10	564.00
A4	Sulphur Dioxide (24 Hour Mean)	Estimated	15%	100	0.015667	100	0.0156667	0.07	0.35	36.05	564.00
A4	Sulphur Dioxide (Ecological - Sensitive Lichens)	Estimated	15%	100	0.015667	100	0.0156667	0.07	0.35	61.10	564.00
A6	Ammonia (ecological receptor - Sensitive Lichens)	Estimated	100%	3.5	0.017986	3.5	0.0179861	0.57	1.76	44.47	18500.00
A6	Ammonia (human health receptor)	Estimated	100%	3.5	0.017986	3.5	0.0179861	0.57	1.76	44.47	18500.00

A13	Ammonia (ecological receptor - Sensitive Lichens)	Estimated	100%	17.9	0.000161	17.9	0.0001611	0.01	0.02	0.63	32.40
A13	Ammonia (human health receptor)	Estimated	100%	17.9	0.000161	17.9	0.0001611	0.01	0.02	0.63	32.40
A19	Ammonia (ecological receptor - Sensitive Lichens)	Estimated	100%	1129	0.000888	1129	0.0008875	0.03	0.13	3.46	2.83
A19	Ammonia (human health receptor)	Estimated	100%	1129	0.000888	1129	0.0008875	0.03	0.13	3.46	2.83
A20	Ammonia (ecological receptor - Sensitive Lichens)	Estimated	100%	1129	0.000888	1129	0.0008875	0.03	0.13	3.46	2.83
A20	Ammonia (human health receptor)	Estimated	100%	1129	0.000888	1129	0.0008875	0.03	0.13	3.46	2.83
A21	Ammonia (ecological receptor - Sensitive Lichens)	Estimated	100%	1129	0.000888	1129	0.0008875	0.03	0.13	3.46	2.83
A21	Ammonia (human health receptor)	Estimated	100%	1129	0.000888	1129	0.0008875	0.03	0.13	3.46	2.83
A22	Ammonia (ecological receptor - Sensitive Lichens)	Estimated	100%	0.04	0.000001	0.04	0.0000009	0.00	0.00	0.00	81.00
A22	Ammonia (human health receptor)	Estimated	100%	0.04	0.000001	0.04	0.0000009	0.00	0.00	0.00	81.00

Table A.3 Ouput: Air impacts - pollutants

Number	Substance	Long term EAL (ug/m3)	Long term PC (ug/m3)	Short term EAL (ug/m3)	Short term PC (ug/m3)
1	Nitrogen Dioxide	40	133.8593647	200	6518.4015
2	Nitrogen Dioxide (Ecological - Daily Mean)	30	133.8593647	75	3845.856885
3	Sulphur Dioxide (15 Min Mean)	0	16.85	266	664.67
4	Sulphur Dioxide (1 Hour Mean)	0	16.85	350	496.02
5	Sulphur Dioxide (24 Hour Mean)	0	16.85	125	292.65
6	Sulphur Dioxide (Ecological - Sensitive Lichens)	10	16.85	0	496.02
7	Carbon monoxide (8h mean)	0	465.65	10000	9263.09
8	Benzene (24h mean)	5	330.52	30	5252.30
9	Ammonia (ecological receptor - Sensitive Lichens)	1	2.18	0	55.48
10	Ammonia (human health receptor)	180	2.18	2500	55.48

Table A.4 Ouput: Air impacts – Test 1

Number	Substance	Long term EAL (ug/m3)	Long term PC (ug/m3)	%PC of EAL (long term)	>1% of EAL? (long term)	Short term EAL (ug/m3)	Short term PC (ug/m3)	%PC of EAL (short term)	>10% of EAL? (short term)
1	Nitrogen Dioxide	40	133.8593647	334.65%	fail	200	6518.4015	3259.20%	fail
2	Nitrogen Dioxide (Ecological - Daily Mean)	30	133.8593647	446.20%	fail	75	3845.856885	5127.81%	fail
3	Sulphur Dioxide (15 Min Mean)		16.85243111			266	664.6659067	249.87%	fail
4	Sulphur Dioxide (1 Hour Mean)		16.85243111			350	496.0193333	141.72%	fail
5	Sulphur Dioxide (24 Hour Mean)		16.85243111			125	292.6514067	234.12%	fail
6	Sulphur Dioxide (Ecological - Sensitive Lichens)	10	16.85243111	168.52%	fail		496.0193333		
7	Carbon monoxide (8h mean)		465.6534771			10000	9263.088683	92.63%	fail
8	Benzene (24h mean)	5	330.5226954	6610.45%	fail	30	5252.296092	17507.65%	fail
9	Ammonia (ecological receptor - Sensitive Lichens)	1	2.182831856	218.28%	fail		55.48463861		
10	Ammonia (human health receptor)	180	2.182831856	1.21%	fail	2500	55.48463861	2.22%	pass

Table A.5 Ouput: Air impacts – Test 2

Number	Substance	Long term EAL (ug/m3)	Long term PC (ug/m3)	Air Background conc (ug/m3)	%PC of headroom (long term)	PEC Long term (µg/m3)	%PEC of EAL% (Long term)	%PEC of EAL>70 %? (long term)	Short term EAL (ug/m3)	Short term PC (ug/m3)	%PC of the EAL-2*background	%PC of headroom >=20%? (short term)
1	Nitrogen Dioxide	40	134	9.94	4.45	143.8	3.59	fail	200	6518	36.2	fail
2	Nitrogen Dioxide (Ecological - Daily Mean)	30	134	13.7	8.21	147.6	4.92	fail	75	3846	80.8	fail
3	Sulphur Dioxide (15 Min Mean)		16.9	2.47	-6.82	19.32			266	664.7	2.55	fail
4	Sulphur Dioxide (1 Hour Mean)		16.9	2.47	-6.82	19.32			350	496.0	1.44	fail
5	Sulphur Dioxide (24 Hour Mean)		16.9	2.47	-6.82	19.32			125	292.7	2.44	fail
6	Sulphur Dioxide (Ecological - Sensitive Lichens)	10	16.9	3.64	2.65	20.49	2.05	fail		496.0	-68.1	
7	Carbon monoxide (8h mean)		466	125	-3.73	590.7			10000	9263	0.95	fail
8	Benzene (24h mean)	5	331	0.24	69.4	330.8	66.2	fail	30	5252	178	fail
9	Ammonia (ecological receptor - Sensitive Lichens)	1	2.18	1.77	-2.83	3.953	3.95	fail		55.5	-15.7	
10	Ammonia (human health receptor)	180	2.18	1.77	0.01	3.953	0.02	pass	2500	55.5	0.02	pass

Table A.6 Output: Deposition to land from air

Number	Substance	%PC of EAL (long term)	Insignificant?
1	Nitrogen Dioxide	3.35	No
2	Nitrogen Dioxide (Ecological - Daily Mean)	4.46	No
3	Sulphur Dioxide (15 Min Mean)	0.00	Yes
4	Sulphur Dioxide (1 Hour Mean)	0.00	Yes
5	Sulphur Dioxide (24 Hour Mean)	0.00	Yes
6	Sulphur Dioxide (Ecological - Sensitive Lichens)	1.69	No
7	Carbon monoxide (8h mean)	0.00	Yes
8	Benzene (24h mean)	66.1	No
9	Ammonia (ecological receptor - Sensitive Lichens)	2.18	No
10	Ammonia (human health receptor)	0.01	Yes

Table A.7 Results: Air Assessment

Option	Substance	Test 1	Test 2
1	**Nitrogen Dioxide**	**Fail**	**Fail**
1	**Nitrogen Dioxide (Ecological - Daily Mean)**	**Fail**	**Fail**
1	**Sulphur Dioxide (15 Min Mean)**	**Fail**	**Fail**
1	**Sulphur Dioxide (1 Hour Mean)**	**Fail**	**Fail**
1	**Sulphur Dioxide (24 Hour Mean)**	**Fail**	**Fail**
1	**Sulphur Dioxide (Ecological - Sensitive Lichens)**	**Fail**	**Fail**
1	**Carbon monoxide (8h mean)**	**Fail**	**Fail**
1	**Benzene (24h mean)**	**Fail**	**Fail**
1	**Ammonia (ecological receptor - Sensitive Lichens)**	**Fail**	**Fail**
1	Ammonia (human health receptor)	Fail	Pass

Appendix B Proposed CHPs, technical specification

TEDOM
Combined Heat & Power

Quanto 1200

Basic technical data

Electrical output	1200	kW	Voltage	400	V
Heat output nominal/max.	1238/-	kW	Frequency	50	Hz
electrical efficiency	42,4	%	secondary circuit temperature inlet/outlet	70/90	°C
heat efficiency nominal/max.	43,8/-	%	Service weight of complete CHPU		
total efficiency nominal/max.	86,2/-	%	- container (C)	38	t
fuel input	2828	kW			

Emission	lean mixture	
NOx emission at 5% O2 in exhaust gas standard/option	500/-	mg/Nm^3
CO emission at 5% O2 in exhaust gas standard/option	1100/-	mg/Nm^3

Noise parameters		standard	
C	- CHPU at 10m	66	dB(A)

Notes

The Basic Technical Data are applicable for the standard conditions pursuant to the "Technical instructions" document. The minimum permanent electrical output must not drop below 50 % of the nominal output. Gas consumption is expressed under the normal conditions (0°C, 101.325 kPa) and gas LHV according to the section Fuel. Gas consumption tolerance, or fuel input tolerance, at 100% load is +5%. Tolerances of other parameters are mentioned in "Technical Instructions-Validity of Technical Data" document.

The manufacturer reserves the right to change this document and related documents.

TEDOM
Combined Heat & Power

Quanto 1200

Extended technical data

Standard design	100%	75%	50%	
electrical output	1200	900	600	kW
heat output	1238	976	725	kW
gas consumption	569	439	310	m^3/h
fuel input	2828	2183	1543	kW
electrical efficiency	42,4	41,2	38,9	%
heat efficiency	43,8	44,7	47,0	%
total efficiency	86,2	85,9	85,9	%

1) Heat output is formed of a secondary circuit heat output with exhaust gas cooled to 150°C.

Guaranteed parameters		
electrical output	1200	kW
electrical efficiency	40,4	%
heat efficiency	45,8	%
total efficiency	86,2	%
fuel input	2969	kW
NOx emission at 5% O2 in exhaust gas	500	mg/Nm^3
CO emission at 5% O2 in exhaust gas	1100	mg/Nm^3
CHPU at 10m	70	dB(A)

Electrical parameters

voltage	400	V
frequency	50	Hz
nominal current	2000	A
nominal power factor (GCB settings)	0,87	

operational current at cos φ=0,9	1925	A
short circuit resistance of the switchboard	40	kA
contribution of the actual source to the short-circuit current	< 20	kA
cos φ regulation range (underexcited/overexcited) [1)]	0,9÷1÷0,9	

1) Operation of generator with power factor lower than 0,98 decreaes generator efficiency, what can cause reduction of the CHPU active power.

