Environmental Permit Variation Application Amendment Report EPR/VP3034RX/V001

Burton Agnes Biogas Plant

Future Biogas Limited

CRM.0163.001.PE.R.003

'Experience and expertise working in union'

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Environmental Permit Variation Application Amendment Report CRM 0163 001 PE R 003

Project:	Burton Agnes Biogas Plant
For:	Burton Agnes Renewables Limited
Status:	DRAFT
Date:	May 2023
Author:	Steph Charnaud, Director of Permitting
Reviewer:	Jane Hall, Associate Consultant

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1.0 Introduction

1.1 Overview

1.1.1 This is an addition to the previously sent Application Document for a Variation to the Permit reference EPR/VP3034RX/V001, held by Future Biogas Limited for their Anaerobic Digestion plant; Burton Agnes Biogas Plant.

1.1.2 This amendment is required as the Operator has been informed that the CHP which they have on site is required to be replaced due to its age and operating capabilities. The replacement CHP will be located in the same place as the current CHP with the same net rated thermal input and stack height.

1.1.3 As per the previous document reference CRM 537 004 PE R 003 there are no other changes to the Facility.

1.2 Background

1.2.1 The Facility was regulated by the EA under a standard rules permit SR2012 No11 but following the recent revision of this standard rules permit, the Facility no longer meets the revised standard rules. The Environment Agency have replaced standard rules permit SR2012 No11 with standard rules permit SR2021 No6 : anaerobic digestion facility, including use of the resultant biogas – installations.

1.2.2 Under standard rules permit SR2021 No6, the Facility cannot be located within a groundwater source protection zone I or II. As the eastern half of the Facility is located within source protection zone II, the new standard rules cannot be met.

1.2.3 The only change to the Facility is the replacement of the current CHP with a new CHP of the same net rated thermal input and same stack height at the same location as the existing CHP. This change is required as the existing CHP is coming to the end of its lifespan.

1.2.4 There are no other changes to the Facility as a result of this variation application, specifically:

- The quantity of wastes received and associated European Waste Catalogue (EWC) codes.
- The Facility's operational hours.
- The infrastructure on site. With the exception of a new CHP plant which replace the current CHP plant and be located at the same site as the existing CHP plant.
- Emissions to land and water.
- The management of the site and its operations.

1.3 Planning Permission

1.3.1 Planning Permission for the Facility and its operations has been previously granted and is not required to be amended as a result of this Variation Application.

1.4 Relevant Legislation and Guidance

1.4.1 The proposed activities are subject to a number of National, European and International legislation and statutory and non-statutory guidance documents.

1.4.2 In relation to the proposed Anaerobic Digestion operations the following key pieces of legislation and guidance are relevant:

- Waste Framework Directive 2008/98/EC revised 05/07/2018;
- Environmental Permitting (England & Wales) Regulations 2016 (as amended);
- Environment Agency, Control and monitor emissions from your environmental Permit, 17th May 2021;
- Environment Agency, Develop a management system: environmental Permits, 4th August 2021;
- Environment Agency, Risk assessments for your environmental permit, March 2021;
- Environment Agency, Risk assessment for specific activities; environmental permits, 2nd February 2016;
- Environment Agency, Appropriate measures for the biological treatment of waste, consultation draft July 2020;
- Best Available Techniques (BAT) reference Document for Waste Treatment, 2018;
- Environmental Permitting Core Guidance, Defra; March 2020;
- Environment Agency, H4 Odour Management, March 2011;
- Environmental Permitting Guidance: The Waste Framework Directive, October 2009; and
- The Environment Agency (Environmental Permitting and Abstraction Licensing) (England) Charging Scheme 2022

1.5 Site Location and Environmental Setting

1.5.1 The Facility is located at:

Burton Agnes Biogas Plant
Harpham Grange Farm
Burton Agnes
East Riding of Yorkshire
YO25 4NQ

1.5.2 The National Grid Reference for the site is TA 09311 64064. The installation is in a rural area with agricultural land surrounding all boundaries.

1.5.3 The installation is a considerable distance away from any human or ecological receptors. The nearest residential property is approximately 1120m, to the Southeast. The nearest surface watercourse is the Burton Agnes Pond and Mill Beck approximately 1.36km Southeast of the site.

1.5.4 The Facility lies within flood zone 1, which has a low probability of flooding.

1.5.5 The Facility lies within designated Nitrate Vulnerable Zones, designations from 2017.

1.5.6 The Facility lies over a principal bedrock aquifer, with an undifferentiated secondary aquifer in the superficial geology.

1.5.7 The groundwater vulnerability below the site is rated as high to the east of the site and medium to the west of the site due to soluble rock risk.

1.5.8 The site lies within a source protection zone 2 and 3 with a designated source protection zone 1 to the north of the northern site boundary.

1.5.9 The Facility does not lie within a designated air quality management area.

1.5.10 The prevailing wind direction at the Facility is from the west southwest, west and west northwest according to observations taken at the Burton Fleming Weather Station from May 2013 – April 2023. www.windfinder.com

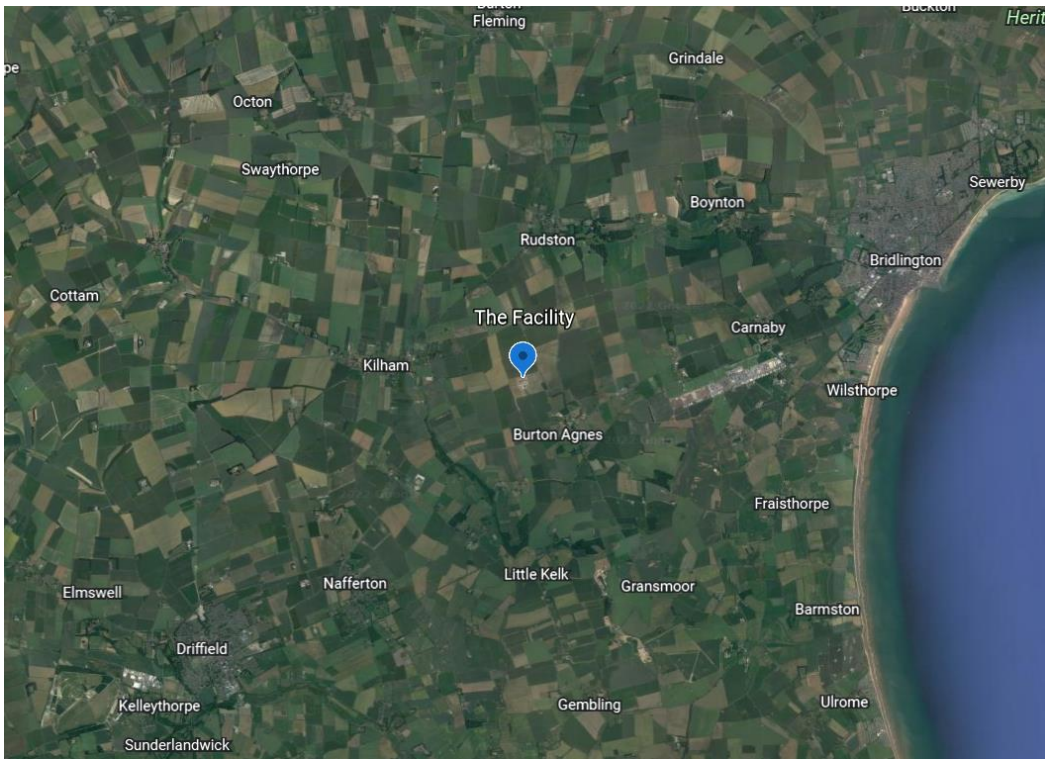
1.5.11 Table 1.5.1 below describes sensitive receptors which have been considered within this report.

Table 1.5.1: Sensitive Receptors

Receptor	Type	Distance (m)	Direction
Principal bedrock aquifer	Hydrogeological	On site	-
Source Protection Zone 2/3	Hydrogeological	On Site	-
Undifferentiated secondary superficial geology aquifer	Hydrogeological	On site	-
Agricultural land	Agricultural	0	N, E, S & W
Bridleway	Recreational	602	SSW
Public right of way	Recreational	624	S
Public right of way	Recreational	660	SW
Recreational ground	Recreational	706	SE
Nearest residential property (Burton Agnes Village)	Residential	1120	SE
Harpham Grange	Residential	1121	S
Burton Agnes primary school	Educational	1225	SE
Tuft Hill farm	Residential	1573	NNW
Agua House	Residential	1627	SE
Kilham Village	Residential	1726	WNW
Keeper's cottage	Residential	1781	SSE
Thornholme Village	Residential	1844	ESE
Commercial site	Commercial	1860	W

1.5.12 Figure 1.5.2 below shows the site location.

Figure 1.5.2: Site Location



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1.5.13 The Facility will be operated by Burton Agnes Renewables Ltd whose company registration number is: 09701511.

1.5.14 The primary contact for the application is Jane Hall, Associate Consultant, Enzygo Limited, Jane.Hall@enzygo.com (Tel: 01454 269237).

1.6 Regulated Activities

1.6.1 The table below provides details of the current regulated activities, no changes to these activities are proposed for this permit variation application. The replacement CHP is already covered. There are no changes to the waste received in terms of throughput, capacity or waste codes.

Table 1.6.1: Regulated Activities

Activity	Description of specified activity and WFD Annex I and II operations	Limits of specified activity and waste types
Activity listed in Schedule 1 of the EP Regulations		
Section 5.4 Part A(1)(b)(i) Recovery or a mix of recovery and disposal of non-hazardous waste with a capacity exceeding 75 tonnes per day (or 100 tonnes per day if the only waste treatment activity	R3: Recycling of reclamation of organic substances that are not used as solvents.	From receipt of waste through to digestion and recovery of by-products (digestate). Anaerobic digestion of waste in three tanks (one buffer tank feeding one digester and a digestate storage tank)

Activity	Description of specified activity and WFD Annex I and II operations	Limits of specified activity and waste types
is anaerobic digestion) involving biological treatment		followed by burning of biogas produced from the process. Waste types suitable for acceptance are limited to those specified in the Permit
Directly Associated Activities		
Description of activity	**Annex IIA or IIB Codes**	**Limits of specified activity and waste types**
Storage of waste pending recovery or disposal	R13: Storage of waste pending any of the operations numbered R1 to R12 (excluding temporary storage, pending collection, on the site where it is produced)	From the receipt of waste to dispatch off site for recovery and/or disposal. Storage of waste in silage clamps on an impermeable surface with sealed drainage. Storage of liquid digestate. Storage of solid digestate. Storage of dirty water from the process in dirty water lagoon prior to use in the AD process. Waste types are suitable for acceptance are limited to those specified within the Permit.
Physical treatment of non-hazardous waste	R3: Recycling/reclamation of organic substances which are not used as solvents	From the receipt of waste to dispatch for anaerobic digestion or dispatch off site for recovery and/or disposal. Storage of waste in clamps on an impermeable surface with sealed drainage. Waste types are suitable for acceptance are limited to those specified within the Permit.
Gas combustion in combined heat and power (CHP) engine to produce heat and power	R1: Use principally as a fuel to generate energy	From the receipt of biogas produced at the on-site anaerobic digestion process to combustion with the release of combustion gases. Combustion of biogas in one replacement combined heat and power (CHP) engine with an aggregated thermal input of 1.315MWth.

Activity	Description of specified activity and WFD Annex I and II operations	Limits of specified activity and waste types
Treating biogas and biomethane	R13: Storage of waste pending the operations numbered R3 (excluding temporary storage, pending collection, on the site where it is produced) R3: Recycling/reclamation of organic substances which are not used as solvents	From the receipt of biogas produced at the on-site anaerobic digestion process to dispatch for use within the Facility's replacement CHP.
Gas upgrading plant	Clean and upgrade biogas using membrane separation technology and propane injection.	From receipt of biogas produced onsite to upgrading biogas to biomethane for export to the grid.
Emergency flare operation.	D10: Incineration on land Use of one auxiliary flare required for periods of breakdown or maintenance only	From the receipt of biogas produced at the on-site anaerobic digestion process to incineration with the release of combustion gases.
Biogas storage	Storage of biogas produced from anaerobic digestion of permitted waste in roof (headspace) of digesters.	From the storage of biogas produced from anaerobic digestion to point of use in the Facility.
Digestate storage	Storage of liquid digestate in the secondary digestate tank and storage of solid digestate in a clamp	From the receipt of digestate produced from the on-site anaerobic digestion process to dispatch for use off site.
Raw material storage	Storage of raw materials including lubrication oil, antifreeze, ferric chloride, activated carbon, diesel	From the receipt of raw materials to dispatch for use within the Facility
Surface water collection and storage	Collection and storage of uncontaminated site surface water in a clean water lagoon	From the collection of uncontaminated site surface water from non-operational areas only for storage in the onsite clean surface water lagoon and discharge to land via soakaway
Emergency Diesel Generator Operation	Combustion of diesel in engine	Generator is used for <50 hours per annum, with usage recorded.

1.7 Process Description

1.7.1 Maize, hybrid rye and wheat straw is delivered to the site and ensiled after harvest. The material is covered to ensure that it is maintained in an anaerobic environment and to reduce the potential for odours and facilitate the silaging process. This feedstock is mechanically loaded into one of the two covered feeders which transfers the material into the primary digester.

1.7.2 Manure is typically brought onto the site once a week and stored in the clamps. The manure is mechanically loaded into one of the two covered feeders which transfers the manure into the primary digester.

1.7.3 Pig slurry is typically brought onto the site once a week and transferred directly to the Facility's buffer tank then fed into the 7043m³ primary digester tank.

1.7.4 Upon the addition of further feedstock, the digestate transfers to the secondary digester via a gravity overflow system. The substrate is constantly mixed by rotating paddle stirrers in the primary and secondary digesters. The material has a 70-day residence time within the AD process. Once the digestate has achieved its residence time it is fed into the 12268m³ digestate storage tank.

1.7.5 The solid and liquid fractions of the digestate are separated. The solid fraction of the digestate is stored in one of the Facility's silage clamps before being removed off site for use as a fertilizer. The liquid fraction of the digestate is stored in the digestate tank before being transported off-site for use as a fertilizer on local agricultural land. The digestate is periodically collected from the digestate storage tank for use as a fertiliser on local farmland.

1.7.6 Biogas produced during the process is stored within the roof space of the digestate storage tank before being fed to either the biogas upgrading plant or the replacement CHP, with the heat and power being utilised both on site and power also exported off site. The volume of the double membrane gas holder is 8000m³.

1.7.7 A full description of the process is contained within section 3.0 of this report and a process flow diagram can be found in Appendix D of CRM 537 004 PE R 003 Application Document.

1.8 Emissions from the Facility

1.8.1 The emission point currently referenced as A5, associated with the current CHP flue stack, will be removed and replaced with a new emissions point A5, associated with the replacement CHP flue stack.

1.8.2 There are no other changes to the emissions from the Facility as a result of this Permit Variation application.

1.8.3 The point source emissions to air are detailed below.

1.8.4 There are no point source emissions to land.

1.8.5 Surface water is collected and directed to the surface water lagoon which acts as a large soakaway.

1.8.6 Dirty water is collected and directed to the lined dirty water lagoon. This is either used within the process or used to irrigate the local agricultural land.

1.9 Emission to Air

1.9.1 There are no additional point source emissions to air as a result of this permit variation application. However, as mentioned above the current air emission reference point for the current CHP stack will be replaced by the replacement CHP stack.

1.9.2 Emission points to air comprise the replacement CHP engine stack, auxiliary boiler stack, emergency flare, biogas cleaning stack, emergency diesel generator, and pressure relief valves on the buffer tank, primary digester, secondary digester and digestate storage tank.

1.9.3 The point source emissions to air, which remain unchanged as a result of this permit variation, are listed in Table 1.9.1 below.

Table 1.9.1: Point Source Emissions to Air

Air Emission Point Reference	Source of Emission	Emissions
A5	Replacement CHP Engine	CO, CO_2, NOx, VOCs, SO_2.
A6	Standby Auxiliary Boiler	CO, NOx, SO_2, VOCs
A7	Emissions from the Auxiliary/Emergency High Temperature Flare Stack	CO, CO_2, NOx, SO_2, VOCs
A8	Biogas Upgrading Stack	CO_2, VOCs
A9	Emergency Diesel Generator	CO, CO_2, SO_2, NOx, VOCs.
PRVs	One buffer tank PRV One primary digester PRV One secondary digester PRV One digester storage tank PRV One biogas holder PRV	CO_2 (44.5%), CH_4 (55%), H_2S, NH_4, VOCs

1.10 Emissions to Water

1.10.1 There are no other point source emissions to water, groundwater or sewer and all leachate and dirty water is captured by the sealed, on-site drainage system. The drainage system feeds into the lined dirty water lagoon where water is stored until it is either reused within the anaerobic digestion process or used as irrigation water. This arrangement is unchanged.

1.11 Fugitive Releases

1.11.1 Release of fugitive emissions to air will be prevented through infrastructure and management controls as per existing arrangements. As the input wastes comprise potentially odorous substances, they shall be covered at all times when material is not being added or removed.

1.11.2 It is considered highly unlikely that offsite nuisance as a consequence of dust will occur as a result of the operation of the Facility due to the mitigation measures which are in place and the distance between the Facility and the nearest receptor.

1.11.3 The potential for fugitive releases to water or land are limited to risks associated with the storage of liquids. Release of fugitive emissions to land and water will be prevented through infrastructure and management controls as per existing arrangements.

1.11.4 There are no additional fugitive emissions as a result of this Variation application.

1.12 Non-Permitted Activities

1.12.1 The operator is not proposing to undertake any activities at the site other than those which will be included in the Environmental Permit.

1.13 Management and Control

1.13.1 There are no changes to the personnel or the management of the on-site activities. The site's Technically Competent Manager (TCM), Andrew Saunders and Site Manager are unchanged.

Andrew Saunders' WAMITAB Certificate and Continuing Competency Certificate is provided in Appendix B of document reference CRM 537 004 PE R 003 Application Document.

1.13.2 It is considered that current arrangements meet Environment Agency guidance in relation to management of the Facility.

1.13.3 The Facility has in place an Environmental Management System which will be reviewed as part of the Permit Variation.

1.14 Environmental Risk Assessment

1.14.1 An Environmental Risk Assessment has been completed to support this permit variation application, to assess the impacts of the Facility's operation. This assessment has been completed in line with the Environment Agency's guidance documents, '*Risk assessments for your environmental permit, 25 March 2021*' and 'Risk assessments for specific activities: environmental permits, 2 February 2016',

1.14.2 The risk assessment has concluded that the activities at the Facility will not result in an unacceptable risk to nearby sensitive receptors. The Environmental Risk Assessment is presented in full within section 5 of this permit variation application report.

1.15 Closure and Decommissioning

1.15.1 In the event that activities cease on site and decommissioning is required, the Facility's 'Closure plan' will be submitted to the Environment Agency. This will include details of how the Facility will be dismantled, how wastes produced from dismantling will be either recycled/reused or where appropriate disposed of. Finally, the site will be decontaminated to its pre-operational state i.e., agricultural status. As the proposed changes do not involve any changes to equipment, infrastructure or land use, the Facility's closure plan remains valid.

2.0 Process Description

2.1 Overview

2.1.1 This Permit Variation is to allow the Operator to continue to run the Facility due to the replacement of Standard Rules Permit, SR2012 no11 with Standard Rules Permit SR2021 no6 in. This variation application is for a bespoke permit.

2.1.2 The only change to the activities on site relating to this variation application is the replacement of the existing CHP with a new CHP of the same net rated thermal input and stack height. This is required as the existing CHP is reaching the end of its lifespan.

2.1.3 There will be no other changes to the operations at the Facility as a result of this variation application.

2.2 Waste Acceptance and Pre-Acceptance

2.2.1 There are no changes to waste acceptance or pre-acceptance procedures or operations as part of this Variation. Techniques, controls, infrastructure, waste types and quantities accepted, and storage volumes all remain the same.

2.3 Waste Storage

2.3.1 There are no changes to the incoming waste storage facilities on-site. Incoming wastes are stored covered within the Facility's sheeted clamps and tanks. The non-waste crops are stored in the silage clamps which are sheeted.

2.3.2 Pig slurry is transferred directly into the Facility's buffer tank, which is located, along with the digesters, within the Facility's bund.

2.3.3 Manure is stored within any vacant silage clamps and is sheeted. A maximum of 3 days' worth of manure is stored on-site at any one time.

2.3.4 The digestate produced as a result of the anaerobic digestion process is not a waste. The solid fraction is stored within one of the Facility's clamps prior to be taken off site. The liquid fraction is stored within the digestate tank before being taken off site. Both fractions of the digestate are utilised as a fertilizer on local agricultural land.

2.4 Waste Treatment

2.4.1 There are no changes to the treatment of waste imported onto the site. Wastes and non-wastes are loaded into the hopper then fed into the 7043m³ primary digester.

2.4.2 Upon the addition of further feedstock, the digestate transfers to the secondary digester via a gravity overflow system. The substrate is constantly mixed by rotating paddle stirrers in the primary and secondary digesters. The material has a 70-day residence time within the AD process. Once the digestate has achieved its residence time it is fed into the 12,268m³ digestate storage tank.

2.4.3 The solid and liquid fractions of the digestate are separated. The solid fraction of the digestate is stored in one of the Facility's silage clamps before being removed off-site for use as a fertiliser. The liquid fraction of the digestate is stored in the digestate tank before being transported off-site for use as a fertilizer on local agricultural land. The digestate is periodically collected from the digestate storage tank for use as a fertiliser on local farmland.

2.4.4 Biogas produced during the process is stored within the roof space of the digestate storage tank before being fed to either the biogas upgrading plant or the replacement CHP, with the heat and power being utilised both on site and power exported off site. The volume of the double membrane gas holder is 8000m³.

2.4.5 The biogas which is sent to the biogas upgrading unit is treated for contaminants and tested for conformity before having odorant added and being injected into the National Grid via the network entry facility.

2.5 Management of the Facility

2.5.1 Operations at the site shall continue to be controlled within Burton Agnes Renewables Limited's EMS, to ensure that all activities are managed to minimise any emergency scenarios and potential environmental harm. A summary of the operator's EMS can be found in Appendix E of document reference CRM 537 004 PE R 003 Application Document.

2.5.2 There are no changes to the personnel or the management of the on-site activities. WAMITAB Certificates are provided in Appendix B of document reference CRM 537 004 PE R 003 Application Document.

2.6 Accident Prevention

2.6.1 As stated above, there are no changes proposed to the management of the Facility. The site's current Accident Management Plan is deemed satisfactory as the replacement CHP will pose the same risks as the current CHP.

2.7 Energy Use

2.7.1 There is no change to the energy use at the site as a result of this Permit Variation application. The electrical energy demand for the Facility will continue to be met by both energy generated by combustion of biogas and imported electricity.

2.8 Raw Materials and Water

2.8.1 There will be no change in raw materials or water usage as a result of this Permit Variation application.

2.9 Waste Avoidance, Recovery and Disposal

2.9.1 The waste throughput and waste types are unchanged as a result of this Permit Variation application.

2.9.2 There is very minimal waste generated as part of the operations on the site and this Permit Variation application will not increase the quantity of waste produced.

2.10 Control of Emissions

2.10.1 There are no additional releases to water, sewer or land.

2.10.2 The emission point A5 which arises from the current CHP is to be associated with the replacement CHP which is part of this Permit Variation Application. As such, there will not be any additional emissions to air.

2.10.3 The waste input will not change as a result of this Variation.

2.10.4 Existing emissions controls will be applied to the replacement CHP and are therefore considered to adequately control emissions from the Facility following this proposed change.

2.11 Monitoring

2.11.1 There will be no change to the emissions monitoring which is carried out in line with Permit conditions at the Facility. The emissions from the replacement CHP will be monitored in line with the conditions for monitoring the current CHP.

3.0 BAT Assessment

3.1 Introduction

3.1.1 BAT is determined by the Waste Treatment BATc. This section addresses the specific BATc's relevant to the Installation and compares the proposed techniques which will be employed on-site with the techniques described in the Waste Treatment BATc and provides an answer for question 3a on Application Form C3.

3.1.2 BAT is determined within the following documents:

- COMMISSION IMPLEMENTING DECISION (EU) 2018/1147 of 10 August 2018 establishing best available techniques (BAT) conclusions for waste treatment, under Directive 2010/75/EU of the European Parliament and of the Council ('Waste BAT')
- Appropriate measures for the biological treatment of waste, Environment Agency, Consultation Draft July 2020.
- Environment Agency, Medium Combustion Plant Guidance Collection, updated in March 2023.

3.1.3 No formal BAT assessment has been carried out previously, techniques in place to control any potential risks are described in this section and in section 4 which are in accordance with BAT for this sector. This BAT assessment also covers the replacement CHP.

3.2 Environment Management System Summary

3.2.1 The Operator will operate in accordance with an Environmental Management System (EMS). The EMS will be developed to comply with EA guidance and includes a defined environmental policy as well as standard operating procedures, maintenance, clear reporting lines, staff training, process and environmental monitoring and incident/accident management.

3.2.2 There are no changes to the management of the Burton Agnes Biogas Plant as a result of this Permit Variation Application.

3.2.3 The EMS summary is included in Appendix E of document reference CRM 537 004 PE R 003 Application Document, which demonstrates how key elements required in an EMS meet standard Permit Condition 1.1:

The operator shall manage and operate the activities:

in accordance with a written management system that identifies and minimises risks of pollution, including those arising from operations, maintenance, accidents, incidents, non-conformances, closure and those drawn to the attention of the operator as a result of complaints; and

using sufficient competent persons and resources.