Engine / Generator

Engine	TCG2020V12	
manufacturer	MWM	
oil consumption	0,15	g/kWh
quantity of oil in the engine	715	dm^3
volume of oil tank for refilling	350	dm^3

Generator	MJB 500 MB4
manufacturer	MARELLI

TEDOM
Combined Heat & Power

Quanto 1200

Heat system

Secondary circuit

heat carrier: water		
heat output	1238	kW
inlet/outlet temperature	70/90	°C
min./max. inlet temperature	50/70	°C
nominal flow	14,8	kg/s
max. allowed pressure in circuit	600	kPa
volume (OM/SE/C)	-/-/145	dm^3
pressure drop at nominal flow (OM/SE/C)	-/-/45	kPa

Aftercooler circuit

heat carrier: antifreeze		
ethylene glycol concentration	35	%
heat output	91	kW
max. coolant inlet temperature into CHPU	50	°C
nominal flow	7,7	kg/s
expansion vessel volume (OM/SE/C)	/-/35	dm^3
min. inlet pressure into CHPU	100	kPa
max. inlet pressure into CHPU	300	kPa
max. outlet pressure from CHPU	450	kPa
volume (OM/SE/C)	-/-/45	dm^3
dry cooler volume	*tbd	dm^3

Primary circuit

heat carrier: antifreeze		
ethylene glycol concentration	35	%
heat output (OM, C)	1238	kW
max. allowed pressure in circuit	300	kPa
volume (OM/SE/C)	-/-/980	dm^3
dry cooler volume	*tbd	dm^3

**tbd - to be defined*

Exhaust gas

quantity	6254	kg/h	temperature at the CHPU outlet nominal/max.	150/180	°C
temperature at the engine outet	466	°C	max. allowed back-pressure	1	kPa

Fuel

biogas			nominal methane content	50	%
low heat value	17,9	MJ/m^3	pressure (C)	10 - 15	kPa
min. methane content	45	%	max. temperature	35	°C

Combustion and ventilation air

Combustion air

ambient temperature min./max. (C)	-20/35	°C
combustion air temperature min./max.	10/35	°C
quantity	5490	kg/h

Ventilation

	C	
unused heat removed by the ventilation	76	kW

Quanto 1200

Related documents

dimensional drawing C	R0550

TEDOM
Combined Heat & Power

Quanto 1200

Basic technical data

Electrical output	1200	kW	Voltage	400	V
Heat output nominal/max.	1220/-	kW	Frequency	50	Hz
electrical efficiency	42,0	%	secondary circuit temperature inlet/outlet	70/90	°C
heat efficiency nominal/max.	42,7/-	%	Service weight of complete CHPU		
total efficiency nominal/max.	84,7/-	%	- container (C)	38	t
fuel input	2854	kW			

Emission	lean mixture	
NOx emission at 5% O2 in exhaust gas standard/option	250/-	mg/Nm^3
CO emission at 5% O2 in exhaust gas standard/option	1100/-	mg/Nm^3

Noise parameters		standard	
C	- CHPU at 10m	66	dB(A)

Notes

The Basic Technical Data are applicable for the standard conditions pursuant to the "Technical instructions" document. The minimum permanent electrical output must not drop below 50 % of the nominal output. Gas consumption is expressed under the invoicing conditions (15°C, 101.325 kPa) and gas LHV according to the section Fuel. Gas consumption tolerance, or fuel input tolerance, at 100% load is +5%. Tolerances of other parameters are mentioned in "Technical Instructions-Validity of Technical Data" document.

The manufacturer reserves the right to change this document and related documents.

TEDOM
Combined Heat & Power

Quanto 1200

Extended technical data

Standard design	100%	75%	50%	
electrical output	1200	900	600	kW
heat output	1220	962	714	kW
gas consumption	302	233	165	m^3/h
fuel input	2854	2203	1558	kW
electrical efficiency	42,0	40,8	38,5	%
heat efficiency	42,7	43,7	45,8	%
total efficiency	84,7	84,5	84,3	%

1) Heat output is formed of a secondary circuit heat output with exhaust gas cooled to 150°C.

Guaranteed parameters		
electrical output	1200	kW
electrical efficiency	40,0	%
heat efficiency	44,7	%
total efficiency	84,7	%
fuel input	2997	kW
NOx emission at 5% O2 in exhaust gas	250	mg/Nm^3
CO emission at 5% O2 in exhaust gas	1100	mg/Nm^3
CHPU at 10m	70	dB(A)

Electrical parameters

voltage	400	V
frequency	50	Hz
nominal current	2000	A
nominal power factor (GCB settings)	0,87	

operational current at cos φ=0,9	1925	A
short circuit resistance of the switchboard	40	kA
contribution of the actual source to the short-circuit current	< 20	kA
cos φ regulation range (underexcited/overexcited) [1)]	0,9÷1÷0,9	

1) Operation of generator with power factor lower than 0,98 decreaes generator efficiency, what can cause reduction of the CHPU active power.

Engine / Generator

Engine	TCG2020V12	
manufacturer	MWM	
oil consumption	0,15	g/kWh
quantity of oil in the engine	715	dm^3
volume of oil tank for refilling	350	dm^3

Generator	MJB 500 MB4
manufacturer	MARELLI

TEDOM
Combined Heat & Power

Quanto 1200

Heat system

Secondary circuit

heat carrier: water		
heat output	1220	kW
inlet/outlet temperature	70/90	°C
min./max. inlet temperature	50/70	°C
nominal flow	14,6	kg/s
max. allowed pressure in circuit	600	kPa
volume (OM/SE/C)	-/-/145	dm^3
pressure drop at nominal flow (OM/SE/C)	-/-/45	kPa

Aftercooler circuit

heat carrier: antifreeze		
ethylene glycol concentration	35	%
heat output	95	kW
max. coolant inlet temperature into CHPU	47	°C
nominal flow	9,7	kg/s
expansion vessel volume (OM/SE/C)	/-/35	dm^3
min. inlet pressure into CHPU	100	kPa
max. inlet pressure into CHPU	300	kPa
max. outlet pressure from CHPU	450	kPa
volume (OM/SE/C)	-/-/45	dm^3
dry cooler volume	*tbd	dm^3

Primary circuit

heat carrier: antifreeze		
ethylene glycol concentration	35	%
heat output (OM, C)	1220	kW
max. allowed pressure in circuit	300	kPa
volume (OM/SE/C)	-/-/980	dm^3
dry cooler volume	*tbd	dm^3

**tbd - to be defined*

Exhaust gas

quantity	7114	kg/h
temperature at the engine outet	402	°C
temperature at the CHPU outlet nominal/max.	150/180	°C
max. allowed back-pressure	1	kPa

Fuel

natural gas		
low heat value	34	MJ/m^3
min. methane number	101	
pressure (C)	10 - 15	kPa
max. temperature	35	°C

Combustion and ventilation air

Combustion air

ambient temperature min./max. (C)	-20/35	°C
combustion air temperature min./max.	10/35	°C
quantity	6896	kg/h

Ventilation

	C	
unused heat removed by the ventilation	77	kW

Quanto 1200

Related documents

dimensional drawing C	R0550

Appendix C Emergency flare, technical specification

UNIFLARE™
GLOBAL ENVIRONMENTAL TECHNOLOGY

UF10 2500 Emissions Page EA Compliant Biogas Flare Stack

Customer	**ACORN BIOENERGY**			
Our Reference No.				
Machine type	**UF10-2500** High Temperature Enclosed Flare Stack			
Turndown Ratio	**5:1**			
Design Flow – Biogas	**500 - 2500**	**Nm3hr (Variable)**		
Pilot System	Uniflare Fire Blaster Optional Propane ZAI ionisation pilot			
Use environment	Site in open air with restricted access.			
Hazardous area classification in compliance with ATEX requirements.	Zone 2 in sphere 200 mm radius around all positive gas pipe connections and 100 mm radius around all negative pressure gas pipe connections			
Maximum design emissions Normalised at 0°C, 101.3 k Pa and 3% O2:	Carbon monoxide (CO)	50 mg Nm-3		
	Oxides of nitrogen (NOx)	150 mg Nm-3		
	Total volatile organic carbon as carbon	10 mg Nm-3		
	Non-methane volatile organic carbon	5 mg Nm-3		
Operation	Unattended Intermittent use			
Design Media	65%	Methane CH^4		
Design Burner Pressure	Minimum Burner inlet Pressure	70	mbarg	
Thermal Rating	16.20	MW		
Design Destruction Efficiency	>99.7%			
Design Combustion temperature	Combustion >1000°C Fully refractory line with automated combustion control			
Minimum retention time	> 0.3 seconds			
Control system	PLC controlled with Hardwired interface. Remote Start Stop. Status and Information available for Remote and site SCADA system.			
Safety systems	CE marked equipment Piltz PNOZ monitoring e-stop circuit Gas pressure protection IS barriers Local Isolators Flash back protected Flame arrestor Pressure and Temperature monitoring DSEAR and ATEX compliant			

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Registered in England Number 05689034

UF10 2500 Emissions Page EA Compliant Biogas Flare Stack

Design Calculation Page

UF10-2500 High Temperature Flare @ 65%CH4

CALCULATION OF RETENTION TIME					
CALCULATION OF COMPOSITION OF COMBUSTION PRODUCTS BS 5854					
per one volume of fuel @ 15° C and 1013 mbar					
Constitituent	Percentage in fuel	rel den	rel den fuel to air		
CH4	65%	0.554	0.3601		
CO2	35%	1.5198	0.53193		
	1	OK	0.89203		
STOICHIOMETRIC AIR PER UNIT VOLUME OF METHANE IS 9.55					
	biogas flow rate	2500	m3h-1 >	1625	m3h-1 CH4
	min air required	15518.75	m3h-1		
	excess air	200%			
	specific volume of air	0.819	m3 kg-1		
	mass flow rate of air	56845	kg h-1		
	mass flow rate of biogas	2723	kg h-1		
	total mass flow rate	59568	kg h-1		
fuel gases above their dew point have a specific volume similar to air at the relevant temperature					
	the volume of 1 kg of				
	flue gases at	1000	° C is		
		4	m3 kg-1		
	therefore the volume flow rate	227491	m3 h-1		
		63	m3 s-1		
	hot face diameter	2.645	m		
	area	5.49	m2		
	velocity	11.5	m s-1		
	height above flame	5.5	m		
	retention time	0.48	s		
	Retention time at sample port	0.39	s	Port 1m down from top	
	Heat release turn down ratio	5	:1		
	Combustion heat release full load	16.20	MW		
	Minimum heat release	3.24	MW	**Created**	RPB
EA Guidance on Landfill Gas Flaring 4.8.7 Page 24				**Checked**	MIJ

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Appendix D Emergency boiler, example technical specification

VIESMANN

VITOPLEX 200

Low temperature oil/gas boiler
90 to 560 kW

Datasheet

Part no. and prices: See pricelist

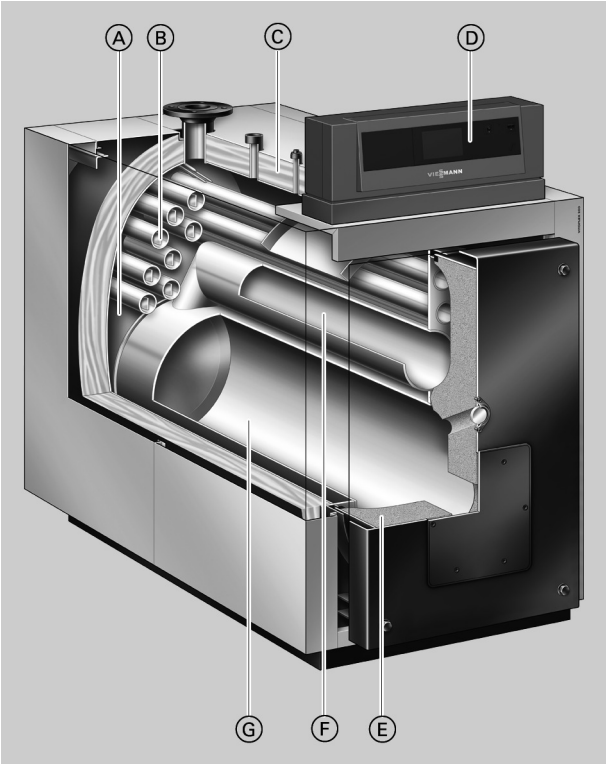
VITOPLEX 200 Type SX2A

Low temperature oil/gas boiler
- Three-pass boiler
- For operation with modulating boiler water temperature
- With Vitotrans 300 as condensing unit

Information for type SX2A, 90 to 350 kW:
In accordance with the Ecodesign Directive for Heating Appliances and Water Heaters (Dir. 2009/125/EC), Implementing Regulation (EU) No. 813/2013 and (EU) No. 814/2013, these boilers may not be sold and used within the EU for the purpose of generating space heating and domestic hot water. A sale is subject to the proviso of exclusive use for purposes not included in the regulations stated above.

Benefits at a glance

- Economical and environmentally responsible due to modulating boiler water temperature.
- Standard seasonal efficiency [to DIN] for operation with fuel oil: 89 % (H_s) [gross cv].
- Optional stainless steel flue gas/water heat exchanger enables the utilisation of condensing technology for higher standard seasonal efficiency [to DIN].
- Three-pass boiler with low combustion chamber loading, resulting in clean combustion with low emissions.
- Wide water galleries and large water content provide excellent natural circulation and reliable heat transfer.
- Integral Therm-Control start-up system for easy hydraulic connection – no shunt pump or return temperature raising facility are required.
- No low water indicator required for boilers up to 300 kW.
- Compact design for easy transport into boiler rooms and economical use of space – important for modernisation projects.
- Fastfix assembly system for control unit and thermal insulation.
- Easy to use Vitotronic control unit with colour touchscreen.
- Integral WiFi for service interface.
- Economical and safe operation of the heating system through the Vitotronic control system with communication capability which, in conjunction with Vitogate 300 (accessories), enables integration into building management systems.
- Vitocontrol control panel can be supplied on request.



Ⓐ Wide water galleries and large water content ensure excellent natural circulation and easy hydraulic connection
Ⓑ Third hot gas flue
Ⓒ Highly effective thermal insulation
Ⓓ Vitotronic control unit with colour touchscreen
Ⓔ Thermal insulation on boiler door
Ⓕ Hot gas flue (second pass)
Ⓖ Combustion chamber

5797332

Boiler specification

Specification

Rated heating output	**kW**	**90**	**120**	**150**	**200**	**270**	**350**	**440**	**560**
Rated heat input	kW	98	130	163	217	293	380	478	609
CE designation									
– According to Efficiency Directive					CE-0085BQ0020			—	—
– According to Gas Appliances Directive					CE-0085BQ0020				
Permiss. flow temperature (= safety temperature)	°C				110 (up to 120 °C on request)				
Permiss. operating temperature	°C				95				
Permiss. operating pressure	bar				4				
	kPa				400				
Pressure drop on the hot gas side	Pa	60	80	100	200	180	310	280	400
	mbar	0.6	0.8	1.0	2.0	1.8	3.1	2.8	4.0
Boiler body dimensions									
Length (dim. q)*1	mm	1195	1400	1385	1580	1600	1800	1825	1970
Width (dim. d)	mm	575	575	650	650	730	730	865	865
Height (incl. connectors) (dim. t)	mm	1145	1145	1180	1180	1285	1285	1455	1455
Total dimensions									
Total length (dim. r)	mm	1260	1460	1445	1640	1660	1860	1885	2030
Total length incl. burner and hood, depending on burner make (dim. s)	mm	1660	1860	1865	2060	2085	–	–	–
Total width (dim. e)	mm	755	755	825	825	905	905	1040	1040
Total height (dim. b)	mm	1315	1315	1350	1350	1460	1460	1625	1625
Service height (control unit) (dim. a)	mm	1485	1485	1520	1520	1630	1630	1795	1795
Height									
– Adjustable anti-vibration feet	mm	28	28	28	28	28	28	28	28
– Anti-vibration boiler supports (under load)	mm	–	–	–	–	–	37	37	37
Foundation									
Length	mm	1000	1200	1200	1400	1400	1650	1650	1800
Width	mm	760	760	830	830	900	900	1040	1040
Combustion chamber diameter	mm	380	380	400	400	480	480	570	570
Combustion chamber length	mm	800	1000	1000	1200	1200	1400	1400	1550
Weight boiler body	kg	315	365	415	460	585	700	895	1100
Total weight Boiler incl. thermal insulation and boiler control unit	kg	360	410	465	510	635	760	960	1170
Capacity boiler water	litres	180	210	255	300	400	445	600	635
Boiler connections									
Boiler flow and return	PN 6 DN	65	65	65	65	65	80	100	100
Safety connection (safety valve) (male thread)	R	1¼	1¼	1¼	1¼	1¼	1¼	1½	1½
Drain (male thread)	R				1¼				
Flue gas parameters*2									
Temperature (at 60 °C boiler water temperature)									
– At rated heating output	°C				180				
– At partial load	°C				125				
Temperature (at 80 °C boiler water temperature)	°C				195				
Flue gas mass flow rate									
– For natural gas	kg/h				1.5225 x combustion output in kW				
– For fuel oil EL	kg/h				1.5 x combustion output in kW				
Flue gas connection	Ø mm	180	180	200	200	200	200	250	250
Standard seasonal efficiency [to DIN] (for operation with fuel oil) For heating system temperature 75/60 °C	%				89 (H_s) [gross cv]				
Standby loss $q_{B,70}$	%	0.40	0.35	0.30	0.30	0.25	0.25	0.22	0.20

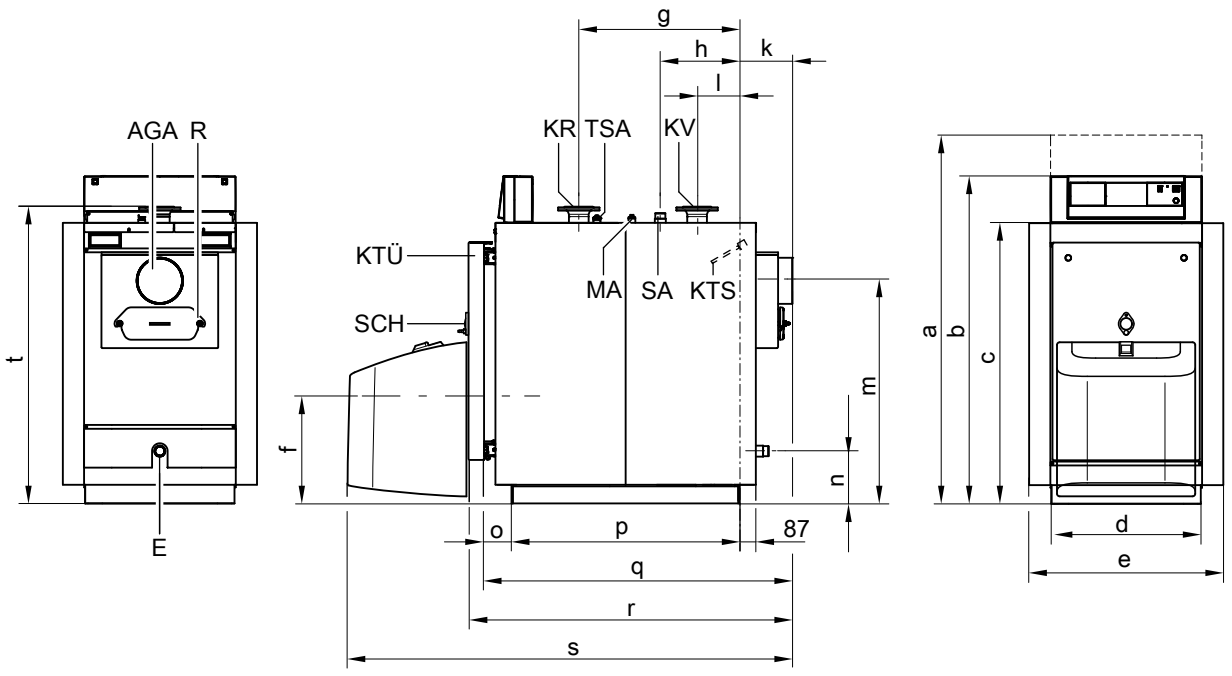
*1 *Boiler door removed.*

*2 *Values for calculating the size of the flue system to EN 13384, relative to 13.2 % CO_2 for fuel oil EL and 10 % CO_2 for natural gas. Flue gas temperatures as actual gross values at 20 °C combustion air temperature. The details for partial load refer to an output of 60 % of rated heating output. If the partial load differs (depending on operating mode), calculate the flue gas mass flow rate accordingly.*

Boiler specification (cont.)