3.3 BAT 1 Environmental Management System

3.3.1 BAT 1 requires Operators to ensure that the sector specific features listed within this BATc are incorporated into the Facility's EMS.

Table 3.3.1: Requirements of BAT 1: EMS

Requirement	Mitigation measures proposed by Operator	Meets BATc for waste treatment
I. Commitment of the management, including senior management.	The Operator's Environmental Policy Statement is signed by the Company Director which demonstrates their commitment to environmental performance.	Yes
II. Definition, by the management, of an environmental policy that includes the continuous improvement of the environmental performance of the installation.	The Environmental Policy Statement will include a commitment to continually improving environmental performance.	Yes
III. Planning and establishing the necessary procedures, objectives and targets, in conjunction with financial planning and investment.	The EMS will include setting objectives and targets. There will be a commitment to continuous improvement in the Policy Statement.	Yes
IV. Implementation of procedures paying particular attention to: (a) structure and responsibility, (b) recruitment, training, awareness and competence, c) communication, (d) employee involvement, (e) documentation, (f) effective process control, (g) maintenance programmes, (h) emergency preparedness and response, (i) safeguarding compliance with environmental legislation;	The EMS include all of these elements through procedures included within the EMS: (a) Roles and Responsibilities will be described in Policy reference. b) Training needs and training modules will be implemented through Future Biogas (FB) policy references DF-P-057 and DF-P-056. Training records are managed in accordance with FB policy. (c) Communications will be managed in accordance with various complaints procedures and in accordance with the Facility's Accident Management Plan (AMP) and Odour Management Plan (OMP). (e) Documentation will be managed in accordance with various procedures including the Document Control Procedure, and in accordance with the Facility's Permit, Accident Management Plan (AMP) and Odour Management Plan (OMP). (f) Process Control will be managed in accordance with various operational procedures and in accordance with the Facility's Permit, Accident Management Plan (AMP) and Odour Management Plan (OMP).	Yes

Requirement	Mitigation measures proposed by Operator	Meets BATc for waste treatment
	(g) Maintenance will be managed in accordance with the Operation Maintenance Plan DFP030, Maintenance Checklist DF-P-011 and other equipment-specific maintenance procedures. (h) Emergency procedures have been developed to cover specific scenarios, in addition to operation within the Facility's AMP. (i) The Legal Register for the Facility will be incorporated within the EMS and updated routinely. A list of procedures within the EMS is included in Appendix E of document reference CRM 537 004 PE R 003 Application Document.	
V. checking performance and taking corrective action, paying particular attention to: (a) monitoring and measurement, (b) corrective and preventive action, (c) maintenance of records, (d) independent internal or external auditing	(a) Process Monitoring Procedure, Sampling Procedures and Statutory Monitoring and Reporting Procedure meets this requirement (b) Incident Reporting Procedures are in place to report and react to incidents, in addition to the AMP. (c) Various records are maintained in accordance with EMS procedures. (d) Annual Management Reviews and Audit Schedule stipulates how the EMS and facility operations are audited.	Yes
VI. review, by senior management, of the EMS and its continuing suitability, adequacy and effectiveness	Annual Management Reviews and the Facilities' Audit Schedule stipulates how the EMS and facility operations are audited.	Yes
VII. following the development of cleaner technologies	The EMS includes setting objectives and targets. There is a commitment to continuous improvement in the Policy Statement.	Yes
VIII. consideration for the environmental impacts from the eventual decommissioning of the plant at the stage of designing a new plant, and throughout its operating life	Closure and Decommissioning Plan is implemented and integrated as part of the Facility's EMS.	Yes
IX. application of sectoral benchmarking on a regular basis	The EMS will include setting objectives and targets. There will be a commitment	Yes

Requirement	Mitigation measures proposed by Operator	Meets BATc for waste treatment
	to continuous improvement in the Policy Statement. The Burton Agnes Plant is recently constructed and adopts a high level of environmental protection.	
X. waste stream management	See BAT 2	Yes
XI. an inventory of wastewater and waste gas streams	There are no changes to wastewater or waste gases as a result of this Permit variation. Records are maintained as required by the current Permit and EMS.	Yes
XII. residues management plan	There is minimal waste generated by the Facility. The main output is digestate arising from non-waste crops and manures which is a non-waste material. A residues plan is therefore not required as it is disproportionate to the nature of the waste generated on-site.	Yes
XIII. accident management plan	See BAT 21	Yes
XIV. odour management plan	See BAT 12	Yes
XV. noise and vibration management plan	See BAT 17	N/A
Measures Specified in EAs Appropriate Measures for the Biological Treatment of Waste Guidance		
Site Infrastructure Plan including: • buildings, and other main constructions; • storage facilities for hazardous materials, chemical stores, waste materials; • location of items for use in accidents and emergencies; • emergency entrances and exits; • points designed to control pollution, (inspection or monitoring points);	These features are included in BAR's infrastructure plan, which is incorporated into the AMP showing all features listed (where relevant).	Yes

Requirement	Mitigation measures proposed by Operator	Meets BATc for waste treatment
• effluent discharge points; • contaminated land; • receptors; • drainage (foul and surface water); and • utility services.		
Waste Storage	There are no changes to the waste storage facilities which are deemed suitable.	Yes
Normal and Abnormal Operation	The EMS considers both normal and abnormal/emergency scenarios. Actions taken to prevent accidents and actions to take in the event of an accident are included in the AMP.	Yes
Maintenance	BAR have a robust programme of planned preventative maintenance in place for all critical plant and equipment which includes using computerised systems to schedule inspections and activity and record defects. This is included in the overarching EMS. Spare parts are maintained on site.	Yes
Accidents and Incidents	An accident management plan is in place which describes the accident scenarios relating to the plant along with mitigation measures and controls.	Yes
Climate Change	The EMS considers the impact of climate change, and operation during extreme weather events such as flooding and heat waves. Any additional implications for the EMS in relation to the additional plant and equipment will also be incorporated.	Yes
Complaints	Complaints are investigated immediately using the complaints reporting form and all reasonable measures are taken to substantiate and alleviate the issue if substantiated.	Yes

Requirement	Mitigation measures proposed by Operator	Meets BATc for waste treatment
Sufficient competent persons, resources and training	A training matrix and training plan forms part of the EMS. Records are kept for all training provided. Critical roles at the site are identified along with staff who can fulfil the requirements of these roles.	Yes
Record Keeping	Records are maintained for all documents associated with the Permit as required by Permit conditions. All records will be maintained for a period of six years, or as otherwise stated in the Permit.	Yes
Review of EMS	The EMS is reviewed routinely by senior plant management for suitability and in the event of a change to ensure that it adequately covers plant operations.	Yes
Closure	A site closure plan has been developed for the existing operations, which will be updated to include the proposed changes.	Yes
Access to Permit and EMS	The varied Permit and updated EMS will be made available to key staff and contractors.	Yes

3.3.2 In conclusion, the EMS in place at the Facility meets the requirements of the Waste Treatment BATc and relevant EA Guidance and is proportionate to the environmental risks associated with the activities carried out.

3.4 BAT 2 Waste Pre-Acceptance, Acceptance and Tracking

3.4.1 The operator only accepts manures, farm slurries and non-waste crops at the Facility which are unlikely to vary significantly in their nature. Waste Acceptance Procedures, Pre-Acceptance Procedures and Supply Agreement Forms for wastes and non-wastes are in place to control inputs. The risk of accepting any non-confirming loads is therefore minimal and will be controlled by these measures.

3.4.2 Non-conforming loads are rejected from site and records of any rejected loads are maintained.

3.4.3 BAT 2 requires Operators to improve the overall performance of their plants. Table 3.4.1 describes how the Facility meets these requirements.

Table 3.4.1: Requirements of BAT 2: Waste Pre-Acceptance, Acceptance and Tracking

Requirement	Measures in Place at Facility	Meets BATc for waste treatment
Set up and implement waste characterisation and pre-acceptance waste procedures	Waste Acceptance Procedure and Pre-Acceptance Procedures and supply agreement forms for wastes and non-wastes are in place to control inputs.	Yes
Set up and implement waste acceptance procedures	The operator only accepts non-waste crops, manures and farm slurries at the Facility which are unlikely to vary significantly in their nature. Waste Acceptance Procedure and Pre-Acceptance Procedures and supply agreement forms for wastes and non-wastes are in place to control inputs.	Yes
Set up and implement a waste tracking system and inventory	Records are made of each load of waste that arrives at the site. Supply agreement forms for wastes and non-wastes are in place to control inputs. As materials arising from the treatment of waste leaving the site are not classed as 'waste', a tracking system would be disproportionate to the risks. Only minimal quantities of maintenance wastes are generated.	Yes
Set up and implement an output quality management system	As materials arising from the treatment of waste leaving the site are not classed as 'waste', an output quality system would be disproportionate to the risks. Only minimal quantities of maintenance wastes are generated. A Quality Policy is in place to maintain a high standard of operation.	Yes
Ensure waste segregation	Inputs are stored in specific clamps and tanks according to the material type.	Yes
Ensure waste compatibility prior to mixing or blending of waste	Pre-acceptance checks ensure that incompatible wastes and non-wastes will not be received at the site. Waste will be blended to optimise treatment.	N/A
Sort incoming solid waste	The only incoming solid wastes will be manures which will be stored in a designated area.	N/A

3.4.4 In conclusion, the waste pre-acceptance and acceptance procedures in place at the Facility meet the requirements of the Waste Treatment BATc.

3.5 BAT 3 Inventory of Wastewater and Waste Gas Streams

3.5.1 Point source emissions to air from the Facility arise from the following sources:

- Replacement CHP engine;
- Auxiliary boiler;

- Biogas upgrading stack;
- Emergency flare;
- Emergency diesel generator; and
- PRVs

3.5.2 Emissions points are listed on Table 3.5.1 below and marked on the installation boundary plan in the Drawings section of this Application. These point source emissions are unchanged as a result of this Permit Variation application.

Table 3.5.1: Point Source Emissions to Air

Air Emission Point Reference	Source of Emission	Emissions
A5	Replacement CHP Engine	CO, CO_2, NOx, VOCs, SO_2.
A6	Auxiliary Boiler	CO, NOx, SO_2, VOCs
A7	Emissions from the Auxiliary/Emergency High Temperature Flare Stack	CO, CO_2, NOx, SO_2, VOCs
A8	Biogas Upgrading Stack	CO_2, VOCs
A9	Emergency Diesel Generator	CO, CO_2, SO_2, NOx, VOCs.
PRVs	One buffer tank PRV One primary digester PRV One secondary digester PRV One digester storage tank PRV One biogas holder PRV	CO_2 (44.5%), CH_4 (55%), H_2S, NH_4, VOCs

3.5.3 BAT 3 requires operators to establish and maintain an inventory of wastewater and waste gas streams as part of an EMS to facilitate the reduction in emissions to water and air.

3.5.4 As described in Section 2, the clamp storage areas will be serviced with a sealed drainage system which is drained to the dirty water lagoon. Any liquid leachate collected will be either fed into the AD Process or used for irrigation of the surrounding farmland. This is unchanged from existing arrangements.

3.5.5 Bund water will be pumped up to a diverter valve which is set to direct the flow to the dirty water lagoon. The pump station consists of a set of 2 submersible pumps set within a concrete sump within the bund.

3.5.6 Clean surface water run-off is directed to the on-site surface water lagoon which acts as a soakaway.

3.5.7 Table 3.5.2 below describes BAT requirements for wastewater and waste gases generated at the Facility.

Table 3.5.2: Requirements of BAT 3: Wastewater and Waste Gas Streams

Requirement	Measures in place at Facility	Meets BATc for waste treatment?
Information about the waste to be treated including; a. simplified process flow sheets that show the origin of the emissions b. descriptions of process-integrated techniques and wastewater / waste gas treatment at source including their performances	The location of all point source emissions to air are shown on the plan in the Drawings section of this application. The Process Description is provided in Section 3. A Mass and Energy Balance is provided in Appendix I of document reference CRM 537 004 PE R 003 Application Document .	Yes
Information about the characteristics of the wastewater streams.	Not applicable. There are no discharges to water from the Facility.	N/A
Information about the characteristics of the waste gas streams, such as: a. average values and variability of flow and temperature b. average concentration and load values of relevant substances and their variability (e.g., organic compounds, POPs such as PCBs) c. flammability, lower and higher explosive limits, reactivity d. presence of other substances that may affect the waste gas treatment system or plant safety (e.g., oxygen, nitrogen, water vapour, dust)	An Air Quality Assessment has been provided in the Environmental Risk Assessment (ERA) submitted with this application.	Yes - see BAT 8

3.5.8 In conclusion, the Operator can demonstrate a good understanding of waste gas streams from the Facility and that requirements of the Waste Treatment BATc are met. There are no process emissions to water.

3.6 BAT 4 Storage Processes

3.6.1 BAT 4 requires operators to describe how they will reduce the environmental risks associated with the storage of waste. Table 3.6.1 describes BAT 4 requirements and the Operator's mitigation measures.

Table 3.6.1: Requirements of BAT 4: Storage of Waste

Requirement	Measures in Place at Facility	Meets BATc for waste treatment?
Optimised storage location	Wastes are stored as far as practically possible away from sensitive receptors such as watercourses. Double handling of waste will be avoided wherever operationally possible.	Yes

Requirement	Measures in Place at Facility	Meets BATc for waste treatment?
Adequate storage capacity	The digester tanks are designed to provide adequate capacity for the maximum permitted throughputs of waste accepted into the Facility. See Mass Balance in Appendix I in document reference CRM 537 004 PE R 004, Application Document. Incoming waste will be managed so that in the event the storage capacity of the site is reached, no additional wastes will be accepted. Storage capacities in treatment tanks cannot be exceeded as tanks are fitted with high level alarms and monitored by operatives. Filling will be supervised by site staff.	Yes
Safe storage operation	All tanks are constructed of a material suitable for the containment of their contents. All tanks are subject to regular inspections to ensure their integrity and maintenance will be undertaken as necessary. All tanks are located within the main site bund which is designed in accordance with CIRIA C736 standards. See Section 6.	Yes
Separate area for storage and handling of hazardous waste	Not applicable. The Facility does not accept hazardous waste.	N/A

3.6.2 In conclusion, the waste storage facilities in place at the Facility meet the requirements of the Waste Treatment BATc.

3.7 BAT 5 Handling and Transfer Processes

3.7.1 BAT 5 requires Operators to consider the risks posed by the handling and transfer of waste at their Facilities, the likelihood of accidents and incidents posed by these activities along with their environmental impact. Table 3.7.1 describes the requirements and the Operator's mitigation measures.

Table 3.7.1: Requirements of BAT 5: Handling and Transfer of Waste

Requirement	Measures in Place at the Facility	Meets BATc for waste treatment?
Handling and transfer of waste is carried out by competent staff	A Technically Competent Manager (TCM) is present on-site. See Appendix B of document reference CRM 537 004 PE R 003 Application Document, for copies of the WAMITAB Certification and Continuing Competency Certification. Staff are appropriately trained in site procedures and all waste management procedures are covered by the EMS.	Yes

Requirement	Measures in Place at the Facility	Meets BATc for waste treatment?
Handling and transfer of waste are duly documented, validated prior to execution and verified after execution	The Operator maintains records of all wastes transferred to and from the Facility.	Yes
Measures are taken to prevent, detect and mitigate spills	The Operator has in place an AMP which describes measures to prevent, detect and mitigate spills. Key mitigation techniques include: • All filling points, vent and sight glasses are located within bunded areas. • Secondary containment will be provided for all liquids stored on site. • Absorbents are used to soak up any spills. • Visual inspections are carried out to detect spills during vehicle movements and during the handling, storage, treatment and transfer of waste. • Storage tank levels are monitored by Supervisory Control and Data Acquisition software (SCADA) and operatives and alarms are in place. • Alarms are in place should the system fall outside of the set parameters or if failure should occur.	Yes
Operation and design precautions are taken when mixing or blending wastes.	Risks from mixing and blending are minimal and involve mixing of non-waste crops, farm slurries and manure. AD treatment processes are carried out within sealed vessels which are sited within a dedicated bund.	N/A

3.7.2 In conclusion, waste handling and transfers meet the requirements of the Waste Treatment BATc.

3.8 BAT 6 and BAT 7 Emissions to Water and Monitoring

3.8.1 There are no process emissions to water resulting from activities at the Facility and as such BAT 6 and 7 are not applicable. Leachate and condensate are recirculated into the AD process.

3.9 BAT 8 Monitoring of Air Emissions

3.9.1 BAT 8 requires defined emissions to air to be monitored in accordance with EN standards. Point source emissions to air from the Facility are associated with the sources described in Section 3.5.

3.9.2 The Operator currently monitors the emissions from the CHP engine annually, from which there are quantifiable levels of pollutants, in accordance with frequencies, standards and methods specified in the Permit. Monitoring is undertaken by an external contactor who is MCERTS accredited. Table 3.9.2 below describes the monitoring which will be undertaken at the site.

Table 3.9.2: Monitoring Requirements

Emission Source	Parameter	Limit (including units)	Monitoring Frequency	Monitoring Standard
CHP Engine	Oxides of Nitrogen (NO and NO_2 expressed as NO_2)	190mg/m³	Annual	BS EN 14792
	Sulphur Dioxide	400mg/m³		BS EN 14791
	Carbon monoxide	1400mg/m³		BE EN 15058
	Total VOCs	1000mg/m³		BS EN 12619:2013
Standby Auxiliary Boiler	Oxides of Nitrogen (NO and NO_2 expressed as NO_2)	500mg/m³	Annual	BS EN 14792
	Sulphur Dioxide	350mg/m³		BS EN 14791
	Carbon monoxide	1400mg/m³		BE EN 15058
	Total VOCs	1000mg/m³		BS EN 12619:2013
Emergency High Temperature Flare Stack	Oxides of Nitrogen (NO and NO_2 expressed as NO_2)	150mg/m³	Monitoring to be undertaken in the event the emergency flare is operational for more than 105 of a year (876 hours)	BS EN 14792
	Carbon monoxide	50mg/m³		BE EN 15058
	Total VOCs	10mg/m³		BS EN 12619:2013
Biogas Upgrading Stack	VOCs including methane	No limit set		BS EN 15446
Emergency Diesel Generator	No parameter set	-	Recording of operating hours	-
Pressure relief Valves	No parameter set	No limit set	Recording of operating hours	-

3.9.3 In conclusion, air monitoring in place at the Facility meets the requirements of the Waste Treatment BATc.

3.10 BAT 10 Monitoring of Odorous Emissions

3.10.1 The applicability of BAT 10 is restricted to cases where an odour nuisance at sensitive receptors is expected and/or has been substantiated. The nature of the materials stored on-site has the potential to give rise to odour, therefore an OMP is in place at the Facility.

3.10.2 Odour monitoring is described in the OMP (see BAT 12). Principally the monitoring regime comprises olfactory field odour monitoring (sniff testing), which will be carried out by site management (or other appropriately competent persons), with records maintained. The odour monitoring includes:

- Daily sniff testing to a standard as defined by the EA's H4 Guidance.
- Daily monitoring of weather conditions.
- Monitoring of process conditions to give early warning of potential odour issues.
- Monitoring of complaints and other forms of community feedback.

3.10.3 Additional monitoring will be carried out during adverse meteorological conditions, plant breakdowns or if a complaint is received.

3.10.4 In conclusion, odour monitoring in place at the Facility meets the requirements of the Waste Treatment BATc.

3.11 BAT 11 Monitoring of Resource Use and Residues and (Wastes)

3.11.1 The Operator, as will be required by the Permit, will monitor the parameters specified by BAT 11:

- water;
- energy;
- raw materials; and
- wastes generated.

3.11.2 Leachate and condensate are re-used within the process therefore there are no emissions of wastewater.

3.11.3 In addition, the Operator will provide information on raw material use and waste generated in their annual Pollution Inventory returns.

3.11.4 In conclusion, monitoring of water, energy and raw materials use and generation of residues in place at the Facility meets the requirements of the Waste Treatment BATc.

3.12 BAT 12 Odour Management Plan

3.12.1 The Operator has a comprehensive OMP in place at the Facility which describes odour sources, mitigation measures, incident management, monitoring and record keeping. BAT 12 requires operators to implement an OMP to prevent, or where that is not practicable to reduce odour emissions to include the requirements described in Table 3.12.1 below.

3.12.2 The Operator's OMP was written in compliance with the EA's guidance note 'Additional guidance for H4 Odour Management: How to Comply with your Environmental Permit' March 2011.

Table 3.12.1: Requirements of BAT 12: OMP

Requirement	Measures in Place at the Facility	Meets BATc for waste treatment?
A protocol containing actions and timelines	The OMP includes a review which identifies whether odour control techniques remain appropriate for the site.	Yes
A protocol for conducting odour monitoring as set out in BAT 10	Monitoring is described in the OMP (see BAT 10 for details).	Yes
A protocol for responding to identified odour incidents	The OMP describes abnormal operation scenarios and actions to be taken to prevent, and in the event of accidental releases. The OMP includes the complaints procedure and review of complaints.	Yes
An odour prevention and reduction programme designed to identify the source(s): to characterise the contributions of the sources; and to implement the prevention and/or reduction measures.	The OMP describes the potential odour sources, potential odorous releases and measures in place to prevent or minimise releases.	Yes

3.12.3 In conclusion, the Operator has developed a comprehensive OMP to implement at the Facility which meets the requirements of BAT 12.

3.13 BAT 13 Prevent or Reduce Odour Emissions

3.13.1 Potentially odorous emissions from the Facility are minimal as treatment activities take place within treatment tanks. Silage camps are sheeted, except for when materials are being added or removed. BAT 13 is to minimise odour emissions, as described in Table 3.13.1 below.

Table 3.13.1: Requirements of BAT 13: Odour Emissions

Requirement	Measures in Place at the Facility	Meets BATc for waste treatment?
Minimise residence times	Residence times are limited where applicable. Solid manures are typically held on site for 3 days before input into the process.	Yes
Using chemical treatment to destroy or reduce the formation of odorous compounds.	There are no channelled odour sources where this treatment process could be applied.	NA

Requirement	Measures in Place at the Facility	Meets BATc for waste treatment?
Optimising aerobic treatment – this may include use of pure oxygen, removal of scum in tanks, frequent maintenance of the aeration system.	Not applicable. All treatment of waste within the Facility is anaerobic.	N/A

3.13.2 In conclusion, measures in place at the Facility meet the requirements of BAT 13, where relevant.

3.14 BAT 14 Reduce Diffuse Emissions to Air

3.14.1 BAT 14 requires Operators to describe how they will prevent or reduce diffuse emissions to air from their operations. Table 3.14.1 sets out the requirements of BAT 14 and describes how operations at the Facility meets these requirements.

Table 3.14.1: Requirements of BAT 14: Diffuse Emissions to Air

Requirement	Measures Proposed by Operator	Meets BATc for waste treatment?
Minimising the number of potential diffuse emission sources	The Operator has in place an AMP which describes measures to prevent, detect and mitigate impacts from release of diffuse emissions to air. Key mitigation techniques include: • Diffuse sources (e.g., silage/manure) are sheeted to minimise odour. • A flare is installed for emergency use. PRVs are only operated in an emergency during instances when the flare is not operational. • The plant will be subject to PPM to prevent accidental releases.	Yes
Selection and use of high-integrity equipment	The plant and equipment used at the Facility is sourced from well-known suppliers, which have been widely used and tested at similar facilities within Europe and the UK.	Yes
Corrosion Prevention	Construction materials and those materials used within the plant and equipment include corrosion prevention where necessary.	Yes
Collection, containment and treatment of diffuse emissions	PRVs are only operated in an emergency if the flare is not available.	Yes
Dampening	Not applicable. Operations are not inherently dust-generating. Crops are sheeted to prevent odour and dust.	N/A

Requirement	Measures Proposed by Operator	Meets BATc for waste treatment?
Maintenance	Plant and equipment on site are maintained in accordance with the manufacturer's instructions and will be subject to PPM.	Yes
Cleaning of waste treatment and storage areas	Cleaning is carried out as required with liquors recirculated within AD system or disposed of via authorised waste contractor.	Yes
Leak Detection and Repair (LDAR) programme	Levels in digester tanks are monitored by a SCADA system and alarms are in place. Any leaks detected by the system will be investigated and rectified.	Yes

3.14.2 In conclusion, the measures in place at the Facility to prevent diffuse emissions to air meet the requirements of the Waste Treatment BATc.

3.15 BAT 15 and BAT 16 Flaring

3.15.1 BAT 15 requires Operators to use flaring for safety reasons only, or for non-routine operating conditions (e.g., start-ups, shutdowns). Table 3.15.1 sets out the requirements of BAT 15 and describes how operations at the Facility meets these requirements.

Table 3.15.1: Requirements of BAT 15: Flaring

Requirement	Measures Proposed by Operator	Meets BATc for waste treatment?
Correct Plant Design	Flare will only be used during emergencies. High integrity PRVs are installed on gas system.	Yes
Plant Management	Plant and equipment will be subject to PPM. Process variables are monitored using SCADA.	Yes

3.15.2 In order to reduce emissions to air from flares when flaring is unavoidable, BAT 16 is to use both of the techniques set out in Table 3.14.2 below.