Rated heating output	kW	90	120	150	200	270	350	440	560
Sound pressure level*3									
1 m in front of the boiler (1st/2nd stage)	dB(A)	<68/<69						–	
In the flue pipe (1st/2nd stage)	dB(A)	<96/<103						–	
Matching Vitotrans 300									
– Gas operation	Part no.	Z010326		Z010327		Z010328		Z010329	
– Oil operation	Part no.	Z010330		Z010331		Z010332		Z010333	
Rated heating output									
Boiler with Vitotrans 300									
– Gas operation	kW	98.7	131.4	164.3	219.0	295.6	383.3	478.7	608.9
– Oil operation	kW	95.8	127.8	159.8	213.0	287.5	372.7	466.4	593.5
CE designation		CE-0085BS0287							
Vitotrans 300 in conjunction with boiler as a condensing unit									
Pressure drop on the hot gas side	Pa	125	145	185	285	280	410	385	505
Boiler with Vitotrans 300	mbar	1.25	1.45	1.85	2.85	2.80	4.10	3.85	5.05
Total length	mm	1990		2290		2570		2950	
Boiler with Vitotrans 300 excl. burner									

Dimensions



90 to 270 kW

AGA Flue outlet
E Drain
KR Boiler return
KTS Boiler water temperature sensor
KTÜ Boiler door
KV Boiler flow
MA Female connection R ½ (male thread) for pressure gauge
R Cleaning aperture
SA Safety connection (safety valve)
SCH Inspection port
TSA Female connection R ½ (male thread) for Therm-Control temperature sensor

*3 *Standard values resulting from sound pressure level testing cannot be guaranteed, as sound pressure level tests are always dependent on the specific system. The data provided here refers to Viessmann Vitoflame 100 pressure-jet oil/gas burners.*

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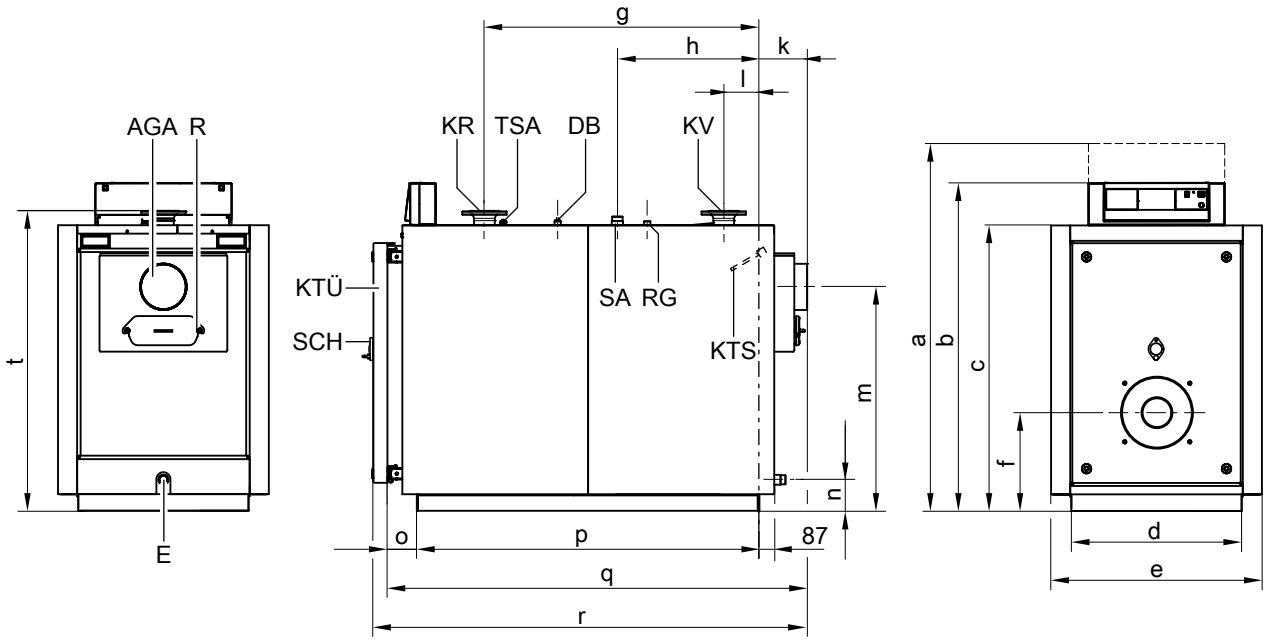
Boiler specification (cont.)



350 to 560 kW

AGA Flue outlet
DB Female connection R ½ (male thread) for maximum pressure limiter
E Drain
KR Boiler return
KTS Boiler water temperature sensor
KTÜ Boiler door
KV Boiler flow
R Cleaning aperture
RG Female connection R ½ (male thread) for additional control equipment
SA Safety connection (safety valve)
SCH Inspection port
TSA Female connection R ½ (male thread) for Therm-Control temperature sensor

Dimensions

Rated heating output	kW	90	120	150	200	270	350	440	560
a	mm	1485	1485	1520	1520	1630	1630	1795	1795
b	mm	1315	1315	1350	1350	1460	1460	1625	1625
c	mm	1085	1085	1115	1115	1225	1225	1395	1395
d	mm	575	575	650	650	730	730	865	865
e	mm	755	755	825	825	905	905	1040	1040
f	mm	440	440	440	440	420	420	470	470
g	mm	622	825	811	1009	979	1179	1146	1292
h	mm	307	395	324	423	409	609	710	783
k	mm	203	203	203	203	203	203	224	224
l	mm	165	165	151	151	153	153	166	166
m	mm	860	860	885	885	960	960	1110	1110
n	mm	200	200	190	190	135	135	135	135
o	mm	110	110	110	110	130	130	130	130
p (length of base rails)	mm	882	1085	1071	1268	1269	1469	1471	1617
q (transport dimension)	mm	1195	1400	1385	1580	1600	1800	1825	1970
r	mm	1260	1460	1445	1640	1660	1860	1885	2030
s (depending on burner make)	mm	1670	1875	1880	2075	2095	–	–	–
t	mm	1145	1145	1180	1180	1285	1285	1455	1455

Where access to the boiler room is difficult the boiler door can be removed.
Dim. f: Observe the installed burner height.
Dim. q: With boiler door removed

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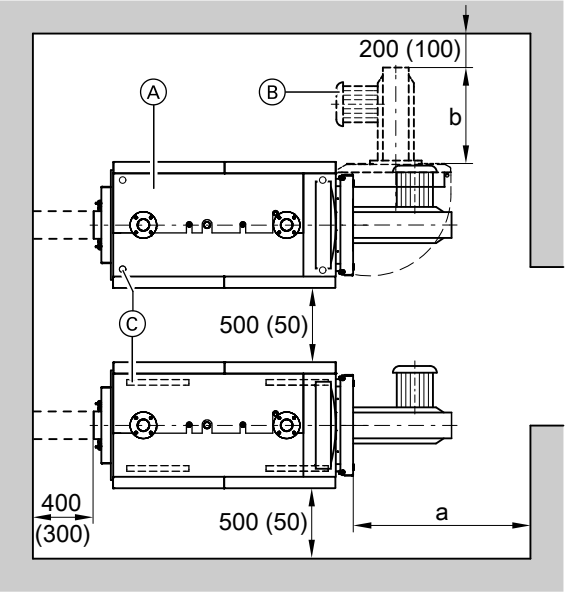
Boiler specification (cont.)

Siting

Minimum clearances



Observe the stated dimensions to ensure easy installation and maintenance. Where space is tight, only the minimum clearances (dimensions in brackets) need to be maintained. In the delivered condition, the boiler door is fitted so it opens to the left. The hinge pins can be repositioned so the door opens to the right.

Ⓐ Boiler
Ⓑ Burner
Ⓒ Adjustable anti-vibration feet (90 to 560 kW) or anti-vibration boiler supports (350 to 560 kW)

Rated heating output	kW	90	120	150	200	270	350	440	560
a	mm	1100			1400		1600		

Dim. a: Maintain this space in front of the boiler to enable removal of the turbulators and cleaning of the hot gas flues.
Dim. b: Observe the installed burner length.

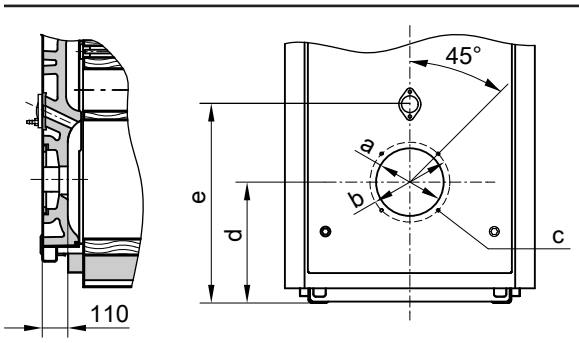
Siting conditions

- Prevent air contamination by halogenated hydrocarbons (e.g. as contained in sprays, paints, solvents and cleaning agents)
- Prevent very dusty conditions
- Prevent high levels of humidity
- Prevent frost and ensure good ventilation

Otherwise the system may suffer faults and damage.
In rooms where air contamination through **halogenated hydrocarbons** may occur, install the boiler only if adequate measures can be taken to provide a supply of uncontaminated combustion air.

Burner installation

Boilers up to 120 kW:
The burner fixing hole circle, burner fixing holes and flame tube aperture comply with EN 226.
Boilers from 150 kW:
The burner fixing hole circle, burner fixing holes and flame tube aperture are as detailed in the table below.
The burner may be mounted directly on the hinged boiler door. If the burner dimensions deviate from those stated in the table below, use the burner plate included in the standard delivery.
Burner tiles can be prepared at the factory on request (chargeable option). If this is required, state the burner make and type when ordering. The flame tube must protrude from the thermal insulation of the boiler door.



Rated heating output	kW	90	120	150	200	270	350	440	560
a	Ø mm	135	135	240	240	240	240	290	290
b	Ø mm	170	170	270	270	270	270	330	330
c	Number/thread	4/M 8	4/M 8	4/M 10	4/M 10	4/M 10	4/M 10	4/M 12	4/M 12

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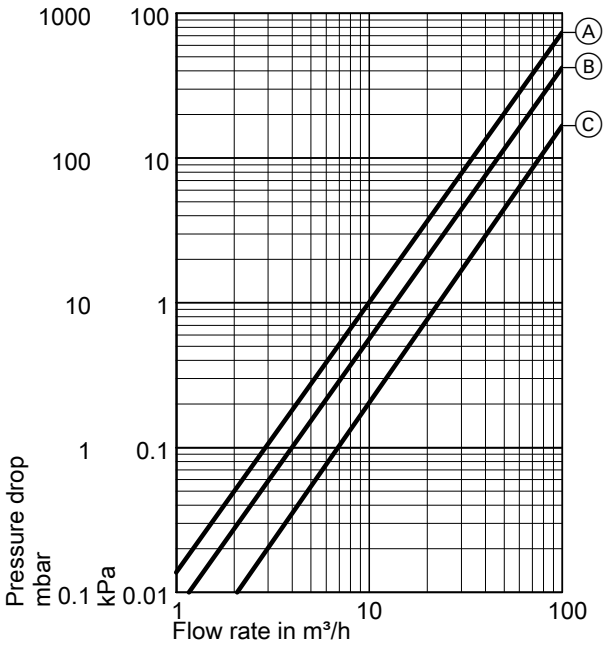
Boiler specification (cont.)