Table 3.15.2: Requirements of BAT 16: Flaring

Requirement	Measures Proposed by Operator	Meets BATc for waste treatment?
Correct Design of Flaring Devices	Flare will only be used during emergencies. Stack height is 7.7m from the ground providing good dispersion and is a high temperature (1000°C) flare ensuring destruction of pollutants.	Yes
Monitoring and Recording as Part of Flare Management	Hours of operation will be recorded and reported to the EA annually.	Yes

3.15.3 In conclusion, operations in place at the Facility relating to the design and use of flares meet the requirements of BAT 15 and 16.

3.16 BAT 17 Noise and Vibration

3.16.1 BAT 17 is to set up, implement and regularly review a noise and vibration management plan. The applicability of BAT 17 is restricted to cases where noise or vibration nuisance at sensitive receptors is expected and/or has been substantiated.

3.16.2 There are no noise sensitive receptors within the immediate vicinity of the Facility. The nearest residence is 1120m from the site. The replacement engine is enclosed within a container to minimise noise levels and other operations are not inherently noise generating. Other plant and equipment are unlikely to generate levels of noise which may cause complaints. BAT 17 is therefore not considered to be relevant to the Facility.

3.17 BAT 18 Prevent or Reduce Noise and Vibration

3.17.1 BAT 18 requires Operators to prevent or reduce noise and vibration from their operations. As noted above in relation to BAT 17, activities are not inherently noise generating. BAT 17 is therefore not considered to be relevant to the Facility.

3.18 BAT 19 Emissions to Water

3.18.1 BAT 19 requires Operators to describe how they optimise water consumption, reduce the quantity of water generated and reduce emissions to soil and water. Table 3.18.1 describes how the Facility meets these requirements.

Table 3.18.1: Requirements of BAT 19: Emissions to Water

Requirement	Measures in Place at the Facility	Meets BATc for waste treatment?
Water management	Water is used in the following applications: • processing water; and • cleaning / maintenance. Site run-off is collected within an on-site lagoon and used within the AD facility or used for irrigation of the surrounding farmland. Leachate and condensate are collected in the on-site lagoon and either used within the process or used for irrigation of the surrounding farmland.	Yes
Water recirculation	Water is recirculated back into the waste processing operation with excess being used for the irrigation of surrounding farmland.	Yes
Impermeable surface	The processing activities are located on a concrete hardstanding surface which is provisioned with a perimeter bund.	Yes
Techniques to reduce the likelihood and impact of	The Operator has in place an AMP which describes measures to prevent and detect spills. Key mitigation techniques are described in response to BAT 5.	Yes

Requirement	Measures in Place at the Facility	Meets BATc for waste treatment?
overflows and failures from tanks and vessels		
Roofing of waste storage and treatment areas	Treatment processes are carried out in tanks which are designed to operate externally to buildings.	Yes
Segregation of water streams	There is no process effluent. The only wastewater stream comprises uncontaminated surface water run-off.	Yes
Adequate drainage infrastructure	There is no process effluent. The only wastewater stream comprises uncontaminated surface water run-off.	Yes
Design and maintenance provisions to allow detection and repair of leaks	Levels in storage tanks are monitored by SCADA and operatives, alarms are in place and wastes are transferred by an in-situ pipeline. Site equipment will be routinely inspected and subject to PPM.	Yes
Appropriate buffer storage capacity	Leachate from the silage clamps is stored within the dirty water lagoon which provides buffer storage. If excess water is generated, it will be used as irrigation water on surrounding farmland.	N/A

3.18.2 In conclusion, measures in place to minimise water use and emissions to water at the Facility meet the BAT requirements.

3.19 BAT 20 Reduce Emissions to Water

3.19.1 BAT 20 requires Operators to treat water using an appropriate combination of techniques provided in the BATc document.

3.19.2 There are no emissions to water from the facility. Surface water is collected and stored within the clean surface water lagoon, which acts as a large soakaway. Effluent produced by the storage of waste will be directed to the dirty water lagoon, and then either used within the process, or used as irrigation water for surrounding farmland.

3.20 BAT 21 Emissions from Accidents and Incidents

3.20.1 The Operator has in place an AMP which is an operational document to identify and minimise accidental risks. The risks posed by the replacement CHP are equivalent to those posed by the existing CHP.

3.20.2 During the replacement of the existing CHP the biogas will be directed to the biogas upgrading plant and injected into the grid.

3.20.3 BAT 21 requires Operators to describe how the environmental consequences from accidents and incidents will be prevented and/or limited. Table 3.20.1 describes how the Operator meets these requirements.

Table 3.20.1: Requirements of BAT 21: Accidents

Requirement	Measures in Place at the Facility	Meets BATc for waste treatment?
Protection measures	The Operator has in place an AMP which describes measures to prevent and mitigate impacts from accidents. Key mitigation techniques include: • Site security systems. • Containment of liquids. • Emergency drills and incident training. • Inspections and PPM. • SCADA system to monitor process variables. • PRVs installed. • Site access will be secured when unoccupied.	Yes
Management of incidental/accidental emissions	Procedures to manage the containment of accidental emissions are included in the AMP.	Yes
Incident/accident registration and assessment system	The EMS includes Incident Reporting Procedures which include measures to prevent recurrence.	Yes

3.20.4 In conclusion, the measures proposed at the Facility to prevent or limit the environmental consequences from accidents meet the requirements of the Waste Treatment BATc.

3.21 BAT 22 Material Efficiency

3.21.1 BAT 22 requires the Operator to substitute materials with waste where possible. Raw materials used in large quantities, and it is not currently considered feasible to replace any other non-waste materials used to operate the Facility with waste materials. However, opportunities to substitute a raw material with a waste material will continue to be reviewed by the Operator if future developments allow substitution to occur.

3.22 BAT 23 Energy Efficiency

3.22.1 BAT 23 requires Operators to use energy efficiently. Table 3.22.1 describes how the Facility will meet these requirements.

Table 3.3.22: Requirements of BAT 23: Energy Efficiency

Requirement	Measures Proposed by Operator	Meets BATc for waste treatment
Energy Efficiency Plan	An energy efficiency plan has not yet been produced for the site. An energy efficiency plan will be produced by the Operator.	Not currently
Energy Balance Record	The Operator will monitor energy use as will be required by the Environmental Permit	Yes

3.23 BAT 24 Reuse of Packaging

3.23.1 BAT 24 is to minimise the quantity of waste sent for disposal and to maximise the reuse of packaging. There are minimal packaging materials used or generated by the Facility therefore this BAT requirement is not applicable.

3.23.2 Should packaging materials be used at the Facility, they will be re-used, recycled or recovered, where possible, rather than disposed of.

3.23.3 In conclusion, appropriate measures to re-use packing are in place at the Facility, so far as the Operator can control, which meet the requirements of the Waste Treatment BATc.

3.24 BAT 33 Control Waste Inputs

3.24.1 To reduce odour emissions and to improve overall environmental performance, BAT is to select the waste input.

3.24.2 The technique consists of carrying out the pre-acceptance, acceptance and sorting of the waste input (see BAT 2) to ensure the suitability of the waste input for the waste treatment process, e.g., in terms of nutrient balance, moisture or toxic compounds which may reduce the biological activity.

3.24.3 As described in response to BAT 2 and in Section 2 of this report, appropriate measures to control the waste inputs meet the requirements of the Waste Treatment BATc. Only non-waste crops and manure is treated at the Facility.

3.25 BAT 34 Emissions to Air

3.25.1 To reduce channelled emissions to air of dust, organic compounds and odorous compounds, BAT is to employ techniques to minimise such emissions.

3.25.2 Emissions from the replacement CHP engine and Biogas Upgrading Plant will continue to be controlled in the Permit by emission limit values and monitoring will be carried out annually to demonstrate compliance. There are minimal other channelled emissions from the Facility. The requirements of BAT 34 are therefore not considered to be relevant to the Facility.

3.26 BAT 35 Emissions to Water and Water Usage

3.26.1 To reduce the generation of wastewater and to reduce water usage BAT is to use the techniques given in Table 3.26.1 below.

Table 3.26.1: Requirements of BAT 35: Emissions to Water

Requirement	Mitigation Measures in Place at the Facility	Meets BATc for waste treatment
Segregation of water streams	Uncontaminated site drainage is discharged to the clean surface water lagoon. Leachate and condensate are segregated and recirculated back into the AD process.	Yes
Water recirculation	Leachate and condensate are recirculated back into the AD process. Clean surface water is capture in used in the AD process	Yes
Minimisation of the generation of leachate	Not applicable. Leachate may be generated from within the covered silage clamps. Leachate will be recirculated into the AD process.	N/A

3.26.2 In conclusion, there is no process effluent to be released. The measures in place at the Facility to optimise water consumption and minimise emissions to water meet the requirements of the Waste Treatment BATc.

3.27 BAT 38 Monitor the Key Waste and Process Parameters

3.27.1 To reduce emissions to air and to improve the overall environmental performance, BAT is to monitor and/or control the key waste and process parameters. Table 3.27.1 describes BAT for minimising emissions to air.

Table 3.27.1: Requirements of BAT 38: Emissions to Air

Requirement	Mitigation Measures in Place at the Facility	Meets BATc for waste treatment?
Implementation of a manual and/or automatic monitoring system to: ensure a stable digester operation; minimise operational difficulties, such as foaming, which may lead to odour emissions; provide sufficient early warning of system failures which may lead to a loss of containment and explosions.	SCADA is installed to carry out continuous analysis and control of both the liquid digestate and biogas system to ensure the site runs continuously at optimum efficiency. Only three sources of waste (pig and poultry manure and pig slurry) are accepted at the Facility minimising significant variations in the feed. Gas production will be carefully controlled and monitored by SCADA. Flare and PRVs are installed to prevent biogas build up in an emergency.	Yes
Monitoring and/or control of key waste and process parameters, e.g.: pH and alkalinity of the digester feed; digester operating temperature;	All parameters are monitored continuously by SCADA or periodically by in-house or third-party testing laboratories. All results are recorded.	Yes

Requirement	Mitigation Measures in Place at the Facility	Meets BATc for waste treatment?
hydraulic and organic loading rates of the digester feed; concentration of volatile fatty acids (VFA) and ammonia within the digester and digestate; biogas quantity, composition (e.g., H2S) and pressure; liquid and foam levels in the digester.		

3.27.2 In conclusion, measures to minimise emissions to air meet the requirements of the Waste Treatment BATc.

4.0 Environmental Risk Assessment

4.1 Scope

4.1.1 This risk assessment had been prepared in response to Question 6 of the Environment Agency's Environmental Permit Application Form Part C2.

4.1.2 The only change to the current operations is the replacement of the existing CHP with a new CHP with the same net rated thermal input, stack height and location as the current CHP. No other changes to the operation, plant, infrastructure or management of the Facility will be necessary due to this Permit Variation application.

4.2 Nearby Receptors

4.2.1 The key receptors which may be impacted by the Facility are summarised within Table 4.2.1 below.

Table 4.2.1: Nearby Receptors

Receptor	Type	Distance (m)	Direction
Principal bedrock aquifer	Hydrogeological	On site	-
Source Protection Zone 2/3	Hydrogeological	On Site	-
Undifferentiated secondary superficial geology aquifer	Hydrogeological	On site	-
Agricultural land	Agricultural	0	N, E, S & W
Bridleway	Recreational	602	SSW
Public right of way	Recreational	624	S
Public right of way	Recreational	660	SW
Recreational ground	Recreational	706	SE
Nearest residential property (Burton Agnes Village)	Residential	1120	SE
Harpham Grange	Residential	1121	S
Burton Agnes primary school	Educational	1225	SE
Tuft Hill farm	Residential	1397	NNW
Agua House	Residential	1627	SE
Kilham Village	Residential	1726	WNW
Keeper's cottage	Residential	1781	SSE
Thornholme Village	Residential	1844	ESE
Commercial site	Commercial	1860	W

4.2.2 The Facility is located to the northwest of the village of Burton Agnes, immediately bounded on all sides by agricultural fields. The closest residential receptor is within Burton Agnes village approximately 1120m southeast of the Facility. The Facility is located entirely within a Flood Zone 1, which is designated as having a low risk of flooding.

4.2.3 None of the following types of ecological sites are located within 2,000m of the Facility:

- Areas of Outstanding Natural Beauty (AONB)

- Local or National Nature Reserves
- National Parks
- Ramsar sites
- Special Areas of Conservation (SAC)
- Special Protection Areas (SPA)
- Sites of Special Scientific Interest (SSSI)

4.2.4 The Facility is located over a Principal Aquifer in the bedrock and an undifferentiated Secondary aquifer in the superficial geology. The groundwater vulnerability is classified as High towards the north-eastern corner of site with the remainder of the site classified as Medium – High.

4.2.5 The site is located within a groundwater source protection zone, with the eastern half of site within Zone II and the western half of site within Zone III. The site is also located within a drinking water safeguard zone for groundwater and surface water.

4.3 Emissions to Air

4.3.1 The emission points to air remain unchanged, with the exception of the current CHP being replaced by a new CHP of the same net rated thermal input and stack height, as a result of this Permit Variation Application. There are 5 main emission point arising from:

- Replacement CHP engine;
- Auxiliary Boiler;
- Emergency Flare Stack;
- Emergency Diesel Generator;
- Biogas Upgrading Plant.

4.3.2 There are also emissions to air arising from PRV's from the buffer tank, primary digester, secondary digester, digester storage tank and the biogas holder

4.3.3 As part of this permit variation application an Air Quality Assessment has been completed modelling the air emissions from the replacement CHP stack, auxiliary boiler stack and the biogas upgrading plant stack. A copy of the Air Quality Assessment is located in Appendix B of this report.

4.3.4 The emergency flare and emergency diesel generator have been screened out of the air quality assessment as they are only used in the case of an emergency.

4.3.5 The report concluded that Predicted annual mean PCs at human receptors did not exceed 1% of the EQS. In the case of short-term impacts PCs did not exceed 20% of the EQS minus twice the background concentration at any human receptor. Impacts on pollution concentrations at all human locations are therefore considered not significant.

4.3.6 The ecological impacts of NO_2, SO_2 and NH_3 PC proportions were screened as being insignificant. The CLDs for nitrogen and acid deposition were exceeded as a baseline condition at all designations, however the PC proportions from the Facility were below 1% and could be

screened out as insignificant using the initial EA screening criteria. Therefore, it is unlikely that adverse impacts would be present at ecological designations as a result of the Facility.

4.3.7 Based on the predictions and the use of conservative assumptions, such as worse case emission limit values and meteorological conditions over a 5-year period, it is considered that the overall air quality impacts of the Facility would be not significant.

4.4 Emissions to Water and Sewer

4.4.1 There are no emissions to sewer. This is unchanged.

4.4.2 Emissions to water will consist of clean site run off only, via the surface water lagoon which acts as a soakaway.

4.4.3 Effluent produced by the storage of waste is captured within the lined dirty water lagoon and used either within the process or as a fertilizer on the surrounding farmland. This is unchanged from what currently occurs.

4.5 Emissions to Land

4.5.1 There are no emissions to land. This is unchanged.

4.6 Bio-aerosols

4.6.1 The Environment Agency's guidance document *Bioaerosol monitoring at regulated facilities – use of M9:RPS 209,* states that if your Facility is located within 250 metres of a sensitive receptor you must monitor bioaerosols and undertake a specific bioaerosol risk assessment. As detailed above in Table 4.2.1, the nearest sensitive receptor which needs to be considered under this guidance is 1120m away. Therefore, a bio-aerosols risk assessment is not required.

4.7 Fugitive Releases

4.7.1 There are no changes to the fugitive releases profile in relation to potential releases to land, water or air.

4.7.2 Activities on site will be managed in accordance with the operator's management systems. A summary of the EMS is included within Appendix E of document reference CRM 537 004 PE R 003 Application Document.

4.8 Global Warming Potential

4.8.1 The Global Warming Impact of this Facility is unchanged and therefore requires no further assessment.

4.9 Noise Emissions

4.9.1 There are no changes the noise profile of the Facility. The noise profile of the replacement CHP is not greater than that of the current aging CHP.

4.9.2 Due to the rural location of the site, none of the sensitive receptors identified are considered close enough to be affected by noise from the site, with the closest at 1120m from the installation's noise sources. The operator has adopted good management practices to ensure that any incidents of noise are appropriately investigated and remedial action taken.

4.10 Odour Emissions

4.10.1 As there are no changes to the daily opening hours, or the nature, type or quantity of the waste, increase in emissions of odour are not anticipated. Existing procedures will be applied to continue to control emissions.

4.10.2 The system in place to manage odorous releases from the site is unchanged from current operations and it was deemed to adequately meet EA standards during determination of the Standard Rules Permit Application.

4.10.3 However, as this application is to vary the Standard Rules Permit to a Bespoke Permit, an odour assessment was carried out to support this Permit Variation Application. A dispersion model using ADMS5 and using 5 years of meteorological data was produced to determine impacts.

4.10.4 Impacts of the operations on site at sensitive receptor locations in the vicinity were quantified, the maximum predicted results compared with the appropriate odour benchmark level.

4.10.5 Predicted odour concentrations were below the EA benchmark level of 3.0 ou_E/m^3 at all sensitive receptors in the vicinity of the site for all modelling years. In addition, using the IAQM guidance significance criteria, worst case impacts were negligible at all representative sensitive receptors.

4.10.6 An odour assessment has been carried out as part of this Permit Variation Application and a copy can be found in Appendix H of document reference CRM 537 004 PE R 003 Application Document.

4.11 Summary and Conclusions

4.11.1 The emissions profile from the installation will not change as a result of this Permit Variation application. The new CHP is only replacing the existing CHP therefore there will be no additional emission points.

4.11.2 It is considered unlikely that there will be additional noise impact on sensitive receptors because of these changes as there is no change to the daily operating hours, or the nature or quantity of waste being brought into the site. The nearest sensitive receptors identified are approximately 1120m from the site boundary which is a significant distance from the Facility's operations.

4.11.3 The odour assessment undertaken as part of the Permit variation application concluded that given the robust assumptions made for odour emissions, the overall potential for odour impacts generated by the Facility can be considered as acceptable and not considered to be significant.

4.11.4 Based on the predictions and the use of conservative assumptions, such as worse case emission limit values and meteorological conditions over a 5-year period, it is considered that the overall air quality impacts of the Facility would be not significant.

4.11.5 The assessments presented in Appendix A conclude that the risks arising from the installation are 'low'.

Table 1: Accidents

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of Risk	Risk Management	Residual risk
Burton Agnes Biogas Plant								
Vehicle Collision/impact	All on-site hazards: wastes, machinery and vehicles	Direct Physical Contact	Drivers, site employees, local environmental receptors	Low	Medium	Medium	Vehicle movements are limited to deliveries of feedstock only, which are scheduled and directed onto site by staff. Activities on-site are managed and operated in accordance with a management system (which includes site security measures to prevent unauthorised access). A speed limit of 10mph is enforced across the site and signage is clearly displayed at the entrance.	Low
Explosion of biogas	Digester tanks. Post digester tank. Gas upgrading compound	Transportation through air	Site employees; Ecological receptors; and Surrounding farmland.	Low	Medium	Low	Activities are managed and operated in accordance with the Operator's management system and monitored with SCADA systems. If abnormal operation occurs, or an issue is perceived, gas will be directed to the site's emergency flare. Should the emergency flare fail, digesters and upgrading unit are fitted with emergency pressure release valves to avoid overpressure. All records of the	

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of Risk	Risk Management	Residual risk
							use of PRVs will be kept on site and the reason for use documented. Should an explosion compromise the integrity of any tank, the tanks are located within an area of bunding sized to contain 110% of the largest tank and 25% of the combined tank volume. Containment systems are designed, manufactured and installed in accordance with CIRIA 736 guidance. The explosion of biogas is highly unlikely.	
Arson and / or vandalism causing the release of polluting materials to air (smoke or fumes), water or land.	Unauthorised Access	Transportation through air then inhalation OR Transportation through air then deposition Surface water drainage system.	Site employees Local residents at nearest farms and IT business Local Wildlife Sites and Ecological areas	Medium	Medium	Medium	The site is fenced to prevent unauthorised access and is under 24hr surveillance from a security contractor. Oils and fuels are stored in a lockable secure unit. Activities are managed and operated in accordance with a management system which includes fire and spillage procedures. Process areas where liquids are stored are constructed of concrete hardstanding. Digestate and other liquids are contained within sealed tanks. The tanks are located within an area of bunding sized to contain 110% of the largest tank and 25% of the combined tank volume.	Low

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of Risk	Risk Management	Residual risk
							Containment systems are designed, manufactured and installed in accordance with CIRIA 736 guidance.	
Contaminated run-off from site surfaces mobilising pollutants off site	Loss of containment on site, spillage or leakage of liquids, oils or fuels	Percolation through soils or direct run-off from site entering surface watercourses	Watercourses and surrounding farmland.	Low	Medium	Low	Process areas where liquids are stored are constructed of concrete hardstanding. Uncontaminated surface water run-off is directed to the clean surface water lagoon. Any spills on site will be cleaned up immediately with spill kits available for this purpose and staff trained in spill response procedures. Digestate and other liquids are contained within sealed tanks. The tanks are located within an area of bunding sized to contain 110% of the largest tank and 25% of the combined tank volume. Containment systems are designed, manufactured and installed in accordance with CIRIA 736 guidance. All maintenance fluids stored on site will be in sealed, leak-resistant containers with appropriate secondary containment. Containers are regularly inspected for leaks, located on impermeable concrete	

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of Risk	Risk Management	Residual risk
							hardstanding and incompatible chemicals are stored in separate locations.	
Accidental fire causing the release of pollution to air, water or land	On site machinery. Combustion of feedstock or digestate. Smoking on site	Transportation through air. Surface water or percolation through soil	Commercial and residential receptors Site employees. Watercourses. Ecological receptors. Surrounding farmland.	Medium	Medium	Medium	All plant and equipment on site are maintained to the manufacturer's specification, with details incorporated into the site's EMS. The main plant areas are provided with secondary containment. Drainage can be sealed to contain firewater on-site and can be directed to and stored in the on-site dirty water lagoon to ensure contaminated water will not be released to the local environment in the case of a fire. Firewater will be evaluated and disposed of by authorised waste contractor. Smoking is prohibited anywhere on site and is clearly signed. Any abnormal operation of the gas upgrading equipment will be detected by the SCADA system and if necessary, biogas can be directed to the emergency flare. If for any reason this fails, pressure release valves will be utilised to release excess gas. All records of their use will be maintained. Risk of self-combustion of waste is low, as the majority of material feedstock into	Low

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of Risk	Risk Management	Residual risk
							the installation has a high-water content and is pumped directly into the plant for processing. Crops (maize, hybrid rye and wheat straw) are unloaded into the clamps when they arrive on site and are covered using protective sheeting. Manure is delivered to the site on a weekly basis and stored in the clamps and covered where possible. Input materials will be processed on a first-in first-out basis. The risk of self-combustion is therefore considered to be low.	
Plant and equipment breakdown and/or failure causing releases of potentially polluting substances	On site infrastructure (digestion tank, biogas upgrading unit, replacement CHP, auxiliary boiler, digestate and surface water and dirty water storage lagoons)	Transportation through air, Surface water drainage system, percolation through soil	Commercial and residential receptors Site employees. Watercourses. Ecological receptors. Surrounding farmland.	Medium	Medium	Medium	All plant and equipment on site are maintained to manufacturer's specification and regularly integrity checked. All details are incorporated into the site's EMS. The SCADA system will identify any abnormal operations prior to any catastrophic failure and automatically notify the operator. The programme will shut off equipment if it reaches unsafe limit set points. If necessary, gas can be directed to the emergency flare. All operations will cease in the event of plant failure, with waste directed to an alternative site where necessary.	Low

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of Risk	Risk Management	Residual risk
							Digestate and other liquids are contained within sealed tanks. The tanks are located within an area of bunding sized to contain 110% of the largest tank and 25% of the combined tank volume. Containment systems are designed, manufactured and installed in accordance with CIRIA 736 guidance. The dirty water lagoon is constructed of chalk but benefits from being double lined.	
Spillage of feedstock from tankers during delivery or off loading	Feedstock delivery vehicles; Site operatives	Surface water drainage system, percolation through soils	Watercourses. Ecological receptors. Surrounding farmland.	Low	Low	Low	Activities are managed and operated in accordance with the Operator's management system, with trained operatives directing tankers to input liquid feedstock directly into the plant for processing. The waste reception areas comprise concrete hardstanding with sealed drainage, preventing any spillages reaching soils or surface water drains. The covered feeding system for solid feedstocks is located on impermeable concrete in the main plant area within the bund. Spill kits will be on hand to address minor spills and site operatives will be trained in their use.	Low

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of Risk	Risk Management	Residual risk
Accidental release of potentially polluting substances through flooding	Loss of containment, contaminated flood water	Percolation through soils or direct run-off from site entering surface watercourses	Watercourses. Ecological receptors. Surrounding farmland.	Very low	Low	Low	The site does not lie in an area at risk of flooding (Flood Zone 1). Chemicals and oils are stored in impermeable containers and are provided with secondary containment. All site areas are constructed of impermeable concrete surfacing. Drainage systems divert all surface water flows to the on-site clean water soakaway lagoon.	Low
Failure of buffer tank, digester tanks or digestate storage tank	Loss of containment	Direct physical contact. Percolation through soils, direct run-off from site across the ground	Site employees, underground water and land	Medium	Medium	Medium	The buffer tank and digester tanks are inspected regularly in line with the Facility's EMS to identify any leaks. The tanks are connected to the Facility's SCADA system and telemetry systems which monitor levels, pressure and foam within the tank continuously. A spill clean-up procedure is in place which is designed to minimise the impact on the environment in the case of any spills. The tanks are located within their own bund which is sized to contain 100% of the volume of the tanks.	Low