Rated heating output	kW	90	120	150	200	270	350	440	560
d	mm	440	440	440	440	420	420	470	470
e	mm	650	650	650	650	670	670	780	780

Pressure drop on the heating water side



Ⓐ Rated heating output 90 to 270 kW
Ⓑ Rated heating output 350 kW
Ⓒ Rated heating output 440 and 560 kW

The Vitoplex 200 is only suitable for fully pumped hot water heating systems.

Vitotrans 300 specification

Specification

Vitotrans 300 **– Gas operation** **– Oil operation**	**Part no.** **Part no.**	**Z010326** **Z010330**	**Z010327** **Z010331**	**Z010328** **Z010332**	**Z010329** **Z010333**
Rated boiler heating output	kW	90-125	140-200	230-350	380-560
Rated heating output range of the Vitotrans 300 for					
– Gas operation	from kW	8.7	12.7	21.8	33.3
	to kW	11.9	19.0	33.3	48.9
– Oil operation	from kW	5.8	8.8	14.9	22.9
	to kW	8.1	13.0	22.7	33.5
Permiss. operating pressure	bar	4	4	4	6
	MPa	0.4	0.4	0.4	0.6
Permiss. flow temperature (= safety temperature)	°C	110	110	110	110
Pressure drop on the hot gas side	mbar	0.65	0.85	1.00	1.05
	Pa	65	85	100	105
Flue gas temperature					
– Gas operation	°C	65	65	65	65
– Oil operation	°C	70	70	70	70
Flue gas mass flow rate	from kg/h	136	213	383	546
	to kg/h	213	341	596	954
Total dimensions					
Total length (dim. h) incl. mating flanges	mm	666	777	856	967
Total width (dim. b)	mm	714	760	837	928
Total height (dim. c)	mm	1037	1152	1167	1350
Transport dimensions					
Length excl. mating flanges	mm	648	760	837	928
Width (dim. a)	mm	618	636	706	839
Height (dim. d)	mm	1081	1098	1172	1296
Heat exchanger weight	kg	94	119	144	234
Total weight Heat exchanger incl. thermal insulation	kg	125	150	188	284
Capacity					
Heating water	litres	70	97	134	181
Flue gas	m^3	0.055	0.096	0.133	0.223
Connections					
Heating water flow and return	DN	40	50	50	65
Condensate drain (male thread)	R	½	½	½	½
Flue gas connection					
– To the boiler	DN	180	200	200	250
– To the flue system	DN	150	200	200	250

Rated heating output range of the Vitotrans 300 and flue gas temperature

Heating output of the Vitotrans 300 with flue gas cooling of 200/65 °C for gas operation and 200/70 °C for oil operation, with a heating water temperature rise in the Vitotrans 300 from 40 °C to 42.5 °C.

For conversion to other temperatures, see chapter "Output data".

Pressure drop on the hot gas side

Pressure drop on the hot gas side at rated heating output. The burner must overcome the hot gas pressure drop of the boiler, the Vitotrans 300 and the flue pipe.

Tested quality

CE designation according to current EC Directives at a permissible flow temperature (safety temperature) of up to 110 °C to EN 12828.

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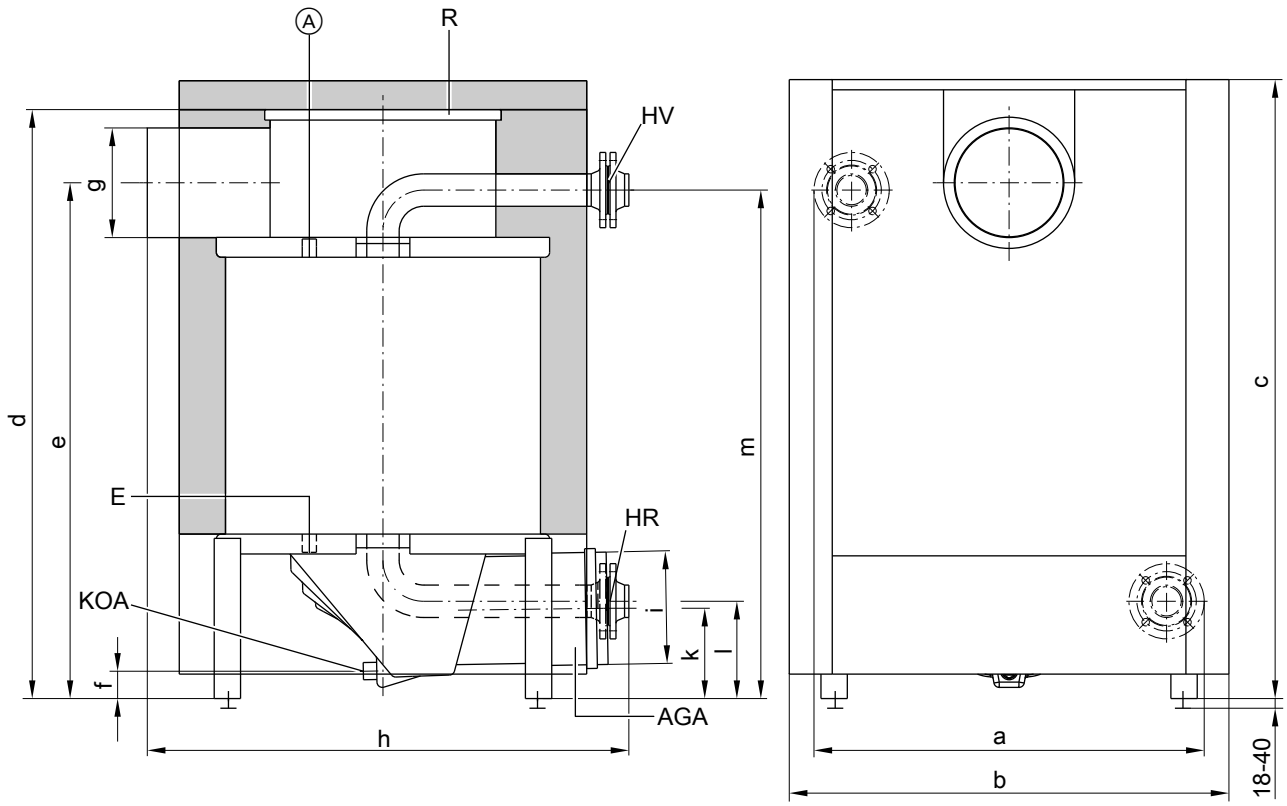
Vitotrans 300 specification (cont.)

Dimensions



Ⓐ Additional female connection R ½ (male thread)
AGA Flue outlet
E Drain R ½ (male thread)
HR Heating water return (inlet)
HV Heating water flow (outlet)
KOA Condensate drain ∅ 32
R Cleaning aperture

Dimensions

Part no.		Z010326 Z010330	Z010327 Z010331	Z010328 Z010332	Z010329 Z010333
a	mm	628	656	726	839
b	mm	714	746	818	912
c	mm	1022	1098	1151	1308
d	mm	965	1043	1096	1245
e	mm	851	907	960	1080
f	mm	73	53	51	88
g (internal)	∅ mm	181	201	201	251
h	mm	707	818	896	1015
i (internal)	∅ mm	151	201	201	251
k	mm	165	170	168	230
l	mm	170	172	181	232
m	mm	851	899	946	1075

Delivered condition

Heat exchanger body with fitted flue gas collector. Mating flanges are fitted to all connectors

1 box with thermal insulation

Connection on the flue gas side

Connect the boiler flue outlet and offset flue adaptor of the flue gas/water heat exchanger through a connection collar (accessories) (do not weld).

Height compensation:
- Vitoplex boiler through adjusting screws
- Vitorond boiler through on-site adaptor

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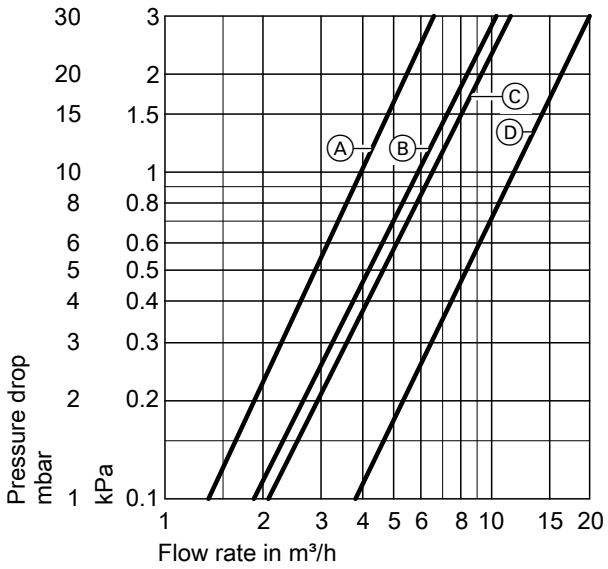
Vitotrans 300 specification (cont.)

Pressure drop on the heating water side

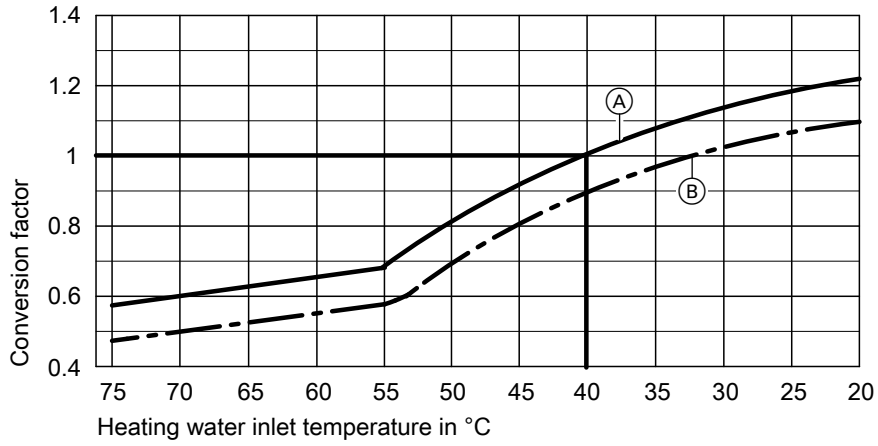
Part no. Z010326 to Z010333



Part no.	Curve
Z010326 Z010330	Ⓐ
Z010327 Z010331	Ⓑ
Z010328 Z010332	Ⓒ
Z010329 Z010333	Ⓓ

Output data

Vitotrans 300 for gas operation



Ⓐ Flue gas inlet temperature 200 °C
Ⓑ Flue gas inlet temperature 180 °C

Conversion of the output data
The heating output data of the Vitotrans 300 flue gas/water heat exchanger refers to a flue gas inlet temperature of 200 °C and a heating water inlet temperature into the heat exchanger of 40 °C.