Table 2: Fugitive Emissions to Air

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual Risk
Releases of gaseous emissions above permit limits	Point Source Emissions	Transportation through air then inhalation or deposition	Commercial and residential receptors Site employees. Watercourses. Ecological receptors. Surrounding farmland.	Low	Medium	Medium	Activities on site are managed in accordance with the Operator's management systems, including regular inspections and maintenance of the replacement CHP, Emergency Flare, Auxiliary Boiler and Biogas Upgrading Unit. The replacement CHP, Biogas Upgrading Plant and Auxiliary Boiler will be monitored annually using MCERTS methods to ensure compliance with permitted limits. SCADA monitoring systems will be used to ensure all equipment is operating at optimal levels.	Low
Releases of particulate matter (dust) and bioaerosols	Fugitive releases of dust and/or bio-aerosols from the Facility	Transportation through air then inhalation or deposition	Commercial and residential receptors Site employees. Watercourses. Ecological receptors. Surrounding farmland.	Low	Medium	Medium	With controls in place, there is a limited potential for the release of dusts and/or bio aerosols from the silage and manure storage areas during acceptance of feedstocks with lower moisture content. Drier feedstocks within the clamps will be covered with protective sheeting. This will form an airtight layer to minimise emissions and will only be removed while feedstock is being added. Manure is sheeted to prevent release of dusts, odour and bioaerosols. Activities on site are managed in accordance with the operator's management systems. This includes regular inspections and maintenance of equipment to ensure they continue to operate at optimum conditions. Good housekeeping practices are applied, such as: Minimising any dust generating activities (such as loading the dry feedstocks) on very dry or	Low

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual Risk
							windy days, regular inspection and cleaning/sweeping of all paved areas on site and sealed deliveries of feedstock. The site area and access road comprise concrete and asphalt hardstanding minimising the potential for dust to be generated by vehicles entering and exiting the site.	
Releases of VOC's	Fugitive emissions; Releases from digestate storage lagoon surface; Feedstock delivery vehicles	Transportation through air then inhalation or deposition	Commercial and residential receptors Site employees. Watercourses. Ecological receptors. Surrounding farmland.	Low	Medium	Medium	The replacement CHP plant, biogas upgrading plant and auxiliary boiler will be maintained to ensure they are operating at optimal conditions, and not releasing VOC's above normal/permitted limits. Emissions of VOCs from the pressure release valves will only occur in emergency situations, where the emergency flare has failed. The loss of biogas through the release valves has financial and operational consequences for the operator and as such, it is in their interest to ensure they are used as infrequently as possible. All records of their use will be maintained. Solid digestate will be stored in one of the on-site clamps before being transferred off-site. All liquid digestate will be transported off site via tanker to be spread on local fields, eliminating releases to atmosphere.	Low

Table 3: Fugitive Emissions to Water

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual Risk
Contaminated run-off from site surfaces	Loss of containment on site	Percolation through soils, direct run-off from site across the ground	Underlying groundwater and land	Low	Medium	Low	All potentially polluting materials are contained within bunded areas and located on sealed surfaces. All main liquid storage and treatment vessels are located within a sealed bunded area sized to contain 110% of the largest tanks capacity or 25% of the maximum volume of all the material stored within the bund. All process water from within the AD system will be fully contained within the plant and/or associated pipework.	Low
Liquor from digestate tanks	Loss of Containment on site	Percolation through soils, direct run-off from site across the ground	Underlying groundwater and land	Low	Medium	Low	Regular inspection of the storage tank will identify leaks. Spill clean-up procedure in place to minimise the impact from spills and leaks. All main liquid storage vessels are designed to withstand catastrophic failure and are located within a sealed bunded area sized to 110% of the largest tanks capacity or 25% of the maximum volume of all the material stored within the bund.	Low

Table 4: Odour

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual Risk
Odour from feedstock while transported to the Facility	Vehicles	Air, prevailing wind direction is from the southwest	Other road users Site employees Members of the Public	Low	Medium	Medium	Feedstock will be delivered to the site via road. Any liquid waste will be delivered directly to the preliminary tank. OMP in place to prevent and minimise odorous releases.	Low
Release of odours from stored materials and AD plant operations	Fugitive releases of dust and/or bio-aerosols from the Facility	Transportation through air then inhalation or deposition	Commercial and residential receptors Site employees. Watercourses. Ecological receptors. Surrounding farmland.	Low	Medium	Medium	With controls in place, there is a limited potential for the release of odour from the silage and manure storage areas during acceptance of feedstocks with lower moisture content. Drier feedstocks (including maize and rye) will be transferred to the clamps and covered with protective sheeting. This will form an airtight layer to minimise emissions and will only be removed while feedstock is being added minimising odorous release. Manure is sheeted to prevent release of dusts, odour and bioaerosols. The digestion process is largely sealed minimising the potential for odour releases. Activities on site are managed in accordance with the operator's management systems. This includes regular inspections and maintenance of equipment to ensure they continue to operate at optimum conditions. The site area and access road comprise concrete and asphalt hardstanding minimising the potential for dust to be generated by vehicles entering and exiting the site. OMP in place to prevent and minimise odorous releases.	Low

Table 5: Pests

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of risk	Risk Management	Residual Risk
Vermin, flies and birds attracted to feedstocks	Pests	Travel across air and/or land	Site employees, local businesses	Low	Low	Low	The primary areas at most AD facilities that attract pests are the feedstock reception and storage areas. The silage and manure storage areas are sheeted apart from during feedstock deliveries. Slurry is fed directly into the system which is enclosed. Cleaning procedures ensure any spills and litter around the site are cleared up immediately. A vermin/pest control contract will be set up with a pest control contractor should pests be found to be inhabiting the facility. Records of all vermin and pest control visits and incidents are maintained and available for inspection.	Low

Appendix B – Air Quality Assessment including replacement CHP

enzygo
environmental consultants

Air Quality Assessment

Burton Agnes Biogas Plant

Burton Agnes Renewables

CRM.0163.001.AQ.R.001

'Experience and expertise working in union'

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Environmental Permit Variation – Air Quality Assessment
CRM.0163.001.AQ.R.001

Project:	Burton Agnes Biogas Plant
For:	Burton Agnes Renewables
Status:	Final
Date:	May 2023
Author:	Josh Davies BSc (Hons) – Senior Air Quality Consultant
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Non-Technical Summary

i. Enzygo Limited was commissioned by Burton Agnes Renewables to undertake an air quality dispersion modelling assessment to support a permit variation application for an Anaerobic Digestion facility located at Harpham Grange Farm, Burton Agnes.

ii. Enzygo understands the variation is required as the Facility will no longer be able to meet the requirements of the appropriate newly revised standard rules permit. It is also understood the onsite CHP is required to be replaced due to its age and operating capabilities. In order to keep operating an application to vary the bespoke permit is being submitted.

iii. This report should be read in conjunction with the facility's Environmental Permit, EPR/VP3034RX.

iv. The operation of the plant has potential to cause impacts at sensitive locations due to onsite combustion sources and ammonia emissions associated the storage and processing of feedstocks. Air Quality dispersion modelling was undertaken to consider impacts in the vicinity of the site. Emissions concentrations were defined based on the plant operations, stack monitoring and where necessary a review of technical data sheets and literature.

v. Model inputs were based on robust operating parameters. Results were then processed and assessed against industry standard significance criteria.

vi. The dispersion modelling results indicated that the relevant screening criteria was met at all sensitive human receptors and impacts were screened as insignificant. Impacts on ecological receptors as result of nitrogen oxide, sulphur dioxide and ammonia emission concentrations were screened as insignificant.

vii. Based on the predictions and the use of worst-case emissions, it is considered that overall air quality impacts associated with the operation of facility would be not significant.

1.0 Introduction

1.1 Background

1.1.1 Enzygo Limited was commissioned by Burton Agnes Renewables to undertake dispersion modelling to support a permit variation for an Anaerobic Digestion (AD) plant at Harpham Grange Farm, Burton Agnes, (the 'Facility').

1.1.2 The facility will process non-waste energy crops, including rye, grass and maize sileage and agricultural manures and slurry. The biogas produced during the process will be upgraded injected into the gas transmission grid. Proportions of biomass will also be combusted on site to provide electricity and heat to the AD process via a Combined Heating and Power (CHP) Plant. In situations where the CHP unit is offline, an auxiliary boiler will operate to ensure demand is maintained.

1.1.3 The Facility comprise will comprise of the following primary elements:

- Acceptance and storage of energy crops in silage clamps;
- Acceptance and storage of agricultural manure and straw;
- Acceptance of liquid slurry via the filling station and storage of slurry in the prelim tank;
- Digestion of crops agricultural manures and slurry;
- Biogas collection, storage and treatment;
- Combustion of biogas in biogas boiler (emergency and backup use only);
- Injection of upgraded biogas into grid;
- Combustion of biogas in a CHP plant and auxiliary boiler;
- Emergency flare operation; and
- Transfer of digestate via pipes to tankers.

1.1.4 Combustion emissions associated with the CHP, biogas boiler and flare have potential to cause increases in ground level pollutant concentrations and cause impacts at sensitive locations within the vicinity of the site. In addition, ammonia (NH_3) emissions from feedstock and digestate have the potential to cause impacts at ecological sensitive receptors.

1.1.5 An Air Quality Assessment has therefore been undertaken to assess the significance of these impacts in line with the requirements of the Environmental Permitting (England & Wales) (Amendment) (No.2) Regulations 2016.

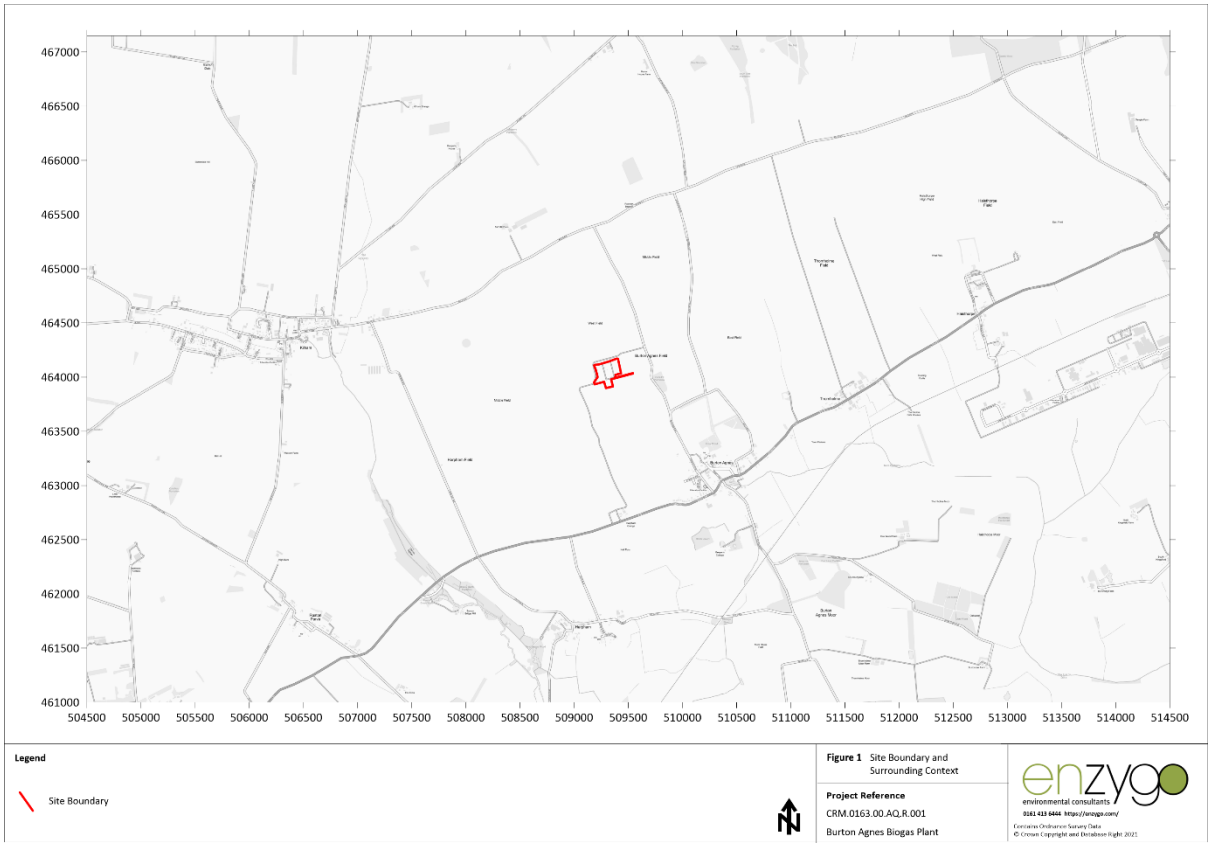
1.1.6 This report details the results and conclusions of the quantitative air quality impact assessment.

1.2 Site Location and Context

1.2.1 The Facility is located on land at Harpham Grange Farm, Burton Agnes, YO25 4NQ, at the approximate National Grid Reference (NGR): 509310, 464065. The site is located in a predominantly agricultural area with a sparse working farms and residential properties in the vicinity of the site. The nearest residential property is The Rectory situated on Rudston Road, approximately 1.1 km southeast of the Facility.

1.2.2 Figure 1 shows a map of the site location and surrounding area.

Figure 1 - Site Surrounding



2.0 Legislation, Guidance and Environmental Standards

The following legislation and guidance will be considered during the preparation of the Air Quality Assessment:

- The Environmental Permitting (England and Wales) (Amendment) Regulations 2016;
- The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, Department for Environment, Food and Rural Affairs (DEFRA), 2007[1];
- The Air Quality Standards (Amendment) Regulations, updated on 31st December 2016;
- Local Air Quality Management Technical Guidance 2022 LAQM (TG22), DEFRA, 2022[2];
- Air emissions risk assessment for your environmental permit, EA, updated on 22nd March 2023[3]; and
- Environmental permitting: air dispersion modelling reports, EA, updated on 19th January 2021[4].

2.1 Environmental Quality Standards

2.1.1 The modelling assessment will be undertaken against relevant long-term and short-term environmental standards. The assessment levels, limit values, objectives and target values which are applicable to this assessment are summarised in Table 1 with relation to human health receptors.

Table 1: Environmental Quality Standards for Human Exposure

Pollutant	Environmental Quality Standards	
	Concentration (µg/m³)	Averaging Periods
Nitrogen dioxide (NO_2)	40	Annual mean, not to be exceeded
	200	1-hour mean; not to be exceeded more than 18 times a year
Sulphur Dioxide (SO_2)	125	24-hour mean; not to be exceeded more than 3 times a year
	350	1-hour mean; not to be exceeded more than 24 times a year
	266	15-min mean; not to be exceeded more than 35 times a year
Carbon monoxide (CO)	10,000	8-hour running mean, not to be exceeded
Hydrogen Sulphide (H_2S)	140	Annual limit
	150	1 hour limit
Total Volatile Organic Compounds (TVOC)	5	Annual limit
	30	24-hour mean limit

2.1.2 The annual and hour limits set out for H_2S and NH_3 are Environmental Assessment Levels (EALs) set out in the EA guidance[3]. EALs represent a pollutant concentration in ambient air at which no significant risks to human health are expected. The remaining pollutants are assessed against their respective Ambient Air Directive (AAD) Limit Values, either under EU directives or UK law.

[1] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, DEFRA, 2007
[2] Local Air Quality Management Technical Guidance 2022 LAQM (TG22), DEFRA, August 2022.
[3] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit
[4] https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports

2.1.3 These criteria are collectively referred to as Environmental Quality Standards (EQSs). Table 2 summarises the advice provided in the DEFRA guidance LAQM (TG16)[2] on where the EQSs apply.

Table 2: Where EQS Apply

Averaging Period	Objectives Should Apply At	Objectives Should Not Apply At
Annual mean	All locations where members of the public might be regularly exposed Building façades of residential properties, schools, hospitals, care homes etc.	Building facades of offices or other places of work where members of the public do not have regular access Hotels, unless people live there as their permanent residence Gardens of residential properties Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term
24-hour and 8 hour mean	As above together with hotels, and gardens of residential properties	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term
1-hour mean	As above, kerbside sites (for example, pavements of busy shopping streets), parts of car parks, bus stations and railway stations etc. which are not fully enclosed, and any location where members of the public might reasonably be expected to spend one hour or more	Kerbside sites where the public would not be expected to have regular access

2.2 Ecological Critical Levels

2.2.1 The assessment of impacts upon ecological designations will be undertaken in accordance with the EA guidance[3]. Predicted impacts will be compared against appropriate Critical Loads (CLDs) and Critical Levels (CLVs) obtained from the UK Air Pollution Information System (APIS)[5] to determine significance.

2.2.2 Table 3 presents the CLVs considered within this assessment. CLVs have been assigned based on worse case sensitivity.

Table 3: Critical Levels for the Protection of Vegetation

Pollutant	Critical Level	
	Concentration (µg/m³)	Averaging Periods
NO_x	30	Annual mean
	75	24-hour mean
SO_2	10	Annual mean
NH_3	1	Annual mean

2.2.3 CLDs used in this assessment are detailed in Section 4.2 for nutrient nitrogen and acidity which refers to deposition of pollutants, while a CLVs refers to pollutant concentrations in the atmosphere.

[5] http://www.apis.ac.uk/

3.0 Dispersion Modelling Inputs

3.1 Emission Sources

3.1.1 The following sources have been considered in the assessment and reflect the relevant emission points listed in EPR/VP3034RX/001 and additional process emissions.

- A1 – A4 - Pressure relief Devices
- A5 - Combined Heat and Power (CHP) Engine 1 Stack
- A6 - Auxiliary Boiler Stack
- A7 - High Temperature Flare
- A8 - Biogas Cleaning Stack
- Feedstock Clamps (Farmyard Manure and Silage); and
- Solid Digestate Storage

3.1.2 Feedstock and digestate sources have been included within the model to account for potential impacts on NH_3 concentrations at ecological designations. NH_3 monitoring has not been undertaken at the Facility and emission rates were based on a literature review.

3.1.3 With regards to emission sources A1-A4 (Pressure Relief Devices) and A7 (High Temperature Flare) it is understood these will only operate infrequently during emergency scenarios. Given their reduced operating schedules, impacts from A1-A4 and A7 are considered insignificant and do not require detailed modelling. Source A5 forms part of the permit variation.

3.1.4 Table 4 details the identifiers and location of modelled emission sources.

Table 4: Stack Locations

Identifier		NGR	
		X	Y
A5	CHP Engine	509331.7	463996.6
A6	Auxiliary Boiler Stack	509335.8	464001.8
A8	Biogas Cleaning Stack	509349.4	463994.2

3.1.5 For further information regarding emission sources please review EPR/VP3034RX.

Table 5: Ammonia Sources

Identifier	NGR		Modelled Area (m^2)
	X	Y	
Silage Clamp 1	509266.4	464060.1	89.8
Silage Clamp 2	509278.2	464017.5	89.9
Silage Clamp 3	509350.7	464081.1	89.6
Silage Clamp 4	509361.7	464039.0	88.1
Manure Clamp 1	509244.4	464078.4	33.8
Digestate Storage	509349.4	464128.8	172.08

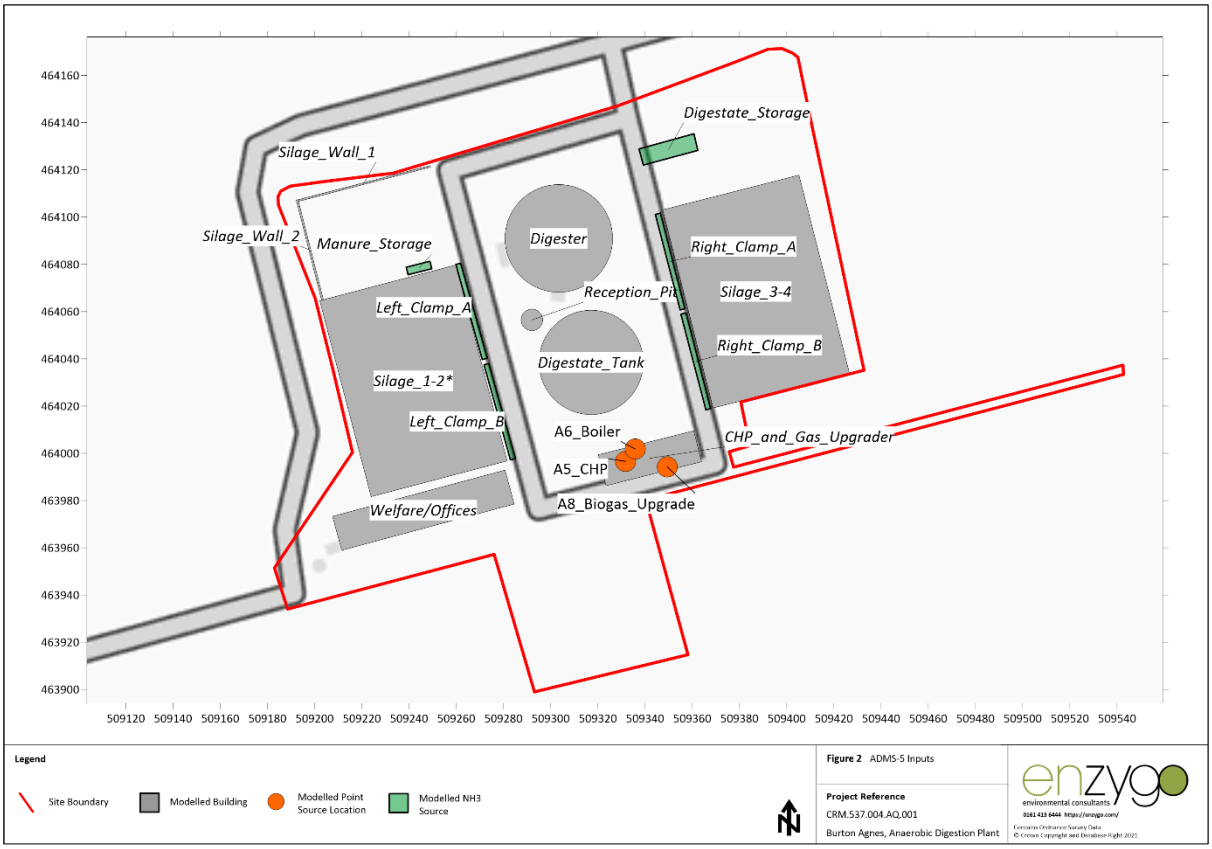
3.1.6 The on-site lagoon does not serve as a liquid digestate storage area and consists primarily of rainwater. As such, it is not considered a source of NH_3 emissions .

3.2 Dispersion Modelling

3.2.1 The information detailed in this section were entered into the ADMS 5.2 (v5.2.2.0) software, which is developed by Cambridge Environmental Research Consultants (CERC) Ltd. Outputs were processed to predict pollutant concentrations in the vicinity of the site to allow comparison against relevant impact significance criteria.

3.2.2 Figure 2 shows a graphical representation of the modelled Air Quality sources.

Figure 2 - ADMS-5 Modelling Inputs



3.3 Modelling Scenarios and Emissions

3.3.1 The pollutant species and averaging periods considered relevant to this assessment are summarised in Table 6. Unless stated modelled pollutant species and average periods relate to human exposure.

Table 6: Dispersion Modelling Scenarios

Pollutant	Modelled As	
	Long Term	Short Term
NO_2	Annual mean	99.79th percentile (%ile) 1-hour mean
NO_x	Annual mean *(Ecological Impacts)*	24-hour mean (Ecological Impacts)
SO_2	-	99.9%ile 15-minute mean
	-	99.73%ile 1-hour mean
	-	99.18%ile 24-hour mean
	Annual mean (*Ecological Impacts)*	-
CO	8-hour rolling mean	-
TVOC as Benzene	Annual mean	-

Pollutant	Modelled As	
	Long Term	Short Term
	24-hour mean	-
H_2S	Annual mean	-
	1-hour limit	-
NH_3	Annual mean (Ecological Impacts)	-
Nitrogen Deposition	Annual mean (Ecological Impacts)	-
Acid Deposition	Annual mean (Ecological Impacts)	-

Process Conditions

3.3.2 Process conditions for source A5 has been obtained from the Jenbacher JM C312 GS-B.L technical datasheet provided by the manufacturer. Conditions for A6 were also informed by the manufacturer's technical datasheet. Conditions for A8 were obtained from heat and mass balance data. Specifications for each source were provided by Future Biogas Limited.

3.3.3 Reference should be made to Table 7 for the parameters for each emission stack.

Table 7: Process Stack Conditions

Parameter	Unit	A5[a]	A6[b]	A8[c]
Stack height	m	10.15	6.00	4.20
Stack diameter	m	0.25	0.30	0.15
Flue gas efflux velocity	m/s	17.16	5.30	4.88
Volumetric flow rate	Am^3/s	0.842	0.374	0.092
Temperature	˚C	450	185	19.5
Moisture Content	%	11	-	-
Oxygen Content	%	9	-	-

[a] Data from Jenbacher JM C312 GS-B.L technical datasheet – Referenced at 15% Oxygen, STP.
[b] Technical Specification – ICI Caldaie REX 62 K F 7130 Boiler
[c] Air Products Heat and Mass Balance Report – 20150722-1604-031

Stack Emissions

3.3.4 NOx and SO_2 concentrations were based on maximum Emission Limit Values (ELVs) obtained from Annex II, of MCP regulations[6]. TVOC and CO concentrations associated with A5 and A6 were obtained from the EAs statutory guidance[7]. TVOC and H_2S emission concentrations associated with A8 were obtained from the Heat and Mass Balance data provided by Future Biogas Ltd[8].