For different conditions the heating output can be calculated by multiplying the specified rated heating output by the conversion factor established from the diagram.

Delivered condition of the boiler

Boiler body with fitted boiler door and cleaning cover.
Mating flanges are fitted to all connectors.
The adjusting screws are supplied in the combustion chamber.
Cleaning equipment can be found on top of the boiler.

2 boxes with thermal insulation
1 box with boiler control unit and 1 bag with technical documentation
1 Therm-Control
1 coding card and technical documentation for Vitoplex 200
1 burner plate (from 150 kW)

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Control unit versions

For a single boiler system

- **Vitotronic 100, type CC1E**
  For the control unit with a constant boiler water temperature.
  For weather-compensated or room temperature-dependent operation in conjunction with an external control unit.
- **Vitotronic 200, type CO1E**
  For weather-compensated operation and mixer control for up to 2 heating circuits with mixer. For the 2 heating circuits with mixer, the accessory "Extension for heating circuits 2 and 3" is required.

For a multi boiler system (up to 8 boilers)

- **Vitotronic 300, type CM1E**
  For weather-compensated operation of a multi boiler system. This Vitotronic control unit also handles control of the boiler water temperature of a boiler within this multi boiler system.
  Vitotronic 100, type CC1E and LON communication module
  To control the boiler water temperature for each additional boiler in the multi boiler system.
- **Vitocontrol 100-M/200-M multi mode system controller**
  For weather-compensated cascade control of boilers with Vitotronic 100 control unit and a Vitobloc 200 CHP unit or other heat generators.

Multi mode system controller in the control panel

For single and multi boiler systems

Vitocontrol 100-M

- For operation of multi mode heating systems with up to 4 heat generators, with various combinations of oil/gas boilers, heat pumps, CHP units and solid fuel boilers. The Vitocontrol 100-M can operate a range of defined standard schemes. The schemes are available via the Viessmann Schematic Browser. For the compatibility of the Vitocontrol 100-M in conjunction with Viessmann control units, see the compatibility list. Connection to Vitoscada for web-based system visualisation is available as an option. This requires an internet connection.
  Viessmann Schematic Browser: **www.viessmann-schemes.com**
  Compatibility list: **www.vitocontrol.info**

Vitocontrol 200-M

- For the operation of customer-specific multi mode energy systems with any number of heat generators in various combinations, as well as cooling, solar, ventilation and electricity components. Solutions are based on a modular system and can be flexibly extended with new functions and process applications. Connection to Vitoscada for web-based system visualisation is available as an option. This requires an internet connection.

Boiler accessories

See pricelist.

Operating conditions for systems with Vitotronic boiler protection

Vitotronic boiler protection, e.g. Therm-Control.

		Requirements	
Operation with burner load		**≥ 60 %**	**< 60 %**
1.	Heating water flow rate	None	
2.	Boiler return temperature (minimum value)*4	None*5	
3.	Lower boiler water temperature	– Oil operation 50 °C – Gas operation 60 °C	– Oil operation 60 °C – Gas operation 65 °C
4.	Two-stage burner operation	Stage 1: 60 % of rated heating output	No minimum load required
5.	Modulating burner operation	Between 60 and 100 % of rated heating output	No minimum load required
6.	Reduced mode	Single boiler systems and the lead boiler in multi boiler systems – Operation with lower boiler water temperature	

*4 *The technical guide "System examples" contains relevant sample systems for use of the Therm-Control start-up system.*

*5 *No requirements; only in conjunction with Therm-Control.*

Operating conditions for systems with Vitotronic boiler protection (cont.)

		Requirements	
Operation with burner load		**≥ 60 %**	**< 60 %**
		Lag boilers in multi boiler systems – Can be shut down	
7.	Weekend setback	As per reduced mode	

For water quality requirements see the technical guide to this boiler.

Operating conditions for systems with on-site boiler protection

		Requirements	
Operation with burner load		**≥ 60 %**	**< 60 %**
1.	Heating water flow rate	None	
2.	Boiler return temperature (minimum value)	– Oil operation 40 °C – Gas operation 53 °C	– Oil operation 53 °C – Gas operation 58 °C
3.	Lower boiler water temperature	– Oil operation 50 °C – Gas operation 60 °C	– Oil operation 60 °C – Gas operation 65 °C
4.	2-stage burner operation	1st stage 60 % of rated heating output	No minimum load required
5.	Modulating burner operation	Between 60 and 100 % of rated heating output	No minimum load required
6.	Reduced mode	Single boiler systems and lead boiler in multi boiler systems – Operation with lower boiler water temperature Lag boilers in multi boiler systems – Can be shut down	
7.	Weekend setback	As per reduced mode	

For water quality requirements see the technical guide to this boiler.

Design/engineering information

Mounting a suitable burner

The burner must be suitable for the relevant rated heating output and the pressure drop on the hot gas side of the boiler (see burner manufacturer's specification).
The material of the burner head must be suitable for operating temperatures of at least 500 °C.

Pressure-jet oil burner
The burner must be tested and designated to EN 267.

Pressure-jet gas burner
The burner must be tested to EN 676 and CE-designated in accordance with Directive 2009/142/EC.

Burner adjustment
Adjust the oil or gas throughput of the burner to suit the rated boiler heating output.

Low water indicator

If the standard boiler control unit is connected in accordance with the installation instructions, the Vitoplex 200 up to 300 kW (except in attic heating centres) does not require a low water indicator to EN 12828.

In the event of a water shortage due to a leak in the heating system and simultaneous burner operation, the control unit will automatically shut down the burner before the boiler and/or flue system reach impermissible high temperatures.

Permissible flow temperatures

Hot water boiler for permissible flow temperatures (= safety temperatures)

Up to 110 °C
- **CE designation:**
  CE-0085 (90 to 350 kW) compliant with Efficiency Directive
  and
  CE-0085 compliant with the Gas Appliances Directive

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Design/engineering information (cont.)

Above 110 °C (up to 120 °C) (with individual test certification on request)

■ **CE designation:**
CE-0035 in compliance with the Pressure Equipment Directive
For operation with safety temperatures in excess of 110 °C additional safety equipment is required.
Boilers with a safety temperature **above 110 °C** require supervision, according to the Health & Safety at Work Act [Germany]. In accordance with the conformity assessment diagram no. 5 of the EU Pressure Equipment Directive, these boilers must be classed as category III.
The system must be tested prior to commissioning.
– Annually: External inspection, inspection of the safety equipment and water quality.
– Every 3 years: Internal inspection (or water pressure test as an alternative).
– Every 9 years: Water pressure test (for max. test pressure see type plate).
An approved inspection body (e.g. TÜV [in Germany]) must carry out the test.

Further information on design/engineering

See the technical guide to this boiler.

Tested quality

CE designation according to current EC Directives

DVGW GEPRÜFT

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Subject to technical modifications.

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Appendix E Centriair Emissions Abatement System, technical specification

Quotation no:	Ver3.1119	Valid through:	2024-01-22	Customer:	Acorn Bioenergy
Date	2023-12-22	Our ref:	Emanuel Andersson	Your ref:	Roger Hammett

Quotation for Odour removal

Centriair develops and offers technology leading solutions for abatement of industrial airborne emissions. We provide solutions with proven environmental and economic benefits. Our systems typically have higher performance and lower energy consumption than prevailing solutions. We help the industry solve a broad range of emission problems while increasing the productivity and reducing operations and maintenance costs.

These benefits are achieved through higher performance, lower energy consumption and by recovering energy from the process. We work across a broad range of industry sectors, however most of our customers are in the food processing and waste processing industries.

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Reg. number 556737-9374

Introduction

Centriair is pleased to offer this quotation for odour removal at the client site based on the ColdOx™ system.

The following design is suggested to be designed for the application. The outlet gas will meet the following criteria:

- Odour concentration less than 1 000 OU/m3 from the chimney.

No	Component
1	Packed Acid Scrubber – treating 18 500 Nm3/h.
1	UV reactor of model Frej with 10 lamp frames – treating 18 500 Nm3/h.
1	Carbon filter 2x6 - treating 18 500 Nm3/h.
1	Main fan - treating 18 500 Nm3/h.
1	Standalone Chimney 16.5 meters high – treating 18 500 Nm3/h.
1	Ducting supply and installation.
1	Piping between equipment
1	Drainpipes with water trap
1	Instrumentation for control and monitoring

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Planned feedstock

Chicken manure and farm yard manure (poultry litter) from the table below:

Feedstock (Inputs)	Category	Mass Required (T/yr)	Dry Matter (%)	Volatile Solids (%)
Wholecrop	Energy Crop/Product	17,500	35.00%	95.00%
Maize Silage	Energy Crop/Product	26,000	32.00%	97.00%
Straw	Residue/Waste	20,000	86.88%	91.56%
Farm Yard Manure	Residue/Waste	9,000	25.00%	80.00%
Dairy Slurry (south lynch spec.)	Residue/Waste	6,000	11.00%	90.00%
Pig Slurry	Residue/Waste	4,500	6.00%	80.00%
Botanical waste	Residue/Waste	-	78.72%	95.34%
Poultry Litter (three maids av spec.)	Residue/Waste	11,000	68.00%	72.00%
Water	Dilution	42,000	0.00%	0.00%
		94,000	45.19%	

Process description

The expected performance from the ColdOx system is illustrated below.