3.3.5 Emission concentrations detailed in Table 8 are referenced at standard temperature (273K) and pressure (101.3kPa) and, in the case of A5 as a dry gas at 15% oxygen, and A6 as a dry gas at 3%.

[6] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32015L2193#ntc28-L_2015313EN.01001501-E0028 [Accessed 26/05/2023]
[7] SR2021 No 6: Anaerobic digestion facility, including use of the resultant biogas – installations, 17th May 2022.
[8] Air Products Heat and Mass Balance Report – 20150722-1604-031.

Table 8: Maximum Emission Concentrations

Pollutant	Emission Concentrations (Nmg/m^3)		
	A5	A6	A8
NO_x (as NO_2)	190	250.00	-
SO_2	40	200.00	-
CO	1,400.00[(b)]	1,400.00[(b)]	-
TVOC (as Benzene)	1,000.00[(b)]	1,000.00[(b)]	392.97[(a)]
H_2S	-	-	2.79[(a)]

a Calculation based on monitored PPM.

b. SR2021 No 6: Anaerobic digestion facility, including use of the resultant biogas – installations, 17th May 2022.

3.3.6 The mass emissions rates shown in Table 9. were calculated to using conditions provided in Table 7 and maximum emission concentrations in Table 8.

Table 9 Emission Rates

Pollutant	Emission Rate (g/s)		
	A5	A6	A8
NO_x (as NO_2)	0.108	0.038	-
SO_2	0.023	0.031	-
CO	0.793	0.215	-
TVOC (as Benzene)	0.566	0.154	0.0363
H_2S	-	-	0.0003

Ammonia Emissions

3.3.7 NH_3 emission rates were considered for silage, FYM and solid digestate storage areas. Feedstock emissions based on emission factors taken from the Natural Resource Wales website *'Emission factors for anaerobic digestion feedstock and digestate for modelling and reporting'* as the most relevant and detailed available factors in the UK at the time of writing the report.

3.3.8 Emission rates are based approximate weights and volumes of feedstocks, confirmed by Future Biogas Ltd, as detailed below:

- Poultry Manure – 1,800 tonnes per annum (tpa);
- Pig Slurry - 16,000 m^3 per annum;
- Maize and Hybrid Rye – 40,000 tpa; and
- Wheat Straw – 1,500 tpa.

3.3.9 Waste masses were based on the proposed mix detailed above. According to a literature review[9] pig slurry has a density of approximately 1 kg/l which has been used to convert the annual slurry volume into an appropriate weight. Future Biogas Limited confirmed the annual digestate output of 7,500 tonnes of dry digestate, and 40,000 tonnes of liquid digestate.

3.3.10 A number controlling methods have been proposed for the feedstock clamps and digestate storage. The emission control methods referenced within this assessment will be fully reviewed during the environmental permitting application.

[9] Evaluation of mechanical separation of pig and cattle slurries by a decanting centrifuge and a brushed screen separator, Agri-Environmental Technologies, Stephen Gilkinson and Peter Frost, September 2007

3.3.11 The FYM manure clamp and digestate stores will be fully covered by a Silostop Max silage film which provides a robust impermeable 80 micron oxygen barrier film and blocks the entry of oxygen into the covered material. FYM manure and digestate stores will be kept covered all times except when loading or unloading. This is assumed to provide an ammonia reduction of up to 95%[10]. As such a conservative overall reduction of 50% has been factored in to the calculations, this accounts for periods of loading and unloading where material is agitated and uncovered.

3.3.12 Emissions associated with silage, manure and digestate storage has been based on information provided by Future Biogas Ltd, including coverage areas and tonnages. Silage clamps have been modelled based on the exposed area representing the front face which is constantly uncovered for loading access.

3.3.13 Table 9 shows NH_3 emission rates for the digestate storage. All NH_3 emissions were assumed to be at ambient temperate and zero velocity.

[10] https://extension.umn.edu/manure-air-and-water-quality/covers-manure-storage

Table 10 NH_3 Emission Calculations

Source	NRW Feedstock Type	N content of fresh matter (kg kg–1)	N in feedstock (kg/kg)	Fresh Mass (kg/day)	Ammonia Emission per kg N	Emission Characteristic	Emission ($g/m^2/s$)
Silage Clamps 1-4	Maize Silage	0.005	0.003	c.13,698 in each clamp	0.009	Emitted over separate silage clamps over c 90 m^2	0.0000039 (per silage clamp)
	Grass Silage	0.009	0.006	c.13,698 in each clamp	0.009		
	Straw	0.005	0.001	c.1,027 in each clamp	0.009		
FYM Clamp	Poultry manure	0.018	0.009	c.4,931	0.009	Emitted over c.33 m^2	0.00013
Solid Digestate[a]	Poultry Manure	0.018	0.009	c.3,950[b]	0.0276	Emitted over c.1720 m^2	0.000013 (combined)
	Maize Silage	0.005	0.003	c.43,891[b]	0.0276		
	Grass Silage	0.009	0.006	c.43,891[b]	0.0276		
	Straw	0.005	0.001	c.3,292[b]	0.0276		
	Pig Slurry	0.005	0.009	c.35,113[b]	0.0276		

a: Solid digestate includes all feedstocks and therefore NH_3 emissions are based on content of all relevant throughputs

b: Tonnage based on annual output of solid digestate

3.4 Time Varied Emissions

3.4.1 Emissions for the silage and FYM clamps and solid digestate storage were assumed to be constant, with the plant in operation 24-hours per day, 365-days per year. Future Biogas Ltd confirmed that the filling of the feeder hoppers, as well as the transfer of feedstock from the silage and FYM clamps would occur for approximately 4-6 hours per day. A time-varied file was therefore applied to represent these conditions.

3.4.2 Future Biogas Ltd also confirmed that the collection of liquid digestate will occur for a maximum of 11 hours per week. A time-varied file was therefore applied to represent a collection from tanker location per week.

3.4.3 The auxiliary boiler (A6) will only operate when the CHP is offline. Future Biogas have confirmed this is likely to occur annually for approximately 260 hours. However, to provide a robust assessment, annual boiler operating hours were modelled for 500 hours. Annual mean PCs associated with the boiler were therefore scaled down using a factor of 0.05 in line with the EA guidance[4]. The factor equates to the operational hours of 500 divided by the maximum operational envelope of 8760 hours. Short term impacts were modelled with the boiler running continuously to consider peak hour contributions.

3.4.4 Modelling of all other sources was assumed to be constant, with the plant in operation 24-hours per day, 365-days per year.

3.5 Terrain Data

3.5.1 Areas of complex terrain have potential to affect the dispersion of pollutants which vary dependent on the height and location of modelled emission sources. The ADMS-5 user guidance suggest that terrain height effect should only be included where gradients exceed 1:10.

3.5.2 Ordnance Survey Landform Panorama terrain data was pre-processed within the ADMS-5 model and covers the Facility and surrounding receptor locations.

3.6 Building Effects

3.6.1 Buildings can influence the dispersion of pollutants and may lead to increases to ground level concentrations. A review of adjacent buildings was therefore undertaken and subsequently included within the model and are summarised in Table 11.

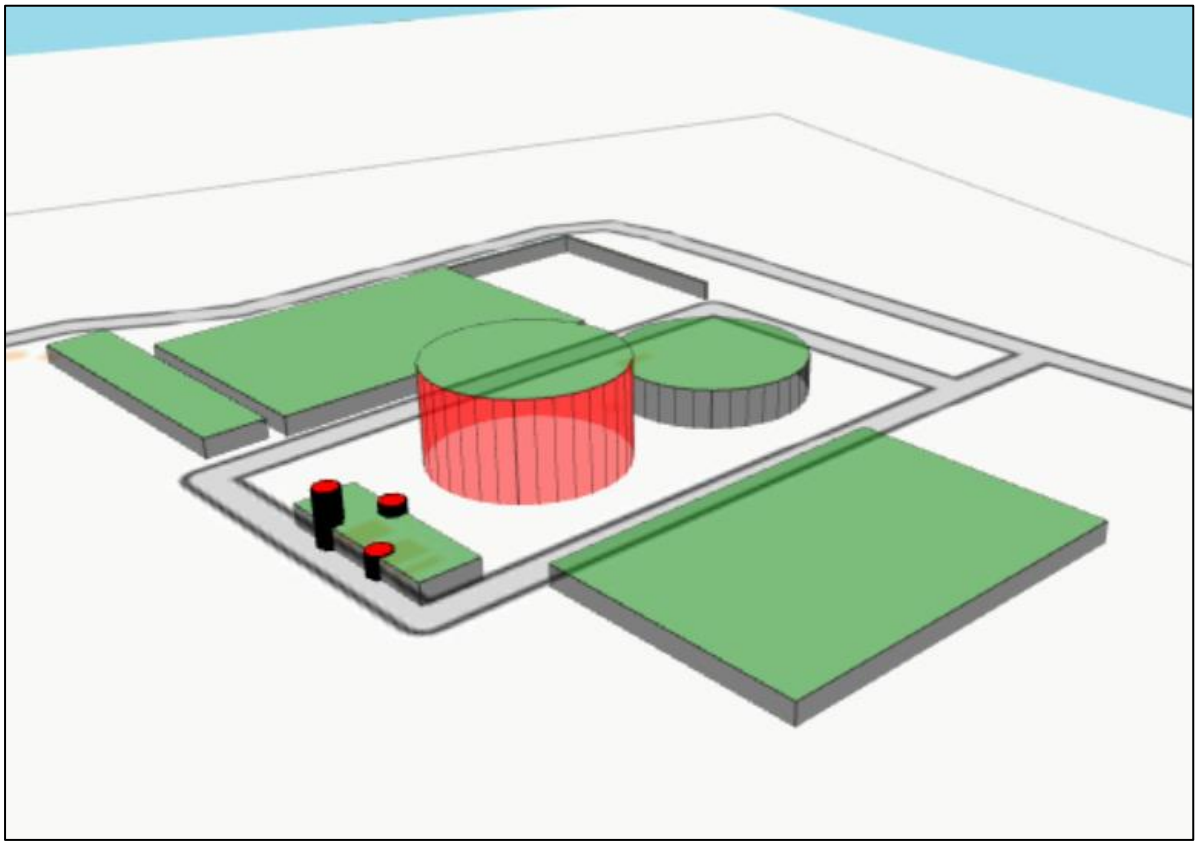
3.6.2 Onsite building heights were provided by Future Biogas Ltd. It should be noted that the effect of buildings on dispersion can only be modelled for points source. As such the modelled area/line sources do not take account of building effects.

Table 11: Building Geometries

Building		NGR (m)		Height (m)	Length/ Diameter (m)	Width (m)	Angle (˚)
		X	Y				
1	Silage 1	509241.8	464030.7	4.0	59.6	85.8	255.3
2	Silage 2	509387.0	464068.5	4.0	86.6	59.6	165.7
3	Digestate Tank	509303.4	464091.0	7.7	45.6	Circular	N/A
4	Digester	509317.1	464038.5	19.0	44.2	Circular	N/A
5	Reception Pit	509292.0	464056.5	4.0	9.1	Circular	N/A
6	Offices &Welfare Block	509246.0	463975.9	4.0	14.9	75.7	165.0
7	CHP & Gas Upgrade Unit	509342.0	463997.9	5.0	13.5	41.7	165.9

Building		NGR (m)		Height (m)	Length/ Diameter (m)	Width (m)	Angle (°)
		X	Y				
8	Silage Walls 1	509220.7	464114.2	4.0	0.7	58.5	165.5
9	Silage Walls 2	509197.9	464086.1	4.0	43.8	0.8	165.8

3.6.3 Reference should be made to Figure 2 for a graphical representation of the modelled building layout. and the ADMS 5 model input. A three-dimensional representation of the modelled building layout is provided below.



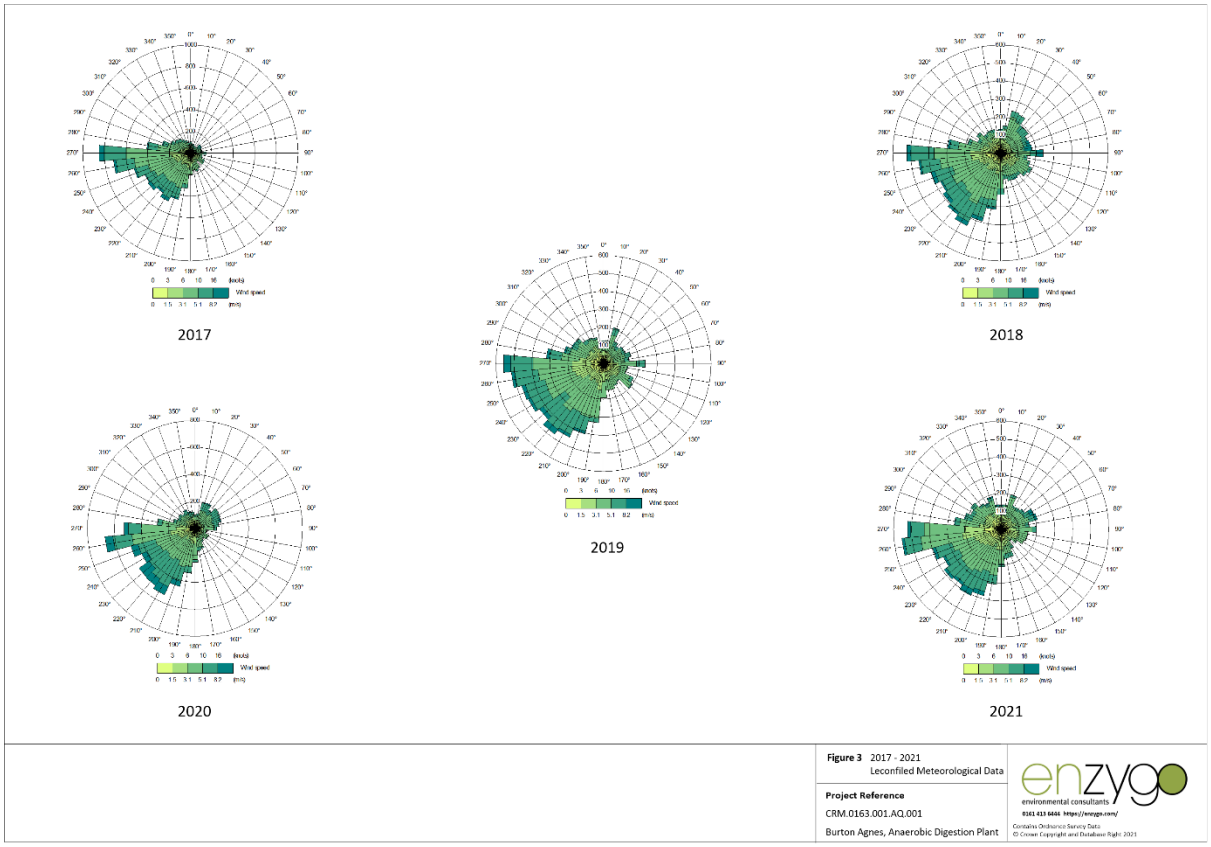
3.7 Meteorological Data

3.7.1 Hourly sequential data used in this assessment was obtain from Leconfield meteorological station, located 22 km southwest of the Facility at the approximate NGR: 503329, 442674.

3.7.2 Although there is some distance between the application site and meteorological station, both sites are located within similar rural contexts and share comparable topographies. The use of this parameter therefore provides a suitable representative of metrological conditions across the modelled domain.

3.7.3 Maximum emissions across the five years of meteorological data (2017 – 2021) were utilised to ensure a worse case assessment. In reality it is unlikely that a combination of worse case meteorological conditions, which give rise to maximum pollutant concentrations, would occur during any one meteorological year. The application of this method ensures a worse case approach which is likely to overestimate actual conditions. Figure 3 shows the meteorological wind roses.

Figure 3– Meteorological Wind Roses



3.7.4 All meteorological data was provided by ADM Ltd.

3.8 Roughness Length

3.8.1 The specific roughness length (z_0) values specified with the ADMS-5 model are summarised in Table 12.

Table 12: Utilised Roughness Length

Location	Roughness length (m)	ADMS Description
Application Site and Meteorological Station	0.2	Agricultural (min)

3.9 Monin-Obukhov Length

3.9.1 The Monin-Obukhov length values are summarised in Table 13.

Table 13: Utilised Monin-Obukhov Length

Location	Monin-Obukhov length (m)	ADMS Description
Application Site and Meteorological Station	10	Small Towns <50,000

3.10 Surface Albedo and Priestley-Taylor Parameter

3.10.1 The surface albedo and Priestley-Taylor parameters used in the assessment were the model default values of 0.23 and 1 respectively.

3.11 NO_x to NO_2 Conversion

3.11.1 Ground level NOx concentrations were predicted through dispersion modelling. NO_2 concentrations reported in the results section assume conversion from NO_x to NO_2, based upon EA guidance[3] detailed below:

- 35% for short-term average concentrations; and
- 70% for long-term average concentrations.

3.12 15-minute Sulphur Dioxide Concentration Predictions

3.12.1 Throughout the assessment, 15-minute mean SO_2 concentrations have been calculated using the following correction factor based upon empirical relationships with the 99.9th percentile of 1-hour means, as described in EA guidance :

- *99.9th* percentile *of 15-minute means = 1.34 x 99.9th percentile of 1-hour means*

4.0 Baseline and Sensitive Receptors

4.1 Human Receptors

4.1.1 A sensitive receptor is defined as any location which may be affected by changes in air quality. A desk-top study was undertaken in order to identify sensitive receptor locations which require a detailed assessment. Identified receptors were modelled at the minimum height of relevant exposure. The modelled receptors are summarised in Table 14.

Table 14: Sensitive Human Receptors

Receptor		Use	NGR (m)		Distance from Centre of Site (m)	Height (m)
			X	Y		
R1	Tuft Hill Farm, Woldgate	Commercial	508423.1	465341.4	1,573	1.5
R2	Sunset Cottage, Thornholme	Residential	511290.0	463726.8	2,010	1.5
R3	Home Farm, Burton Agnes	Residential	510434.8	463162.0	1,430	1.5
R4	Rectory, Rudston Road	Residential	510063.3	463213.3	1,121	1.5
R5	Phos-n-las, Main Street	Residential	509907.3	462860.0	1,323	1.5
R6	Harpham Grange, Main Road	Residential	509411.9	462738.9	1,303	1.5
R7	Harpham Lane Farm	Commercial	507244.0	464106.0	2,061	1.5
R8	East End Cottages, East End	Residential	507455.7	464580.2	1,926	1.5

4.1.2 Figure 4 shows a graphical representation of the receptor locations.

Figure 4 - Modelled Sensitive Human Receptor Locations

Human Receptor Baseline

4.1.3 A desktop study was undertaken to define the baseline air quality within the vicinity of the Facility. The baseline year will correspond with either the current year or the most recent year that monitoring data is available. 2022 predicted background concentrations are summarised in Table 15.

Table 15: Predicted Long Term Background Pollutant Concentrations

Receptor	Predicted Background Concentration (µg/m³)					
	NO_x	NO_2	SO_2	CO	TVOC	H_2S
R1	6.01	4.79	3.17	197.00	0.12	1.49
R2	6.84	5.43	3.14	198.00	0.12	1.49
R3	6.80	5.40	3.19	198.00	0.12	1.49
R4	6.80	5.40	3.19	198.00	0.12	1.49
R5	6.67	5.30	3.14	203.00	0.12	1.49
R6	6.67	5.30	3.14	203.00	0.12	1.49
R7	6.19	4.93	3.22	197.00	0.12	1.49
R8	6.19	4.93	3.22	197.00	0.12	1.49

4.1.4 Background concentrations of NO_x and NO_2, were obtained from DEFRA website[11] for 2022, with CO, SO_2 and benzene predictions obtained from the 2001 base maps.

4.1.5 Background data for H_2S was obtained via a literature review which indicated background concentrations typically range between 0.11 ppb and 0.33 ppb, although concentrations in urban areas can be as high as 1 ppb[12]. A background concentration of 1.49 µg/m³ (1 ppb) was therefore utilised in the absence of data from DEFRA prediction or monitored sources.

4.1.6 These are the most reliable and recent predictions available and are therefore considered to provide a reasonable representation of background concentrations in the vicinity of the site.

Short term Background Concentrations

4.1.7 With reference to short-term background concentrations, it was assumed that the short-term concentration of a substance is twice its long-term concentrations provided in Table 15 as suggested within EA risk assessment for your environmental permit guidance[3].

4.2 Ecological Sensitive Receptors

4.2.1 With regard to receptors of ecological sensitivity, the EA guidance 'Air emissions risk assessment for your environmental permit'[3] states:

"Note that conservation sites need only be considered where they fall within set distances of the activity:

- *Special Protection Areas (SPAs), Special Areas of Conservation (SACs) or RAMSAR sites within 10km of the installation; and*

[11] https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2018

[12] Environmental Toxicology of Hydrogen Sulphide, Nitric Oxide, Samantha L. Malone et al, 2017

- *Site of Special Scientific Interest (SSSIs), National Nature Reserves (NNRs), Local Nature Reserves (LNRs), Local Wildlife Site (LWS) and Ancient Woodlands (AW) within 2km of the location."*

4.2.2 A desk top study was undertaken using the Multi-Agency Geographic Information for the Countryside (MAGIC)[13] to identify statutory and locally designated sites within the distances stated above.

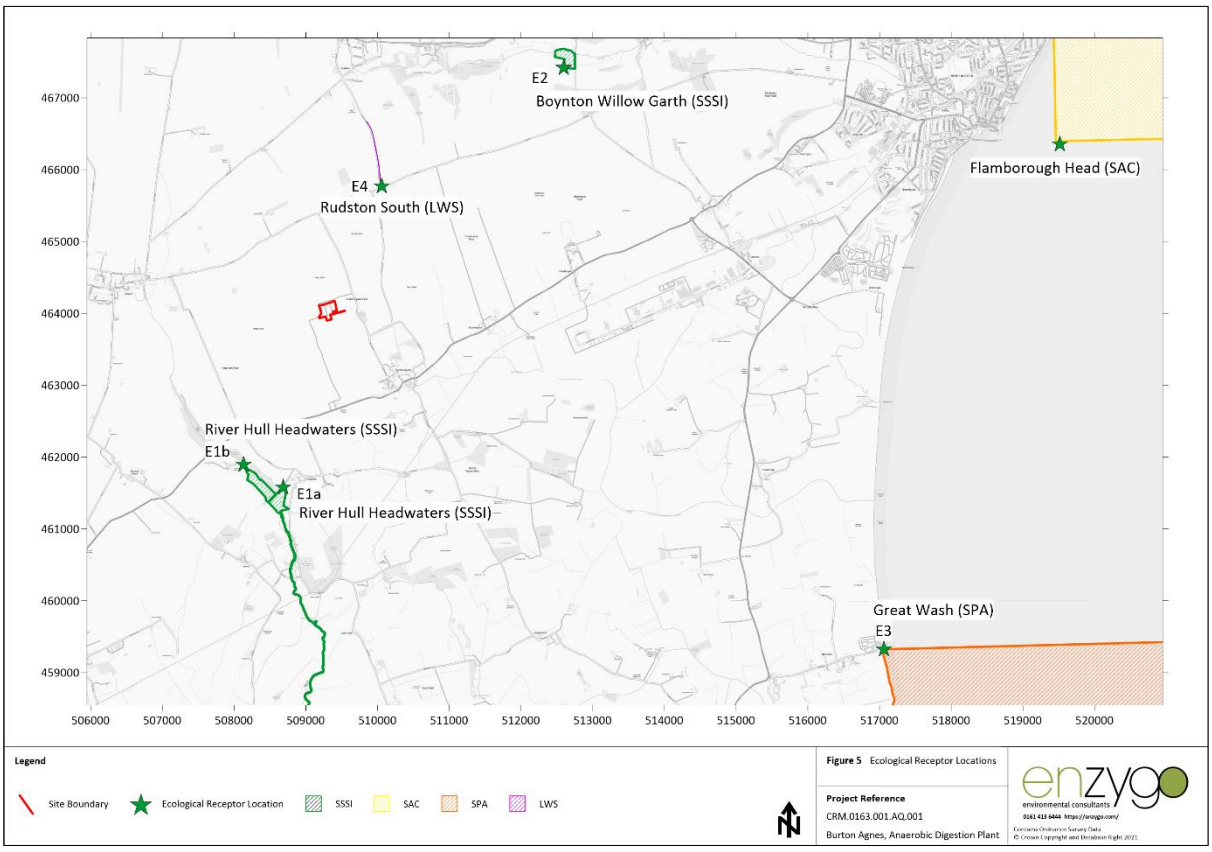
4.2.3 The choice of receptor locations was informed by the Nature and Heritage Conservation Screening document (ref: EPR/VP3034RX/V002) issued by the EA on the 25th of March 2022. Whilst the River Hull Headwater and Boynton Willow Garth SSSI are located outside the screening zones they have been included for completeness.

4.2.4 Identified designations are displayed in Table 16 and Figure 5.

Table 16: Ecological Sensitive Receptors

ID	Ecological Receptor	NGR		Closest Distance to Facility (m)
		X	Y	
E1a	River Hull Headwaters (SSSI)	508683.4	461579.9	2,548
E1b	River Hull Headwaters (SSSI)	508133.0	461895.0	2,454
E2	Boynton Willow Garth (SSSI)	512594.0	467417.5	4,707
E3	Great Wash (SPA)	517061.0	459326.0	9,082
E4	Rudston South (LWS)	510059.9	465768.1	1,876

Figure 5– Modelled Sensitive Ecological Receptor Locations



[13] https://magic.defra.gov.uk/MagicMap.aspx

Ecological Receptor Baseline

4.2.5 CLDs are designated within the UK based on the sensitivity and relevant features of the receiving habitat. A review of the APIS website was undertaken to identify suitable habitat descriptions and associated CLDs. For the receptors with multiple habitats, the most sensitive habitat has been taken for both nitrogen and acid deposition. The CLDs for nitrogen deposition are presented in Table 17.

Table 17: Nitrogen Critical Load

ID	Designation	APIS Habitat	Nitrogen Critical Load (kgN/ha/yr)	
			Min	Max
E1a	River Hull Headwaters	Broadleaved deciduous woodland	10	15
E1b	River Hull Headwaters	Rich fens	15	25
E2	Boynton Willow Garth	Broadleaved deciduous woodland	10	15
E3	Great Wash	Coastal stable dune grasslands	5	10
E4	Rudston South	No Priority Habitat		

*APIS database accessed 31/05/2023

4.2.6 As confirmed by the North & East Yorkshire Ecological Data Centre, Rudston South LWS has no stated priority habitat and therefore an assessment was not possible. Additionally, North & East Yorkshire Ecological Data Centre confirmed the site is a road verge site and therefore does not present a high sensitivity with regard to nutrient nitrogen or acidity. This LWS has not been considered further during the assessment.

4.2.7 Table 18 shows the relevant critical loads for acid deposition.

Table 18: Acid Critical Load

ID	Designation	APIS Habitat	Critical Load (ke/ha/yr)		
			CLmaxS	CLmaxN	CLminN
E1a	River Hull Headwaters	Unmanaged Broadleafed Woodland	0.809	1.166	0.142
E1b	River Hull Headwaters	Acid Grassland	0.170	0.608	0.223
E2	Boynton Willow Garth	Unmanaged Broadleafed Woodland	10.782	10.924	0.142
E3	Great Wash	Calcareous grassland	4.000	4.856	0.856

*APIS database accessed 31/05/2023

4.2.8 Background deposition rates and concentrations were downloaded from the APIS website and are summarised in Table 19 and represent the maximum predicted concentrations at each designation.

Table 19: Background Deposition Rates

ID	Nitrogen Deposition (kgN/ha/yr)	Acid Deposition (keq/ha/yr)		Background Concentration ug/m$_3$		
		N	S	NO_x	SO_2	NH_3
E1a	33.65	2.86	0.52	6.14	0.78	3.00
E1b	19.85	1.40	0.52	6.14	0.78	3.00
E2	28.66	2.51	0.50	5.93	0.68	2.48
E3	15.99	1.33	0.38	6.29	0.85	2.84

*APIS database accessed 31/05/2023

Deposition Rates

4.2.9 Deposition rates were calculated using the conversion factors provided within EA document 'Technical Guidance on Detailed Modelling approach for an Appropriate Assessment for Emissions to Air AQTAG 06[14]. Predicted pollutant concentrations were multiplied by the relevant deposition velocity and conversion factor to calculate the speciated dry deposition flux. The conversion factors used are presented within Table 20.

Table 20 Conversion Factors to Determine Dry Deposition Flux

Pollutant	Grassland Deposition Velocity (m/s)	Forest Deposition Velocity (m/s)	Conversion Factor (µg/m²/s to kg/ha/yr)	Conversion Factor (µg/m²/s to keq/ha/yr)
NO_2	0.0015	0.003	96	6.84
SO_2	0.012	0.024	157.7	9.84
NH_3	0.020	0.030	260	18.50

4.2.10 Predicted ground level pollutant concentrations were converted to kilo-equivalent ion depositions (keq/ha/yr) for comparison with the critical load for acid deposition at each of the identified ecological receptors. The standard conversion factors are shown in Table 21.

Table 21 Conversion Factors to Units of Equivalents

Species	Conversion Factors from kg/ha/yr to keq/ha/yr
N	0.07143
S	0.06250
NH_3	0.07143

4.2.11 The total N proportion was calculated from NO_x and NH_3 PCs. The proportion of the EQS consisting of the PC and PEC were then calculated using the tool available on the APIS website.

4.3 Assessment Criteria and Significance of Impacts

EA Guidance Criteria

4.3.1 Guidance for assessing the significance of emissions impacts from point sources are also given in the EA's guidance[3]. Predicted pollutant concentrations are summarised in the following formats:

- Process contribution (PC) - Predicted pollutant concentration as a result of emissions from the site only; and
- Predicted environmental concentration (PEC) - Total predicted pollutant concentration as a result of emissions from the site and existing baseline levels.

Initial Screening Stage

4.3.2 The significance of predicted impact was assessed in accordance with EA criteria and through consideration of likely effects as a result of the proposals. The EA guidance states that process contributions can be considered insignificant if:

- the short-term PC is less than 10% of the short-term environmental standard; and

[14] AQTAG 06: Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air, EA, 2014

- the long-term PC is less than 1% of the long-term environmental standard.

4.3.3 If both criteria are met predicted impacts can be considered insignificant and no further analysis is required. It is critical to note that exceedances of the 1% or 10% insignificance criteria does not by itself correspond to significant risk or adverse harm.

Second Screening Stage

4.3.4 If the above criteria are not met, then a second stage of screening is required to determine the impact of the PEC:

- The short-term PC is less than 20% of the short-term environmental standards minus twice the long-term background concentration; and
- The long-term PEC is less than 70% of the long-term environmental standards.

4.3.5 If both criteria are met during the second stage of screening, then predicted impacts can be considered insignificant. Should these criteria be exceeded then the PEC should be checked against the EQS.

Ecological Screening

4.3.6 If emissions that affect SPAs, SACs, RAMSAR sites or SSSIs meet both of the following criteria, they can be considered insignificant:

- the short-term PC is less than 10% of the short-term environmental standard for protected conservation areas; and
- the long-term PC is less than 1% of the long-term environmental standard for protected conservation areas.

4.3.7 If the predicted long-term PC is greater than 1% and the PEC is less than 70% of the long-term environmental standard, the emissions can be considered insignificant. Should the predicted PEC be greater than 70% of the long-term environmental standard, the PEC should be checked against the EQS for the ecological receptor.

4.3.8 When considering impacts at local nature sites and the emissions meet both of the following criteria, impacts can be considered insignificant if:

- The short-term PC is less than 100% of the short-term environmental standard; and
- The long-term PC is less than 100% of the long-term environmental standard.

4.3.9 In addition, the EA guidance also states that the APIS critical load function tool should be used to determine whether there is an exceedance of deposition of nutrient nitrogen or acidity, as the standard of exceedance is site-specific.

4.3.10 It is again critical to note that exceedances of the above insignificance criteria do not directly correspond to significant risk or adverse harm.

4.4 Modelling Uncertainties

4.4.1 Uncertainty in dispersion modelling predictions can be associated with a variety of factors, including:

- Model uncertainty - due to model limitations;

- Data uncertainty - due to errors in input data, including emission concentration estimates, operational procedures, land use characteristics and meteorology; and
- Variability - randomness of measurements used.

4.4.2 The analysis of maximum emissions across five years of meteorological data (2017 - 2021) accounts for variations in modelled predictions. Additionally, worse case assumptions regarding the application of maximum ELVs, operating envelopes, and background concentrations further minimise podetial uncertainties.

4.5 Assumptions

4.5.1 The following assumptions were made during the dispersion modelling:

- Concurrent and continuous operation throughout the year for emission sources A5, A8 and NH_3 sources; Overestimation of A6 operating hours.
- All combustion sources assumed at 100% loading;
- Maximum permitted emission concentrations were applied to A5, based on the Jenbacher JM C312 GS-B.L technical datasheet;
- Emission concentrations associated with A6 are based on maximum ELV provided by the EAs statutory guidance - *SR2021 No 6: Anaerobic digestion facility, including use of the resultant biogas – installations, 17th May 2022*[7]. The application of such ELV is likely to provide an overestimation of actual conditions.
- Emission rates for A8 based on mass balance and heating report for the Facility undertaken during 2015;
- In accordance with the EA guidance it was assumed that the entire TVOC emissions consisted of only C_6H_6 benzene given that all the substances are unknown. However, It is anticipated that benzene emissions would represent a much smaller proportion of the total TVOC content.
- it is considered that a proportion of the Proposed Development's contributions will already be accounted for in background levels and loads as the Facility is currently operational;
- It is understood that the flare and PRV will only operate during emergency scenarios, either a result of system failure or abnormal gas production. Given the reduced operating schedule, impacts are considered insignificant and have not been assessed.
- Following a review of the ERC Planning Portal and EAs Public Register no significant proposed livestock or agricultural activities are located with 3 km of the Facility. Therefore, potential in combination effects have been screened out of the assessment. Furthermore, it is considered the background concentrations and levels used in the assessment account for PC from local activities up to 2020.

4.6 Dispersion Modelling Report Requirements

4.6.1 Table 22 provides the checklist of dispersion modelling report requirements.

Table 22 Dispersion Modelling Report Requirements

Item	Location within Report
Location map	Figure 1
List of pollutants modelled and relevant guidelines	Table 1, Table 2 and Table 3
Details of modelled scenarios	Section 3.3
Details of relevant ambient concentrations used	Table 15 and Table 19
Model description and justification	Section 3.1.6
Special model treatments used	Section 3.3 to 3.12
Table of emission parameters used	Table 8
Details of modelled domain and receptors	Section 4.0 and Figure 4 and 5
Details of meteorological data used	Section 3.7
Details of terrain treatment	Section 3.5
Details of building treatment	Section 3.6 and Table 11

5.0 Results

Dispersion modelling was undertaken with the inputs described in Section 3.0.

Predicted pollutant concentrations were predicted separately for 5 assessment years and the maximum concentration reported for each pollutant. Impact significance was determined using the EA's guidance[4]. Pollutant contours are displayed in Figure 6 to 15 of Appendix A.

Impacts upon human receptor locations relate to the operation of onsite combustion process associated with emission sources A5 and A6, as well as gas upgrading processes associated with emission source A8. With regards to ecological receptor impacts relate to NO_x, and SO_2 emissions associated with combustion sources A5 and A6, and NH_3 emissions from the storage and processing of feedstocks and digestate.

5.1 Human Receptors

Annual Mean NO_2

Table 23 Predicted Annual Mean NO_2 Concentrations

ID	Predicted Concentration (µg/m³)		Proportion of EQS (%)	
	PC	PEC	PC	PEC
AQ1	0.01	4.8	0.03	12.01
AQ2	0.03	5.5	0.07	13.64
AQ3	0.02	5.4	0.05	13.54
AQ4	0.03	5.4	0.06	13.56
AQ5	0.02	5.3	0.04	13.29
AQ6	0.02	5.3	0.05	13.30
AQ7	0.01	4.9	0.03	12.37
AQ8	0.01	4.9	0.03	12.37

Predicted concentrations assessed against the relevant annual mean EQS of 40 µg/m³.

1-hour Mean NO_2

Table 24 Predicted 1-Hour Mean NO_2 Concentrations

ID	Predicted Concentration (µg/m³)		Proportion of EQS (%)	
	PC	PEC	PC	PC[a]
AQ1	0.42	10.00	0.21	0.22
AQ2	0.30	11.16	0.15	0.16
AQ3	0.35	11.15	0.18	0.19
AQ4	0.49	11.29	0.25	0.26
AQ5	0.39	10.99	0.20	0.21
AQ6	0.43	11.03	0.22	0.23
AQ7	0.33	10.20	0.17	0.18
AQ8	0.35	10.22	0.17	0.18

Predicted concentrations were assessed against the relevant 99.79%ile 1-hour mean EQS of 200 µg/m³
a: PC proportion of the EQS minus twice the long-term background.

5.1.1 As presented in Table 23 and Table 24, PC proportions of the annual and 1-hour EQS are less than 1% and 10%, respectively, at all receptor locations. Impacts can be screened out as

insignificant based on the initial EA screening criteria and no further analysis is required for this pollutant.

5.1.2 Based on these predictions no unacceptable adverse impacts are associated with NO_2 emissions.

24-Hour Mean (99.18%ile) SO_2

Table 25 Predicted 24-Hour SO_2 Concentrations

ID	Predicted Concentration (µg/m³)		Proportion of EQS (%)	
	PC	PEC	PC	PC[a]
AQ1	0.07	12.75	0.06	0.07
AQ2	0.09	12.65	0.07	0.08
AQ3	0.10	12.86	0.08	0.09
AQ4	0.12	12.88	0.09	0.11
AQ5	0.08	12.64	0.07	0.07
AQ6	0.09	12.65	0.07	0.08
AQ7	0.07	12.95	0.06	0.07
AQ8	0.07	12.95	0.06	0.06

Predicted concentrations assessed against the 24-hour mean EQS of 125 µg/m³.
a: PC proportion of the EQS minus twice the long-term background

1-Hour Mean (99.73%ile) SO_2

Table 26 Predicted 1-Hour SO_2 Concentrations

ID	Predicted Concentration (µg/m³)		Proportion of EQS (%)	
	PC	PEC	PC	PC[a]
AQ1	0.35	13.03	0.10	0.10
AQ2	0.30	12.86	0.09	0.09
AQ3	0.38	13.14	0.11	0.11
AQ4	0.47	13.23	0.13	0.14
AQ5	0.35	12.91	0.10	0.10
AQ6	0.45	13.01	0.13	0.13
AQ7	0.30	13.18	0.08	0.09
AQ8	0.32	13.20	0.09	0.09

Predicted concentrations assessed the 1-hour mean EQS of 350 µg/m³.
a: PC proportion of the EQS minus twice the long-term background

15-Minute Mean (99.90%ile) SO_2

Table 27 Predicted 15-minute SO_2 Concentrations

ID	Predicted Concentration (µg/m³)		Proportion of EQS (%)	
	PC	PEC	PC	PC[a]
AQ1	0.53	13.21	0.20	0.21
AQ2	0.45	13.01	0.17	0.18
AQ3	0.59	13.35	0.22	0.23
AQ4	0.78	13.54	0.29	0.31
AQ5	0.54	13.10	0.20	0.21

ID	Predicted Concentration (µg/m³)		Proportion of EQS (%)	
	PC	PEC	PC	PC[a]
AQ6	0.66	13.22	0.25	0.26
AQ7	0.43	13.31	0.16	0.17
AQ8	0.47	13.35	0.18	0.19

Predicted concentrations assessed against the 15-minute mean EQS of 266 µg/m³.
a: PC proportion of the EQS minus twice the long-term background

5.1.3 As presented in Table 25, Table 26 and Table 27, PC proportions of the 24-hour, 1-hour and 15 minute mean EQS are less than 10% at all receptor locations. Impacts can be screened out as insignificant based on the initial EA screening criteria and no further analysis is required for this pollutant.

5.1.4 Considering the above no unacceptable adverse impacts are associated with SO_2 emissions.

8-hour Rolling Mean CO

5.1.5 Predicted 8-hour rolling mean CO concentrations are summarised in Table 28.

Table 28 Predicted 8-Hour Rolling Mean CO Concentrations

Receptor	Predicted Concentration (µg/m³)		Proportion of EQS (%)	
	PC	PEC	PC	PEC
AQ1	9.43	403.43	0.09	0.10
AQ2	4.63	400.63	0.05	0.05
AQ3	5.03	401.03	0.05	0.05
AQ4	8.04	404.04	0.08	0.08
AQ5	7.92	413.92	0.08	0.08
AQ6	6.46	412.46	0.06	0.07
AQ7	4.95	398.95	0.05	0.05
AQ8	5.76	399.76	0.06	0.06

Concentrations assessed against 8-hour rolling mean EQS of 10,000µg/m³.
a: PEC proportion of the EQS minus twice the long-term background

5.1.6 As presented in Table 28, the PC proportion of the 8-hour rolling mean EQS is less than 10% at all receptor locations. Impacts can be screened out as insignificant based on the initial EA screening criteria and no further analysis is required for these averaging periods.

5.1.7 Based on these predictions no unacceptable adverse impacts are associated with CO emissions.

Annual Mean TVOC (as Benzene)

Table 29 Predicted Annual Mean Benzene Concentrations

Receptor	Predicted Concentration (µg/m³)		Proportion of EQS (%)	
	PC	PEC	PC	PEC
AQ1	0.11	0.21	**2.14**	4.16
AQ2	0.23	0.33	**4.68**	6.68
AQ3	0.15	0.25	**2.91**	4.93
AQ4	0.20	0.30	**3.98**	5.98
AQ5	0.14	0.24	**2.78**	4.82

Receptor	Predicted Concentration (µg/m³)		Proportion of EQS (%)	
	PC	PEC	PC	PEC
AQ6	0.16	0.26	**3.17**	5.21
AQ7	0.10	0.20	**2.04**	4.08
AQ8	0.11	0.21	**2.14**	4.16

Predicted concentrations were assessed against annual mean EQS of 5 µg/m³.

24-hour Mean TVOC (as Benzene)

Table 30 Predicted 24-Hour Mean Benzene Concentrations

Receptor	Predicted Concentration (µg/m³)		Proportion of EQS (%)	
	PC	PEC	PC	PEC[a]
AQ1	2.48	2.68	8.26	8.32
AQ2	1.80	2.00	6.01	6.05
AQ3	2.56	2.76	8.54	8.60
AQ4	3.63	3.83	**12.11**	12.19
AQ5	1.86	2.07	6.20	6.25
AQ6	2.05	2.25	6.83	6.88
AQ7	3.55	3.75	**11.82**	11.91
AQ8	4.53	4.74	**15.11**	15.21

Predicted concentrations were assessed against 24-hour mean EQS of 30 µg/m³.

a: PEC proportion of the EQS minus twice the long-term background

5.1.8 As presented in Table 29, PC proportions of the annual EQS are greater than 1% at all receptor locations. Impacts cannot be screened out as insignificant based on the initial EA screening criteria and further analysis is required.

5.1.9 Proceeding with the second stage of EA screening, annul mean PEC proportions are predicted to be well below 70% of the EQS at all receptor locations and annual mean impacts can be considered insignificant.

5.1.10 As presented in Table 30, PC proportions of the 24-hour mean EQS are greater than 10% at three receptor locations (AQ4, AQ7 and AQ8). Impacts cannot be screened out as insignificant based on the initial EA screening criteria and further analysis is required.

5.1.11 Proceeding with the second stage of EA screening, 24-hour mean PC proportions are less than 20% of the EQS minus twice the long-term background concentration at AQ4, AQ7 and AQ8, and impacts can be screened out as insignificant.

5.1.12 As the exact composition of TVOC is unknown, It was assumed that all TVOC emissions consist of only benzene (C_6H_6).In reality, it is anticipated that benzene emissions would represent a much smaller proportion of the total TVOC content and therefore predictions provide a worse case overestimation.

5.1.13 Considering the above no unacceptable adverse impacts are associated with TVOC emissions.

Annual Mean H_2S

Table 31 Predicted Annual Mean H_2S Concentrations

Receptor	Predicted Concentration (µg/m³)		Proportion of EQS (%)	
	PC	PEC	PC	PEC[a]
AQ1	6.10E-05	1.49	1.22E-03	1.07
AQ2	1.67E-04	1.49	3.34E-03	1.07
AQ3	1.12E-04	1.49	2.25E-03	1.07
AQ4	1.33E-04	1.49	2.65E-03	1.07
AQ5	8.63E-05	1.49	1.73E-03	1.07
AQ6	1.55E-04	1.49	3.11E-03	1.07
AQ7	6.53E-05	1.49	1.31E-03	1.07
AQ8	7.54E-05	1.49	1.51E-03	1.07

Predicted concentrations were assessed against the annual mean EQS of 140 µg/m³

1-hour Mean H_2S

Table 32 Predicted 1-Hour Mean H_2S Concentrations

Receptor	Predicted Concentration (µg/m³)		Proportion of EQS (%)	
	PC	PEC	PC	PEC[a]
AQ1	4.37E-03	2.99	2.91E-03	2.97E-03
AQ2	5.38E-03	2.99	3.59E-03	3.66E-03
AQ3	1.07E-02	3.00	7.11E-03	7.26E-03
AQ4	8.88E-03	2.99	5.92E-03	6.04E-03
AQ5	4.60E-03	2.99	3.07E-03	3.13E-03
AQ6	1.05E-02	3.00	7.00E-03	7.14E-03
AQ7	4.96E-03	2.99	3.31E-03	3.37E-03
AQ8	5.21E-03	2.99	3.47E-03	3.54E-03

Predicted concentrations were assessed against the 1-hour mean EQS of 150 µg/m³

a: PEC proportion of the EQS minus twice the long-term background.

5.1.14 As presented in Table 31 and Table 32, PC proportions of the annual and 1-hour EQS are less than 1% and 10%, respectively, at all receptor locations. Impacts can be screened out as insignificant based on the initial EA screening criteria and no further analysis is required for these averaging periods.

5.1.15 Based on these predictions no unacceptable adverse impacts are associated with H_2S emissions.

5.2 Ecological Receptors

Annual Mean NO_x

Table 33 Predicted Annual Mean NO_x Concentrations

Receptor	Predicted Concentration (µg/m³)		Proportion of EQS (%)	
	PC	PEC	PC	PEC
E1a	0.01	6.15	0.04	20.51
E1b	0.01	6.15	0.03	20.50
E2	0.01	5.94	0.03	19.80
E3	2.50E^{-03}	6.29	0.01	20.97

Predicted concentrations assessed against the relevant CLV: 30 µg/m³.

24-hour Mean NO_x

Table 34 Predicted 24-Hour Mean NO_x Concentrations

Receptor	Predicted Concentration (µg/m³)		Proportion of EQS (%)	
	PC	PEC	PC	PEC
E1a	0.21	12.49	0.28	16.65
E1b	0.23	12.51	0.30	16.68
E2	0.16	12.02	0.21	16.03
E3	0.06	12.64	0.08	16.85

Predicted concentrations assessed against the relevant CLV: 75 µg/m³.

5.2.1 As presented in Table 33 and Table 34, PC proportions of the annual and 24-hour EQS are less than 1% and 10%, respectively, at all receptor locations. Impacts can be screened out as insignificant based on the initial EA screening criteria and no further analysis is required for these averaging periods.

5.2.2 Based on these predictions no unacceptable adverse ecological impacts are associated with NO_x emissions.

Annual Mean SO_2

Table 35 Predicted Annual Mean SO_2 Concentrations

Receptor	Predicted Concentration (µg/m³)		Proportion of EQS (%)	
	PC	PEC	PC	PEC
E1a	2.679E^{-03}	0.78	0.03	7.83
E1b	2.37E^{-03}	0.78	0.02	7.82
E2	2.30E^{-03}	0.68	0.02	6.82
E3	5.64E^{-04}	0.85	0.01	8.51

Predicted concentrations assessed against the CL of 20 µg/m³

5.2.3 As presented in Table 35, PC proportions of the annual mean EQS are below 1% at all receptor locations and can be screened as insignificant based on the initial EA screening criteria.

5.2.4 Based on these predictions no adverse ecological impacts are associated with SO_2 emissions.

Annual Mean NH_3

Table 36 Predicted Annual Mean NH_3 Concentrations

Receptor	Predicted Concentration (µg/m^3)		Proportion of EQS (%)	
	PC	PEC	PC	PEC
E1a	1.42E^{-03}	3.00	0.14	**300.14**
E1b	1.35E^{-03}	3.00	0.13	**300.13**
E2	9.64E^{-04}	2.48	0.10	**248.10**
E3	2.36E^{-04}	2.84	0.02	**284.02**

Predicted concentrations assessed against the CL of 1 µg/m^3, to reflect the presence of Lichen or Bryophytes

5.2.5 As presented in Table 35, PC proportions of the annual mean EQS are below 1% at all receptor locations. Impacts can be screened out as insignificant based on the initial EA screening criteria and no further analysis is required for these averaging periods.

5.2.6 Analysis of the PECs indicates that the CLV is exceeded at all locations; however, this as a result of existing elevated background concentrations. Notwithstanding this, impacts can be screened out as insignificant and no further analysis is required.

5.2.7 Based on these predictions no unacceptable adverse ecological impacts are associated with NH_3 emissions.

Nitrogen Deposition

5.2.8 Predicted annual mean nitrogen deposition rates are summarised in Table 37.

Table 37 Predicted Annual Mean Nitrogen Deposition Rates

Receptor	Predicted Deposition Rate (kgN/ha/yr)		Proportion of EQS (%)			
			Low EQS		High EQS	
	PC	PEC	PC	PEC	PC	PEC
0.01	0.01	33.66	0.14	**336.64**	0.10	**224.43**
0.01	0.01	19.86	0.06	**132.39**	0.03	**79.43**
0.01	0.01	28.67	0.10	**286.70**	0.07	**191.14**
E3	1.59E^{-03}	15.99	0.03	**319.83**	0.02	**159.92**

5.2.9 As presented in Table 37, the PC proportions of the Low EQS are below 1% at all receptor locations. Analysis of the PECs indicates that CLDs are exceeded; however, this as a result of existing elevated background concentrations. Notwithstanding this, impacts can be screened out as insignificant and no further analysis is required.