Inlet air streams		
source no. 1	air from chicken shed	
air flow	18,500	m^3/h
temperature min.	10	°C
temperature max.	35	°C
humidity	80-90	%rH
O2 content	21	Vol%
dust content	TBD	mg/m^3
pressure at connection point	500	Pa

Inlet air pollutants		
source no. 1	air from chicken shed	
odour	< 20,000	OU/m^3
NH3	<100	ppm
H2S	2	ppm
VOC	not defined	ppm
other	not defined	

Target values for exhaust air		
odour	<1000	OU/m^3
NH3	<5	ppm
H2S	0	ppm

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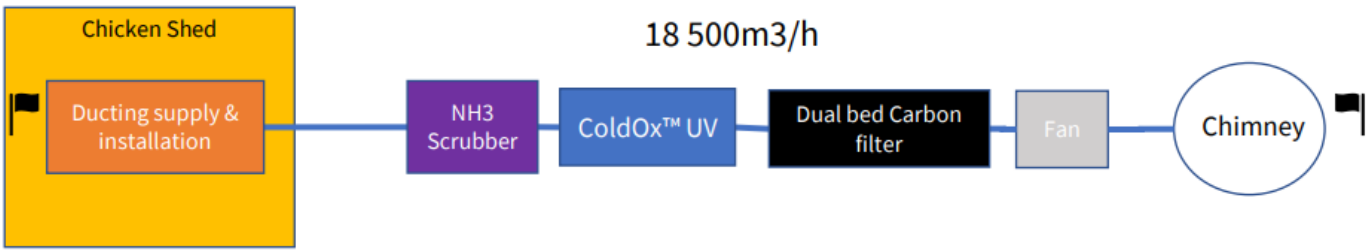
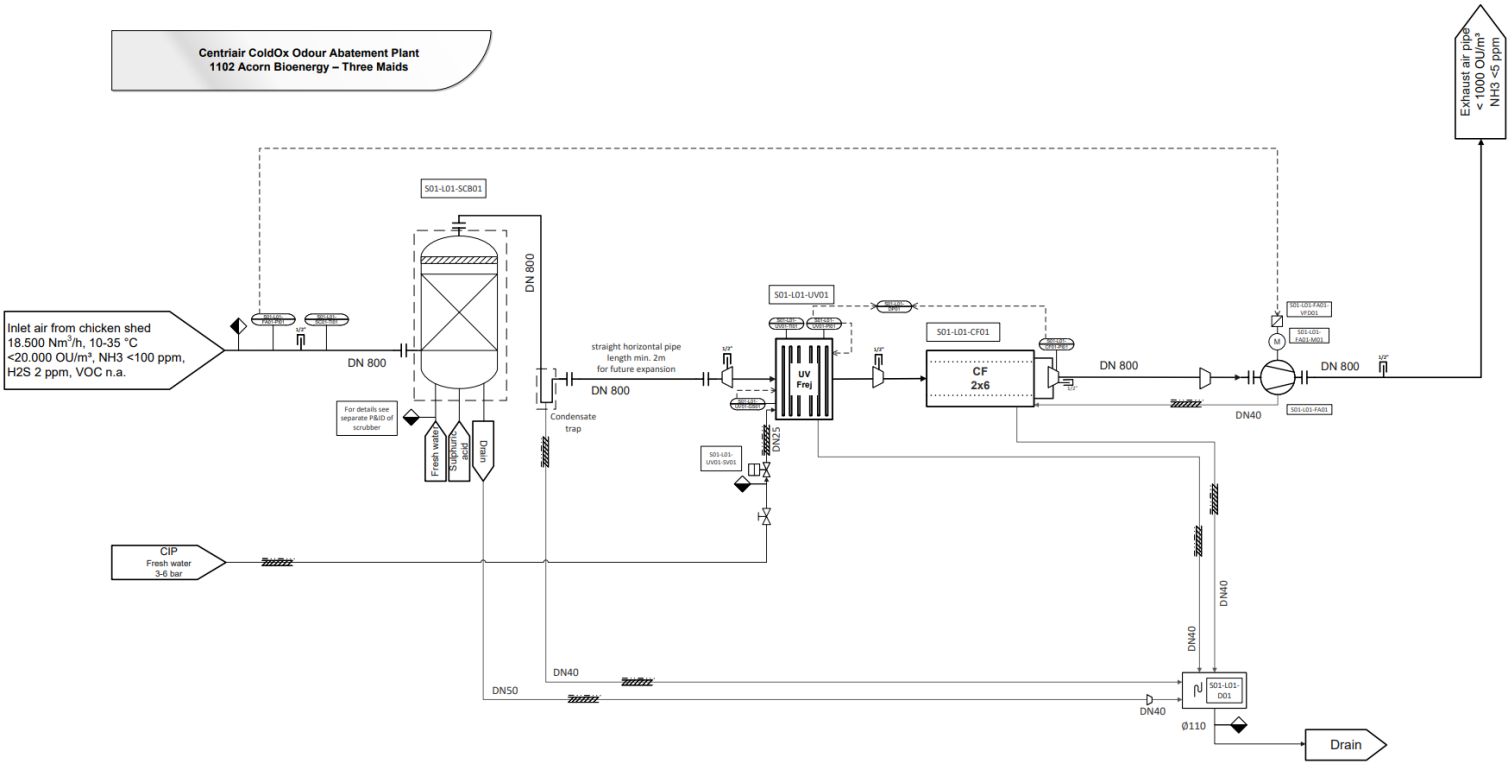
Odour mapping & Conceptual design



P&ID Odour treatment system



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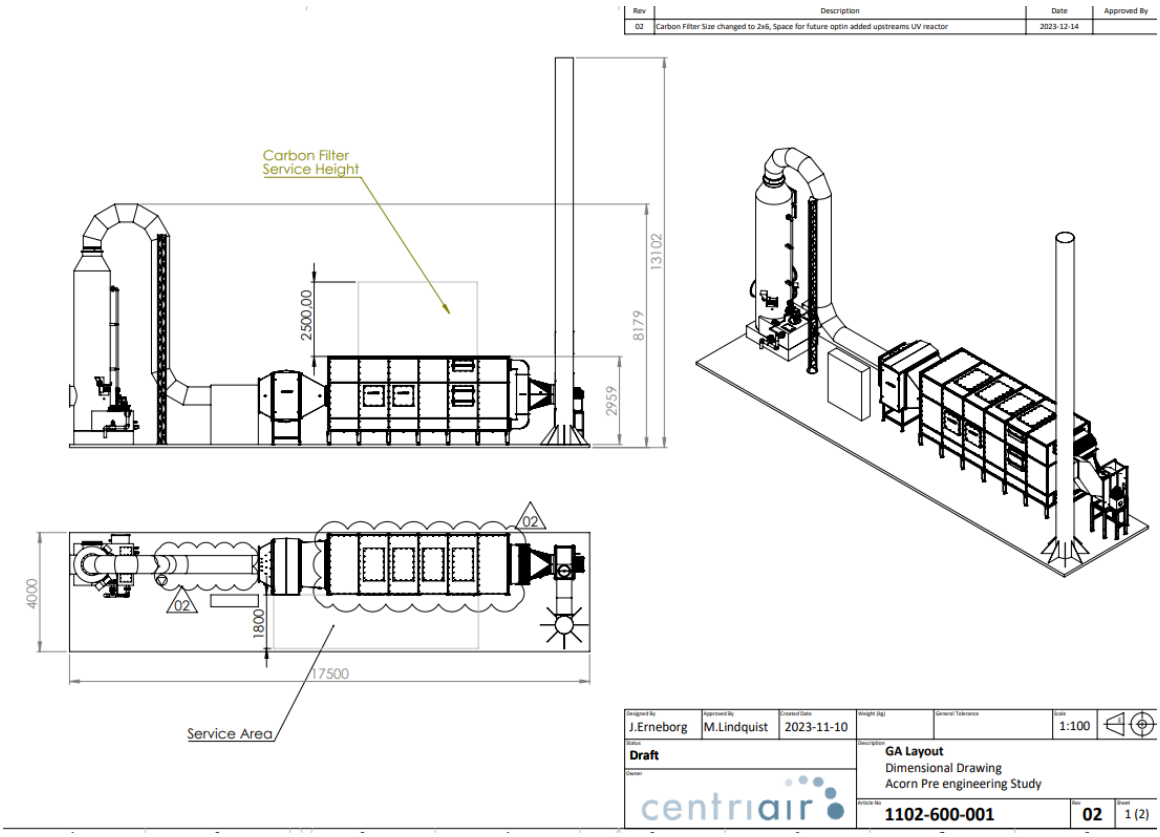
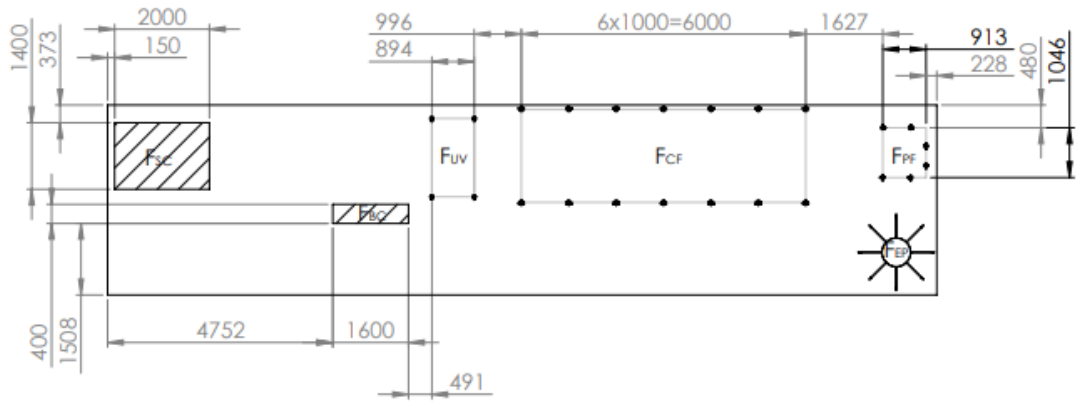
Overall footprint

Below is the preliminary footprint of the odour treatment system.





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Equipment Loads

Equipment Loads		
Equipment	**Tag**	**App. Weight [kg]**
Scrubber	F_{SC}	2500
UV Reactor	F_{UV}	450
Carbon Filter	F_{CF}	9600
Process Fan	F_{PF}	300
Exhaust Pipe	F_{EP}	750
Ballast Cabinet	F_{BC}	300

Overall consumptions

The information about the consumption is conservative.

Total power consumption

Fans come with VFD system to regulate the airflow changes. Thus, the fan can be set to run at a lower frequency, (e.g., 50 %) during less active periods to save power.

Main fan ColdOx :	15.0 kW
UV reactors system:	13,5 kW
Packed Cross-flow scrubber	approx. 5 kW
Summary	**33,5 kW**

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Water consumption UV reactor

The CIP from the UV reactors: 22 l/day

Consumables ColdOx system

Maintenance work	Quantity	Type	Interval (months)	TOTAL GBP	Total per year GBP
Carbon Filter					
Change of carbon	3 500	[kg]	~ 18-24	10 900	5 450
UV lamps					
Replacement of lamps	90	[pcs]	~ 24	4 920	2 460

Water consumption Packed Crossflow Scrubber

The water consumption assuming 18 500 m3/h @ 100 ppm NH3 24 hours each day drift hours. 25% blowdown concentration.

NH3 Scrubber: 20 L/hour + Evap. losses

Consumables Packed Crossflow Scrubber

The total cost of consumables is included in the appendix with the estimated lifetime and cost for the carbon media.

Type	kg/Day	GBP/kg		
75% Acid				
	125	0,19		

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Detailed system specification

UV Specification:

Description :	The UV reactors is in the first treatment stage, built together with the active carbon filter. Lamp life is approximately 16 000 hours. Basic control setup is start/stop signal from your system and running and error signal back to your system. Control and safety solution includes pressure guard for the UV as well as door switches. Equipment prewired with “plug and play” to minimize site wiring. Automatic flushing system of lamps, CIP (Clean in Place). Safety switches with alarm system in case of lamp failure. Controls and signaling see Appendix D.
Note:	The ballast panel should be positioned within 20 meter cable length from the UV reactor.
Electrical connection:	380-400 V/50 A three phase + Neutral 50 Hz
Weight:	Total weight of one reactor including support and lamp frames is 580 kg.
Process gas flow:	18 500 m^3/h
Maximal operating temp:	45 °C.
Control system:	PLC Siemens S7 1200

Active Carbon Specification:

Description:	Active Carbon filter with medium residence time due to the initial treatment and combination effects from oxidation + carbon. Dual carbon beds to minimize pressure drop.
Material:	Stainless steel AISI 304
Disposal of Carbon	For the disposal of spent media, we recommend following the guidelines of the European Waste Catalogue EWC and use the waste code number 19 09 04 or 15 02 03 – non hazard waste. Numerous landfills containing household trash and building materials will accept the loaded gas purification product, which is totally harmless to the environment, after submitting a declaration of analysis.
Other:	Centriair has the right to decide which type of activated carbon that operates.

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Main Fan Specification:

Description:	Industrial centrifugal fan (1) from stainless steel driven by frequency inverter. Fans come with VFD system to regulate the airflow changes. The exact pressure drops in the ducts to our system must be specified before ordering the final fan. This will have to be done already at the detailed design stage. Please revert if additional pressure capacity is needed. For more detailed specification see appendix.
Capacity:	18 500 m^3/h
Electrical connection:	380-400 V
Installed Power:	18,5 kW

Packed Acid Scrubber:

Description:	Scrubber stage for an efficient NH3 removal consisting of a reaction vessel with packing and distributor. Exit from the packed column includes a demister. Water conditioned with sulphuric acid is used in the system. The water reacts with the NH3 to form ammonium sulphate. The process water is drained when concentration reaches for instance 25% and the chemical should be possible to reuse in the customer's process.
Material:	FRP
Capacity:	18 500 m^3/h
Pressure drop:	App. 500 Pa

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Chimney:

Description:	Steel Chimney System
	Single flue Stack Height: 12m manufactured in 2No flanged sections. Structural Shell Diameter: 700mm. Flanged Inlet Dimensions: 550mm wide x 700 deep complete with necessary compensation bars. Inspection Hatch 400mm x 300mm at base level complete with necessary compensation bars. Sample Ports: 2No 125mm dia flanged sample ports. 1No internal drain plate 1No 50N/B drain connection. 2NO Earthing Bosses welded to base plate 1 set of steeplejack access points @ 1.5m centres. 1no drilled base plate complete with gussets to suit foundation bolts. 2No lifting points at the top of each chimney section.
Material.	According to EN10025 grade 304 stainless steel as a minimum

Ducting supply and installation:

Description:	See appendix for detailed information

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Appendix E Fan specification

Project:	1102 Acorn Bioenergy
Fan ID:	**Main Fan S01-L01-FA01**

Description of function and process

A frequency controlled fan used to keep a constant pressure upstream in the system. Fan will be used in an odour treatment process. Low concentrations of residual ozone may be present in the exhaust air. Fan is operated without stopping all year.

Design data, gas

Type of gas	Ventilation air
Dust content inlet	Low (normal outdoor air)
ATEX	No Ex-Zone

Mode of operation	**Normal**
Gas flow inlet, Nm3/h	18.500 Nm³/h
Gas density inlet, kg/m3	1,1
Gas temperature inlet, °C	10 to +35 °C
Static Pressure increase over fan, Pa	2.100 Pa

Design data, surroundings

Environment	Outdoor
Temperature	-20 to +40 °C
Corrosion protection (for painted surfaces)	C3-M (ISO 12944)

Fan Specification and scope

Maximum fan speed, rpm and Hz	*Specified by supplier*
Materials, in gas contact	AISI 304 (1.4301)
Materials, not in gas contact	AISI 304 (1.4301)
Drainage	2"
Inspection hatch	Placed in outer radius of housing
Outlet direction	ISO LG-315
Drive type	Direct driven
Fan wheel type	*Specified by supplier*
Sound level limits, surroundings	<65 dB(A), at 1m distance from fan (while inlet/outlet pipes are connected)

Motor Specification and scope

Motor voltage, V	400
Net frequency, Hz	50
No of Poles, motor	*Specified by supplier*
Motor efficiency class	IE3 or higher
Insulation class	F
Protection class	IP55
Frequency converter driven	Yes

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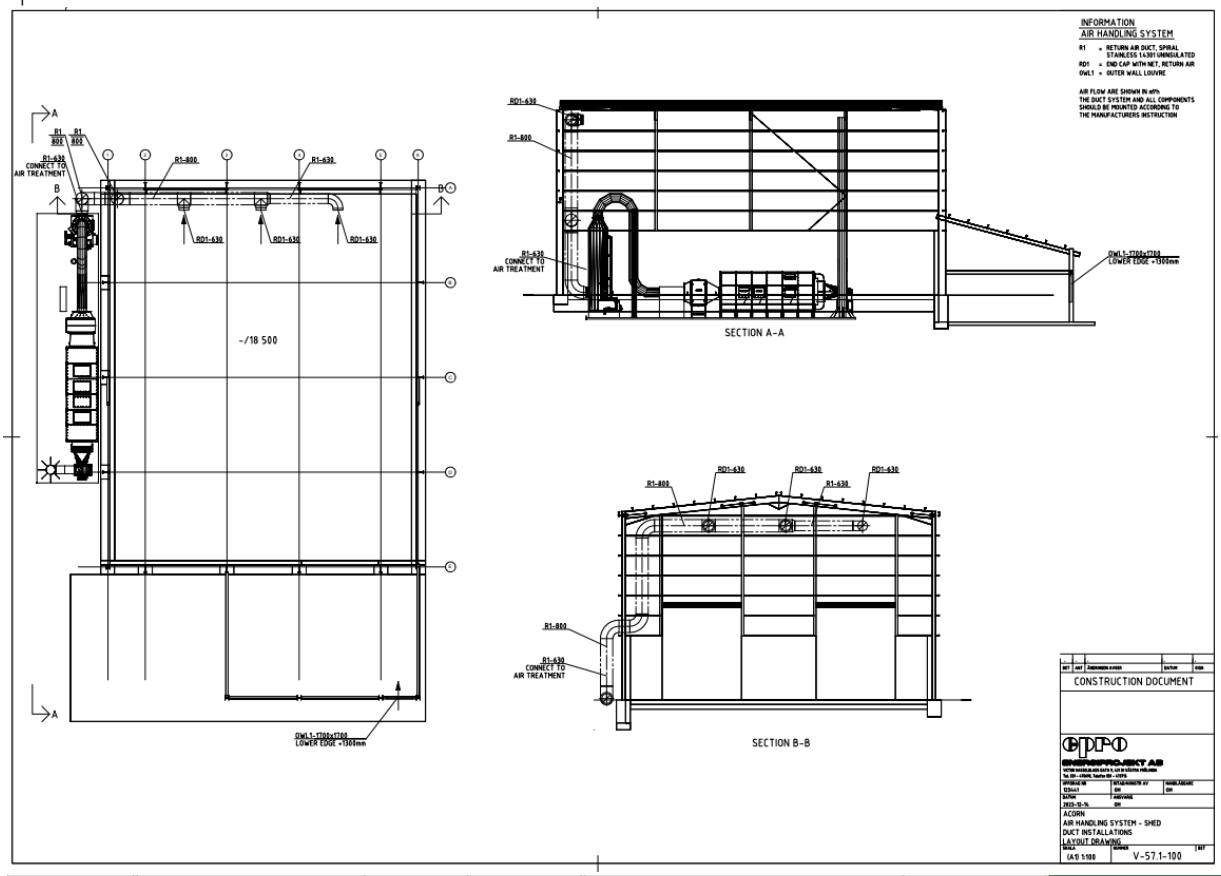
Appendix F Ducting supply and installation

Specification ductwork from shed.



COMPONENT NR.	COMPONENT DESCRIPTION	QUANTITY NO.	CONNECTION SIZE	REMARK 1	REMARK 2	MATERIAL
AIR DUCT SYSTEM						
RETURN AIR			**Ø (mm)**			
RD1-630	END CAP WITH NET	3	630	BIRD SCREEN		STAINLESS STEEL(1.4301)
FRESH AIR			**BxH(mm)**			
OWL1-1700x1700	FRESH AIR LOUVRE	1	1700 x 1700			STAINLESS STEEL(1.4301)
AIR DUCT SYSTEM						
R1-800	Straight duct	20 meters	800	DUCT SIZING ACCORDNING TO DRAWING	SPIRAL TUBE	STAINLESS STEEL(1.4301)
R1-800	Elbow 90 deg	4 pieces	800	DUCT SIZING ACCORDNING TO DRAWING	SPIRAL TUBE	STAINLESS STEEL(1.4301)
R1-800	T-piece	2 pieces	800	DUCT SIZING ACCORDNING TO DRAWING	SPIRAL TUBE	STAINLESS STEEL(1.4301)
R1-800	Reduction 800-630	4 pieces	800/630	DUCT SIZING ACCORDNING TO DRAWING	SPIRAL TUBE	STAINLESS STEEL(1.4301)
R1-630	Straight duct	6 meters	630	DUCT SIZING ACCORDNING TO DRAWING	SPIRAL TUBE	STAINLESS STEEL(1.4301)
R1-630	Elbow 90 deg	1 pieces	630	DUCT SIZING ACCORDNING TO DRAWING	SPIRAL TUBE	STAINLESS STEEL(1.4301)

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