5.2.10 Based on these predictions it is judged that no unacceptable adverse ecological impacts are associated with annual mean N deposition.

Acid Deposition

Table 38 Predicted Annual Mean Acid Deposition Rates

ID	Predicted Deposition Rate (keq/ha/yr)			% of Critical Load Function	
	S	N	Total	PC	PEC
E1a	0.0006	0.0010	0.0017	0.14	**290.02**
E1b	0.0003	0.0006	0.0009	0.15	**315.94**
E2	0.0005	0.0007	0.0013	0.01	27.57

ID	Predicted Deposition Rate (keq/ha/yr)			% of Critical Load Function	
	S	N	Total	PC	PEC
E3	0.0001	0.0001	0.0002	0.00	35.22

5.2.11 As presented in Table 38, the PC proportion of the EQS are below 1% at all receptor locations and impacts can be screened as insignificant based on the initial EA screening criteria. Analysis of the PECs indicate that the CLD is exceeded at ER1; however, this as a result of existing elevated background concentrations. Notwithstanding this, impacts can be screened out as insignificant and no further analysis is required.

5.2.12 Based on these predictions it is judged that no unacceptable adverse ecological impacts are associated with annual mean acid deposition.

6.0 Conclusions

6.1.1 Dispersion modelling was undertaken using the ADMS 5 modelling software. Impacts at human and ecological sensitive receptors were predicted with results compared against industry significance criteria provided by the EA.

6.1.2 Impacts were based on the Facility emitting the maximum permitted pollutant concentration for a full calendar year, as well the use of the maximum predicted concentrations over 5 assessment years. As such, predicted concentrations are likely to be a significant overestimation of actual impacts.

6.1.3 Predicted annual mean PCs at human receptors did not exceed 1% of the EQS. In the case of short-term impacts PCs did not exceed 20% of EQS minus twice the background concentration. On that basis, impacts on pollutant concentrations at all human locations were considered not significant.

6.1.4 Concerning ecological impacts, NO_x, SO_2 and NH_3 PC proportions were screened as insignificant. The CLDs for nitrogen and acid deposition were exceeded as a baseline condition at all designations however the PC proportions from the Facility were below 1% and could be screened out as insignificant using the initial EA screening criteria. Therefore, it is unlikely that adverse impacts would be present at ecological designations as a result of the facility.

6.1.5 Based on the predictions and the use of conservative assumptions, such as worse case emission limit values and meteorological conditions over a 5-year period, it is considered that the overall air quality impacts of the Facility would be not significant.

6.1.6 In terms of air quality, the proposal is therefore considered acceptable for planning and permitting purposes.

7.0 Abbreviations

%ile	Percentile
AAD	Ambient Air Directive
AD	Anaerobic Digestion
ADM	Atmospheric Dispersion Modelling
ADMS	Atmosphere Dispersion Modelling Software
APIS	Air Pollution Information System
AQA	Air Quality Assessment
AQLV	Air Quality Limit Value
AQMA	Air Quality Management Area
AQO	Air Quality Objective
AQS	Air Quality Strategy
AQTAG	Air Quality Technical Advisory. Group.
AW	Ancient Woodland
BAT	Best Available Techniques
C_6H_6	Benzene
CERC	Cambridge Environmental Research Consultants
CHP	Combined Heat and Power
CL	Critical Load/Level
CO	Carbon Monoxide
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency
EAL	Environmental Assessment Levels
ELV	Emission Limit Value
EP	Environmental Permit
EQS	Environmental Quality Standard
FYM	Farmyard Manure
H_2S	Hydrogen Sulphide
LNR	Local Nature Reserve
LWS	Local Wildlife Site
MAGIC	Multi-Agency Geographic Information for the Countryside
MCERT	Monitoring Certification Scheme
N	Nitrogen
NGR	National Grid Reference
NH_3	Ammonia
NNR	National Nature Reserve
NO_2	Nitrogen Dioxide
O_2	Oxygen
PC	Process Contribution
PEC	Predicted Environmental Concentration
PPM	Part per Million
PRV	Pressure Release Valve
S	Sulphur
SAC	Special Area of Conservation
SO_2	Sulphur Dioxide
SPA	Special Protection Area
SSSI	Site of Special Scientific Importance
TVOC	Total Volatile Organic Compounds
z_0	Roughness Length
%ile	Percentile

Appendix A Pollutant Contours

Legend

Site Boundary

Modelled Building Layout

Predicted Annual Mean NO_2 Concentration (µg/m³)

6.4 8.0 10.0 12.0 14.0 16.0

Figure 6 Predicted Annual Mean NO_2 Concentration (µg/m³)

Project Reference

CRM.0163.001.AQ.001

Burton Agnes Biogas Plant

enzygo environmental consultants

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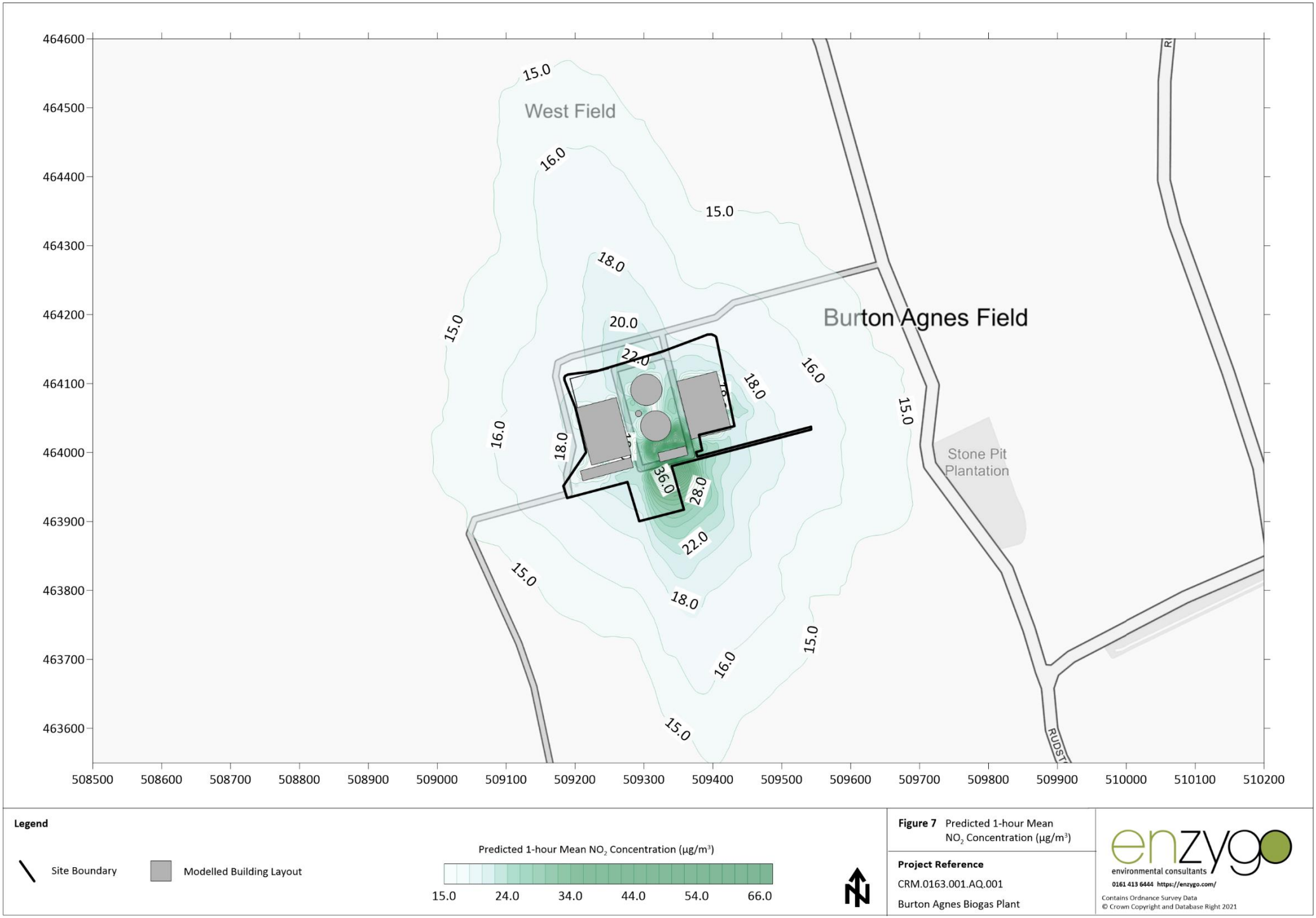

Figure 7 Predicted 1-hour Mean NO_2 Concentration (µg/m³)

Project Reference

CRM.0163.001.AQ.001

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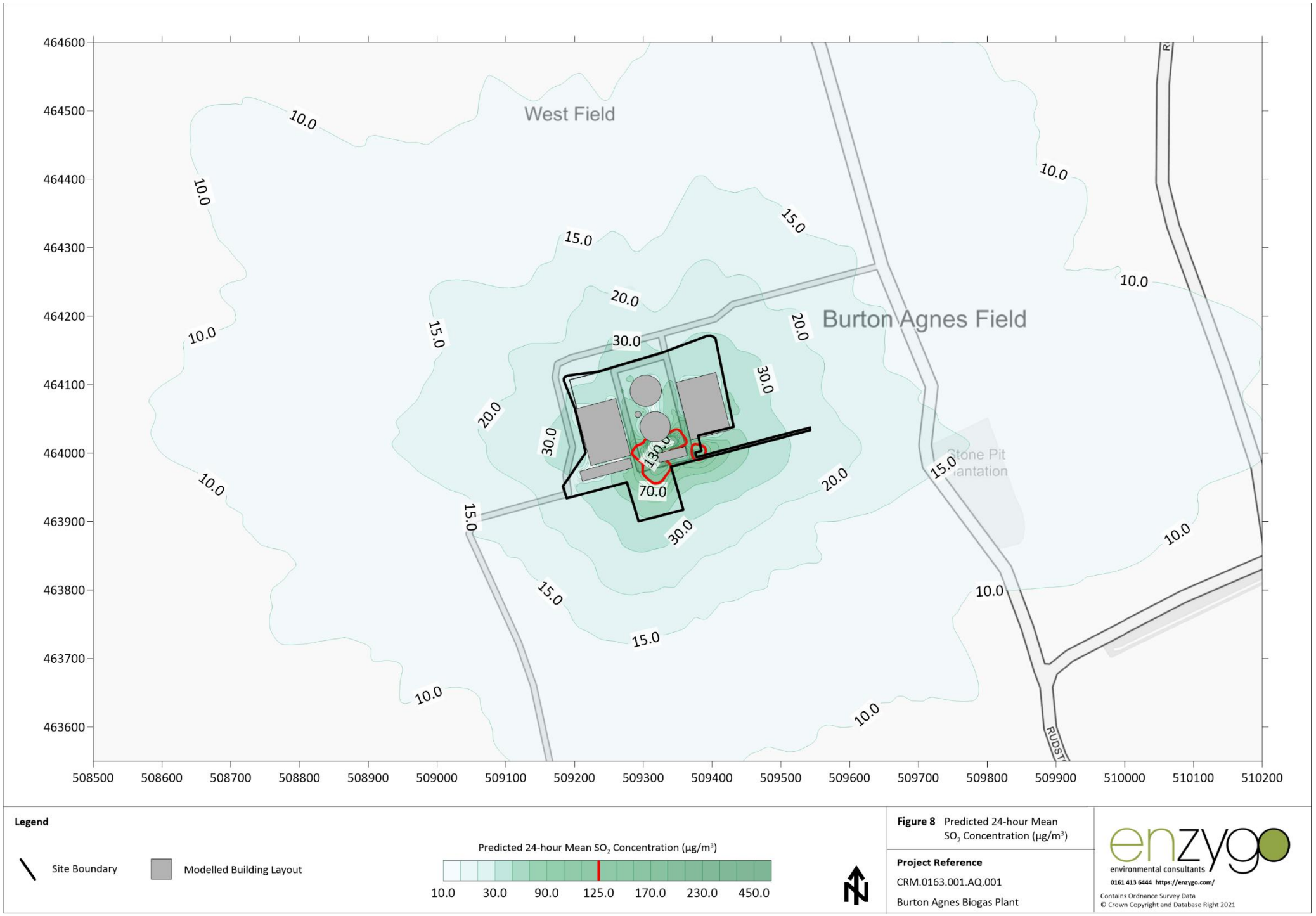

Figure 8 Predicted 24-hour Mean SO_2 Concentration (µg/m³)

Project Reference

CRM.0163.001.AQ.001

Burton Agnes Biogas Plant

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Figure 9 Predicted 1-hour Mean SO_2 Concentration (µg/m³)

Project Reference

CRM.0163.001.AQ.001

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Legend

Site Boundary

Modelled Building Layout

Predicted 15-minute Mean SO_2 Concentration (µg/m³)

25 80 160 240 320 600

Figure 10 Predicted 15-minute Mean SO_2 Concentration (µg/m³)

Project Reference

CRM.0163.001.AQ.001

Burton Agnes Biogas Plant

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Legend

Site Boundary

Modelled Building Layout

Predicted 8-hour Mean CO Concentration (µg/m³)

425 550 700 850 1000 1150 1300

Figure 11 Predicted 8-hour Mean CO Concentration (µg/m³)

Project Reference

CRM.0163.001.AQ.001

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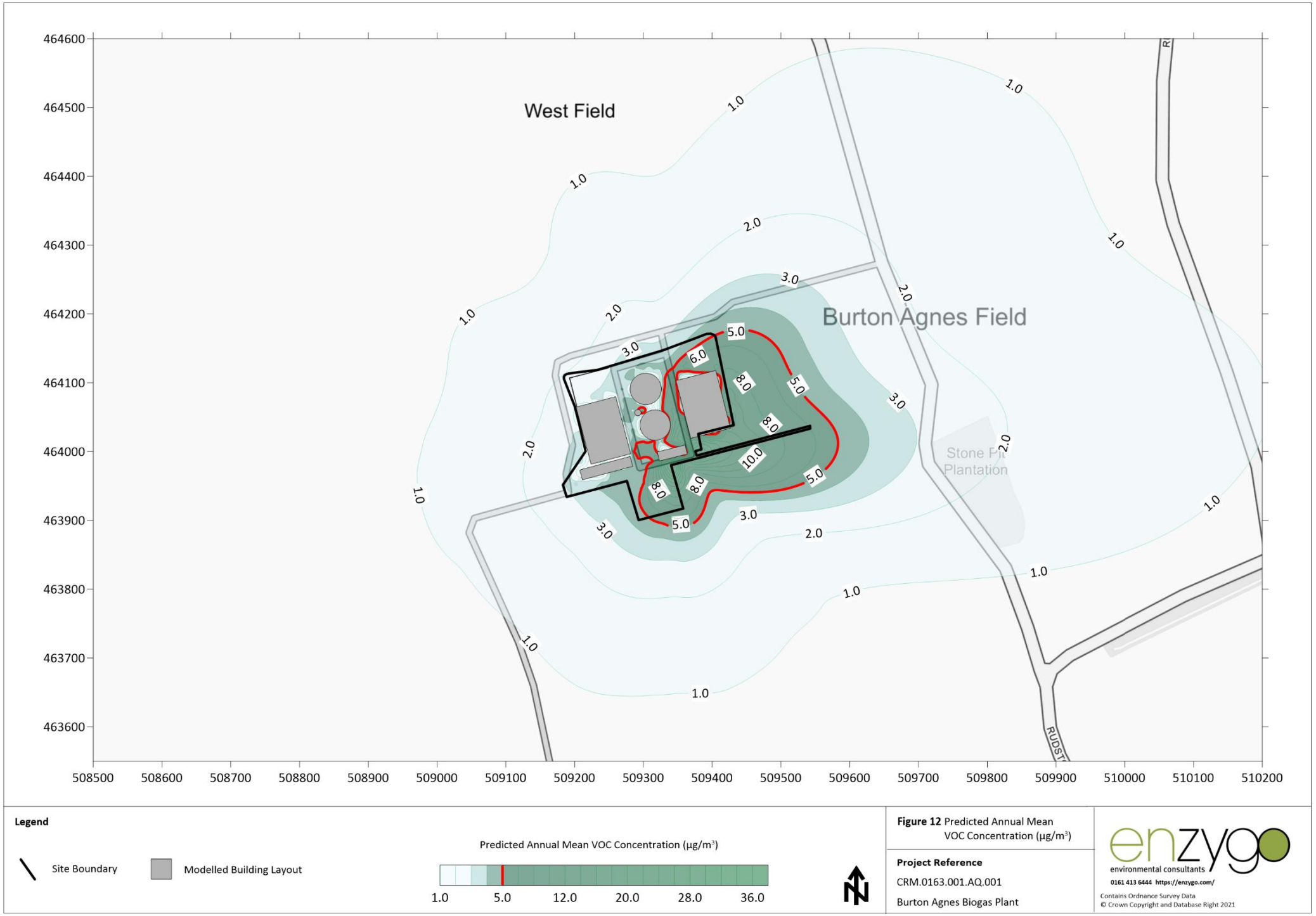

Legend

Site Boundary

Modelled Building Layout

Predicted Annual Mean VOC Concentration (µg/m³)

1.0 5.0 12.0 20.0 28.0 36.0

Figure 12 Predicted Annual Mean VOC Concentration (µg/m³)

Project Reference

CRM.0163.001.AQ.001

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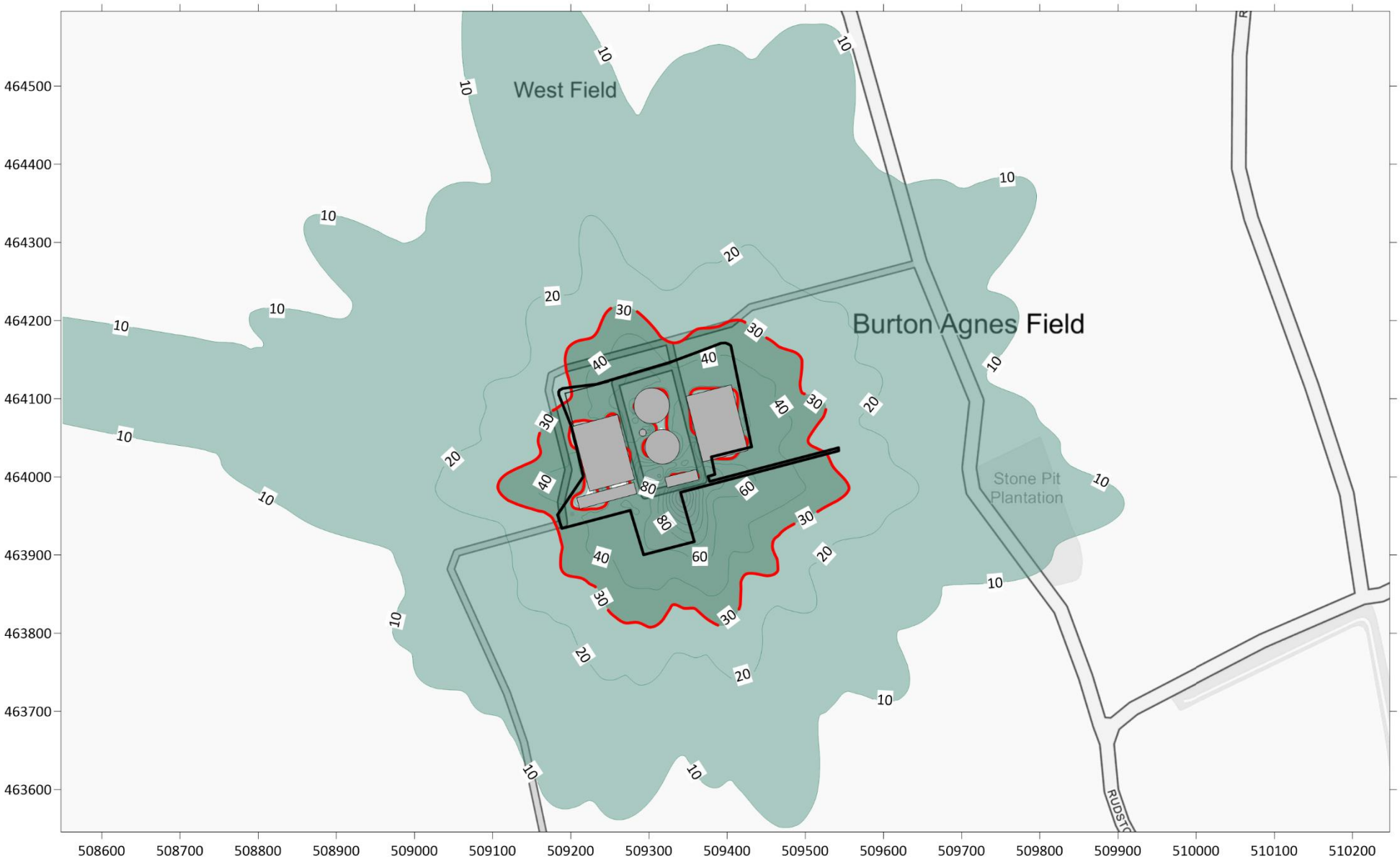

Legend

Site Boundary

Modelled Building Layout

Predicted 24-hour Mean VOC Concentration (µg/m³)

10 30 60 100 140 180 220 260 300

Figure 13 Predicted 24-hour Mean VOC Concentration (µg/m³)

Project Reference

CRM.0163.001.AQ.001

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Legend

Site Boundary

Modelled Building Layout

Predicted Annual Mean H_2S Concentration (µg/m^3)

1.50 1.55 1.60 1.65

Figure 14 Predicted Annual Mean H_2S Concentration (µg/m^3)

Project Reference

CRM.0163.001.AQ.001

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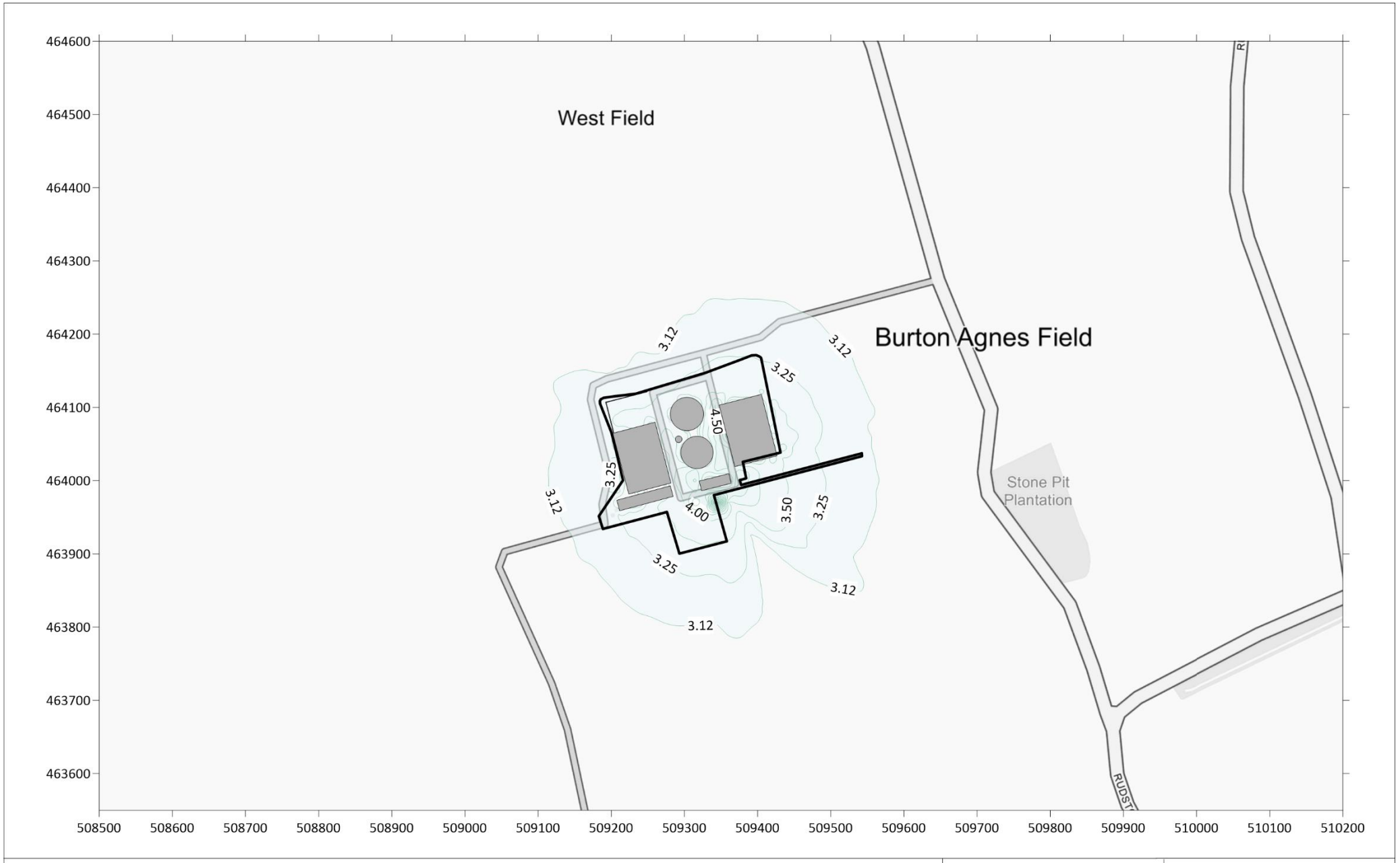

Legend

Site Boundary

Modelled Building Layout

Predicted 1-hour Mean H_2S Concentration (µg/m³)

3.12 4.50 6.50 8.50 10.50

Figure 15 Predicted 1-hour Mean H_2S Concentration (µg/m³)

Project Reference

CRM.0163.001.AQ.001

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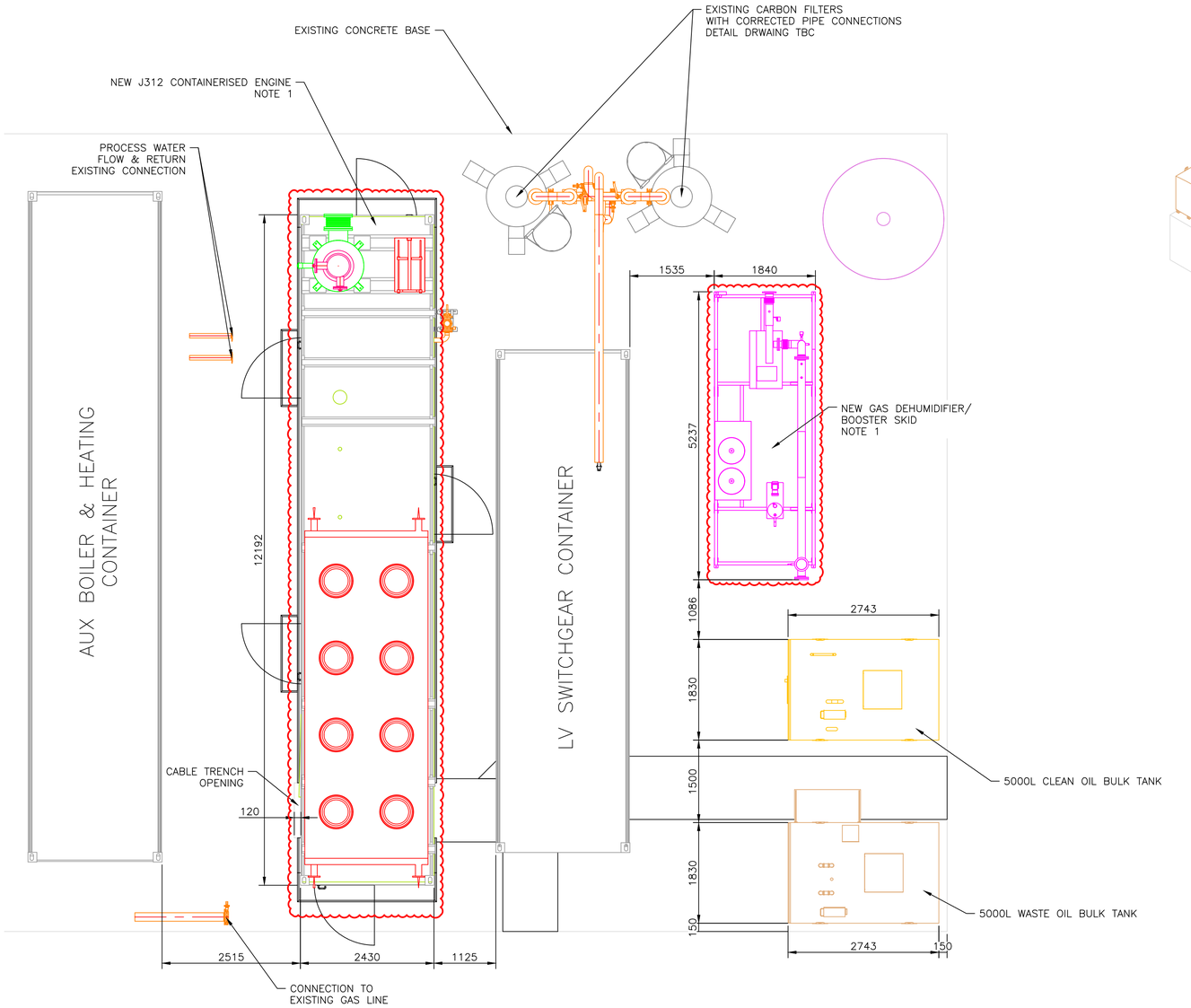
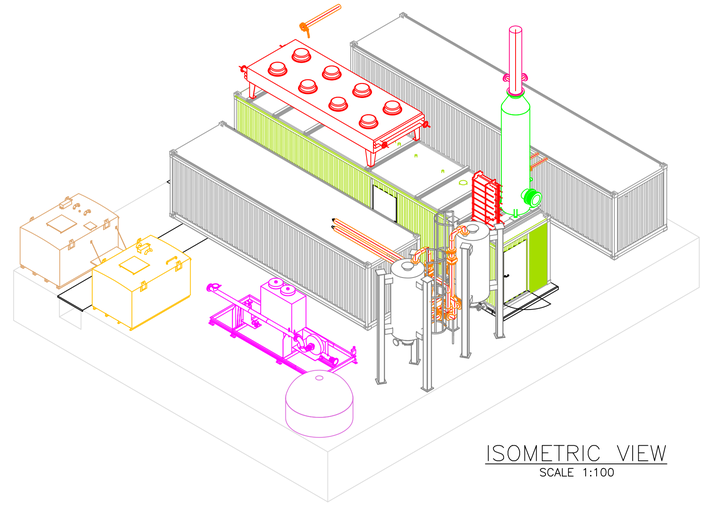
Appendix C – Replacement CHP Technical Specification Sheet

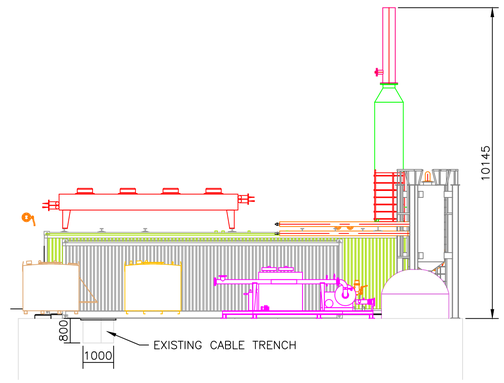
DRAWING No.	C5217-GA-001	DO NOT SCALE	IF IN DOUBT ASK	REMOVE ALL SHARP EDGES	ALL DIMENSIONS IN mm UNLESS OTHERWISE STATED



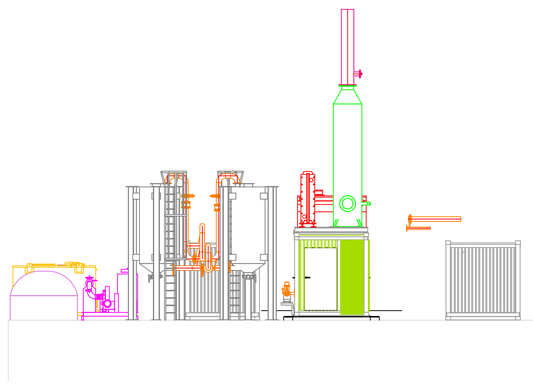
PLAN VIEW
SCALE 1:50



ISOMETRIC VIEW
SCALE 1:100



SIDE ELEVATION
SCALE 1:100



FRONT ELEVATION
SCALE 1:100

NOTES:

1. ENGINE CONTAINER & GAS DEHUMIDIFIER/BOOSTER SKID SHOWN INDICATIVE ONLY AT THIS STAGE.
2. DIESEL TANK MOVED FROM ORIGINAL POSITION TO CREATE MORE SPACE FOR GAS DEHUMIDIFIER/BOOSTER SKID.
3. OIL BULK TANKS REPLACE EXISTING DIESEL GENERATOR AND DIESEL TANK.
4. EXISTING PROCESS WATER LINE FLOW AND RETURN CONNECTIONS TBA.
5. FOR NEW ENGINE PLINTH DETAILS PLEASE SEE DRAWING C5217-C-001.
6. FOR EXISTING CARBON FILTER PIPE CORRECTION PLEASE SEE DRAWING C5217-XX-XXX.
7. STACK HEIGHT TBA.

PRELIMINARY ISSUE

ALL EQUIPMENT & DIMENSIONS SHOWN ARE INDICATIVE ONLY

UNDER NO CIRCUMSTANCE IS THIS DRAWING TO BE USED FOR CONSTRUCTION OR FABRICATION AT THIS ISSUE

REV	AMENDMENT	BY.	E.CHK	M.CHK	APP.	DATE.
PA	PRELIMINARY ISSUE	DK	-	JP	HP	03.05.23

KEY TO FIRST LETTER OF DRAWING ISSUE.
'B' = AS-BUILT ISSUE
'A' = CONSTRUCTION ISSUE
'P' = PRELIMINARY ISSUE
'T' = TENDER ISSUE

FABRICATION/BUILD ONLY TO BE UNDERTAKEN AT CONSTRUCTION ISSUE

Clarke Energy
A KOHLER COMPANY
Engineer - Install - Maintain

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TITLE	GENERAL ARRANGEMENT OF EXISTING SITE WITH NEW J312 CONTAINERISED ENGINE & EQUIPMENT
CLIENT	BURTON AGNES RENEWABLES LTD
SITE	BURTON AGNES

PAPER SIZE.	A1	SCALE.	AS SHOWN	
DRAWN BY.	DANIEL K	DATE DRAWN.	28.04.23	ISSUE.
DRAWING NO.	C5217-GA-001			PA

THIS ASSEMBLY OR PART MUST COMPLY WITH KOHLER SPECIFICATION "PEP-RML-001 RESTRICTED MATERIAL LIST"

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JENBACHER

Technical Description

Cogeneration Unit-Container

JMC 312 GS-B.L

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

Burton Agnes

Electrical output	548	kW el.
Thermal output	543	kW

Emission values

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

0.01 Technical Data (container)

			100%	75%	50%
Power input	[2]	kW	1.315	1.017	719
Gas volume	*)	Nm³/h	292	226	160
Mechanical output	[1]	kW	567	425	283
Electrical output	[4]	kW el.	548	411	272
Recoverable thermal output (calculated with Glykol 37%)					
~ Intercooler 1st stage	[9]	kW	55	28	11
~ Lube oil		kW	58	46	33
~ Jacket water		kW	182	164	129
~ Exhaust gas cooled to 180 °C		kW	248	202	154
Total recoverable thermal output	[5]	kW	543	440	327
Total output generated		kW total	1.091	850	599
Heat to be dissipated (calculated with Glykol 37%)					
~ Intercooler 2nd stage		kW	51	26	6
~ Lube oil		kW	---	---	---
~ Surface heat	ca. [7]	kW	54	~	~
Spec. fuel consumption of engine electric	[2]	kWh/kWel.h	2,40	2,48	2,64
Spec. fuel consumption of engine	[2]	kWh/kWh	2,32	2,39	2,54
Lube oil consumption	ca. [3]	kg/h	0,17	~	~
Electrical efficiency			41,7%	40,4%	37,8%
Thermal efficiency			41,3%	43,2%	45,5%
Total efficiency	[6]		82,9%	83,6%	83,3%
Hot water circuit:					
Forward temperature		°C	90,0	86,2	82,0
Return temperature		°C	70,0	70,0	70,0
Hot water flow rate		m³/h	26,1	26,1	26,1
Fuel gas LHV		kWh/Nm³	4,5		

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

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

Main dimensions and weights (container)

Length	mm	~ 12.200
Width	mm	2500-3000
Height	mm	~ 2.600
Weight empty	kg	~ 20.800
Weight filled	kg	~ 21.900

Connections

Hot water inlet and outlet [A/B]	DN/PN	80/10
Exhaust gas outlet [C]	DN/PN	250/10
Fuel gas connection (container) [D]	DN/PN	100/16
Fresh oil connection	G	28x2"
Waste oil connection	G	28x2"
Cable outlet	mm	800x400
Condensate drain	mm	18

Output / fuel consumption

ISO standard fuel stop power ICFN	kW	567
Mean effe. press. at stand. power and nom. speed	bar	15,53
Fuel gas type		Biogas
Based on methane number | Min. methane number	MZ	135 | 117 d)
Compression ratio	Epsilon	16
Min./Max. fuel gas pressure at inlet to gas train	mbar	80 - 200 c)
Max. rate of gas pressure fluctuation	mbar/sec	10
Maximum Intercooler 2nd stage inlet water temperature	°C	42
Spec. fuel consumption of engine	kWh/kWh	2,32
Specific lube oil consumption	g/kWh	0,30
Max. Oil temperature	°C	~ 90
Jacket-water temperature max.	°C	~ 95
Filling capacity lube oil (refill)	lit	~ 216

c) Lower gas pressures upon inquiry
d) based on methane number calculation software AVL 3.2

0.02 Technical data of engine

Manufacturer		JENBACHER
Engine type		J 312 GS-D225
Working principle		4-Stroke
Configuration		V 70°
No. of cylinders		12
Bore	mm	135
Stroke	mm	170
Piston displacement	lit	29,20
Nominal speed	rpm	1.500
Mean piston speed	m/s	8,50
Length	mm	2.400
Width	mm	1.457
Height	mm	2.065
Weight dry	kg	3.200
Weight filled	kg	3.530
Moment of inertia	kgm²	7,77
Direction of rotation (from flywheel view)		left
Radio interference level to VDE 0875		N
Starter motor output	kW	7
Starter motor voltage	V	24

Thermal energy balance

Power input	kW	1.315
Intercooler	kW	106
Lube oil	kW	58
Jacket water	kW	182
Exhaust gas cooled to 180 °C	kW	248
Exhaust gas cooled to 100 °C	kW	318
Surface heat	kW	29

Exhaust gas data

Exhaust gas temperature at full load [8]	°C	450
Exhaust gas temperature at bmep= 11,7 [bar]	°C	~ 471
Exhaust gas temperature at bmep= 7,8 [bar]	°C	~ 500
Exhaust gas mass flow rate, wet	kg/h	2.935
Exhaust gas mass flow rate, dry	kg/h	2.730
Exhaust gas volume, wet	Nm³/h	2.292
Exhaust gas volume, dry	Nm³/h	2.038
Max.admissible exhaust back pressure after engine	mbar	60

Combustion air data

Combustion air mass flow rate	kg/h	2.709
Combustion air volume	Nm³/h	2.097
Max. admissible pressure drop at air-intake filter	mbar	10

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

Sound pressure level

Aggregate a)			dB(A) re 20µPa		95	
31,5	Hz		dB		80	
63	Hz		dB		87	
125	Hz		dB		91	
250	Hz		dB		91	
500	Hz		dB		90	
1000	Hz		dB		89	
2000	Hz		dB		86	
4000	Hz		dB		86	
8000	Hz		dB		89	
Exhaust gas b)			dB(A) re 20µPa		115	
31,5	Hz		dB		108	
63	Hz		dB		119	
125	Hz		dB		113	
250	Hz		dB		117	
500	Hz		dB		112	
1000	Hz		dB		111	
2000	Hz		dB		103	
4000	Hz		dB		101	
8000	Hz		dB		98	

Sound power level

Aggregate	dB(A) re 1pW	115
Measurement surface	m²	97
Exhaust gas	dB(A) re 1pW	123
Measurement surface	m²	6,28

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

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

0.03 Technical data of generator

Manufacturer		STAMFORD e)
Type		CG 634 H e)
Type rating	kVA	731
Driving power	kW	567
Ratings at p.f. = 1,0	kW	548
Ratings at p.f. = 0,8	kW	542
Rated output at p.f. = 0,8	kVA	678
Rated reactive power at p.f. = 0,8	kVar	407
Rated current at p.f. = 0,8	A	979
Frequency	Hz	50
Voltage	V	400
Speed	rpm	1.500
Permissible overspeed	rpm	1.800
Power factor (lagging - leading) (UN)		0,8 - 0,95
Efficiency at p.f. = 1,0		96,6%
Efficiency at p.f. = 0,8		95,7%
Moment of inertia	kgm²	19,50
Mass	kg	2.145
Radio interference level to EN 55011 Class A (EN 61000-6-4)		N
Cable outlet		~
Ik'' Initial symmetrical short-circuit current	kA	8,13
Is Peak current	kA	20,70
Insulation class		H
Temperature (rise at driving power)		F
Maximum ambient temperature	°C	40

Reactance and time constants at rated output (saturated)

xd direct axis synchronous reactance	p.u.	2,012
xd' direct axis transient reactance	p.u.	0,171
xd'' direct axis sub transient reactance	p.u.	0,119
x2 negative sequence reactance	p.u.	0,134
Td'' sub transient reactance time constant	ms	30
Ta Time constant direct-current	ms	40
Tdo' open circuit field time constant	s	2,44

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

0.04 Technical data of heat recovery

General data - Hot water circuit

Total recoverable thermal output	kW	543
Return temperature	°C	70,0
Forward temperature	°C	90,0
Hot water flow rate	m³/h	26,1
Nominal pressure of hot water	PN	10
min. operating pressure	bar	3,5
max. operating pressure	bar	9,0
Pressure drop hot water circuit	bar	0,80
Maximum Variation in return temperature	°C	+0/-5
Max. rate of return temperature fluctuation	°C/min	10

General data - Cooling water circuit

Heat to be dissipated (calculated with Glykol 37%)	kW	51
Return temperature	°C	42
Cooling water flow rate	m³/h	15
Nominal pressure of cooling water	PN	10
min. operating pressure	bar	0,5
max. operating pressure	bar	5,0
Loss of nominal pressure of cooling water	bar	~
Maximum Variation in return temperature	°C	+0/-5
Max. rate of return temperature fluctuation	°C/min	10

Exhaust gas heat exchanger

Type	shell-and-tube

PRIMARY:

Exhaust gas pressure drop approx	bar	0,02
Exhaust gas connection	DN/PN	250/10

SECONDARY:

Pressure drop hot water circuit	bar	0,20
Hot water connection	DN/PN	80/10

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

JENBACHER

connection variant C

J 312 GS-D225

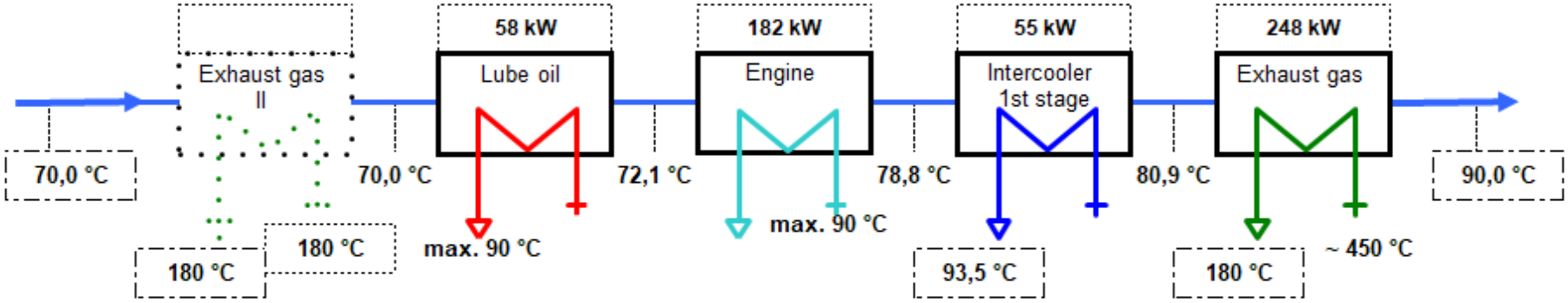
Hot water circuit (calculated with Glykol 37%)

Recoverable thermal output = 543 kW

(+12/-8 % tolerance)

Hot water flow rate = 26,1 m³/h

CUSTOMER SIDE 65-85°C

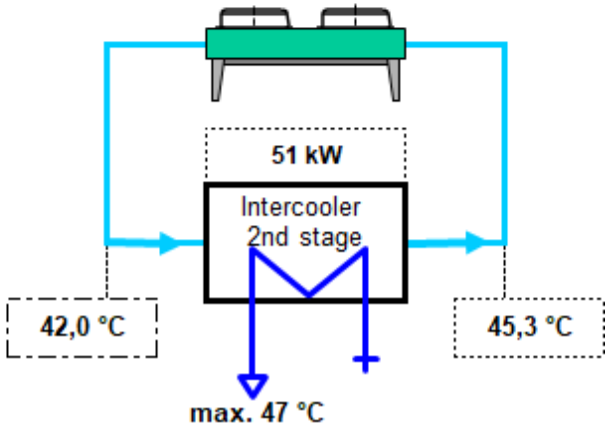


Low temperature circuit (calculated with Glykol 37%)

Heat to be dissipated = 51 kW

(+12/-8 % tolerance)

Cooling water flow rate = 15,0 m³/h



0.10 Technical parameters

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

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

[1] At nominal speed and standard reference conditions ICFN according to ISO 3046-1, respectively
[2] According to ISO 3046-1, respectively, with a tolerance of +**5** %.
Efficiency performance is based on a new unit (immediately upon commissioning).Effects of degradation during normal operation can be mitigated through regular service and maintenance work. The power output reference in point (1) and the power input referenced in point (2) are only valid according to the following criteria:
CH4~65Vol%; CO2~35Vol% and total sulphur <200mg/10kWh as well as the limits according to TA-1000-0300
[3] Average value between oil change intervals according to maintenance schedule, without oil change amount
[4] At p. f. = 1.0 according to IEC 60034-1:2017 with relative tolerances, all direct driven pumps are included
[5] Total output with a tolerance of +12/-8 %
[6] According to above parameters [1] through [5]
[7] As a guiding value at p.f. 0.8 and only valid for (engine, generator, TCM). Other peripheral equipment is not considered.
[8] Exhaust temperature with a tolerance of ±8 %
Note: an optimised operating mode to minimise methane slip can result in changed exhaust gas data (exhaust gas temperature, NOx emissions, etc.) and must be taken into account in the design of the exhaust gas aftertreatment
[9] Intercooler heat on:
*** standard conditions** - If the turbocharger design is done for air intake temperature > 30°C w/o de-rating, the intercooler heat of the 1st stage need to be increased by 2%/°C starting from 25°C. Deviations between 25 – 30°C will be covered with the standard tolerance.
*** Hot Country application (V1xx)** - If the turbocharger design is done for air intake temperature > 40°C w/o de-rating, the intercooler heat of the 1st stage need to be increased by 2%/°C starting from 35°C. Deviations between 35 – 40°C will be covered with the standard tolerance.

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

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

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

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

Loss of engine performance

a) Performance reduction due to gas quality

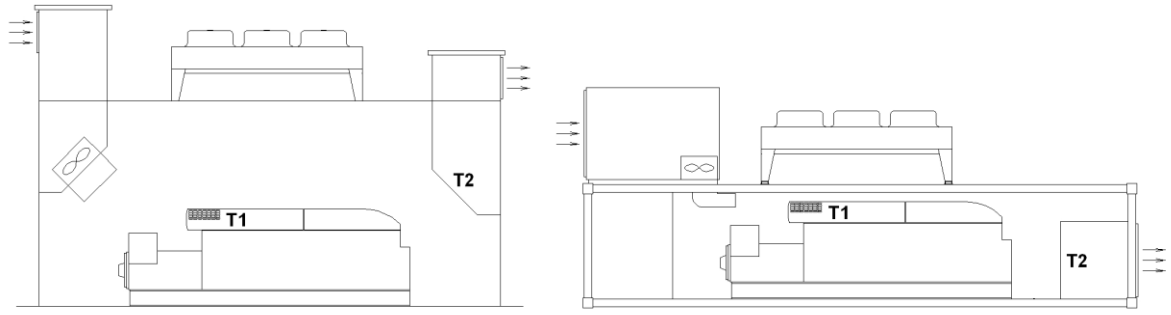
If the reference methane number is not reached and the knock control responds, the ignition timing at full performance is adjusted in conjunction with the engine management system; only then is performance reduced.

b) Performance reduction due to voltage and frequency limits

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

c) Performance reduction due to environmental conditions

Standard rating of the engines is for an installation at an altitude ≤ **500 m** and combustion air temperature ≤ **30 °C** (T1)
Engine room outlet temperature: **50°C** (T2) -> engine stop



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

Parameters for the operation of JENBACHER gas engines

The genset fulfils the limits for mechanical vibrations according to ISO 8528-9.
The following forms an integral part of a contract and must be strictly observed: **TA 1000-0004, TA 1100 0110, TA 1100-0111**, and **TA 1100-0112.**
Transport by rail should be avoided. See **TA 1000-0046** for further details

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

Ready for H2 means the genset can generally be converted to 100% H2 operation in future. Details on cost and timeline of a future conversion package may vary and need to be clarified individually.

Parameters for the operation of control unit and the electrical equipment

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

Parameters for using a gas compressor

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

- Actual gas temperature (limiting temperature according to **TA 1000-0300**)
- Gas humidity (limiting value according to **TA 1000-0300**)
- Gas Pressure
- Calorific value variations (can be equated with methane (CH4) variations in the case of biogas)
- The gas compressor is designed for a max. relative under pressure of 15 mbar(g) (0.22 psi) and a inlet temperature of 40°C (104°F) , if within scope of supply JENBACHER.

0.20 Mode of Operation

Grid Parallel Mode

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

Procedure in the event of mains failure:

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

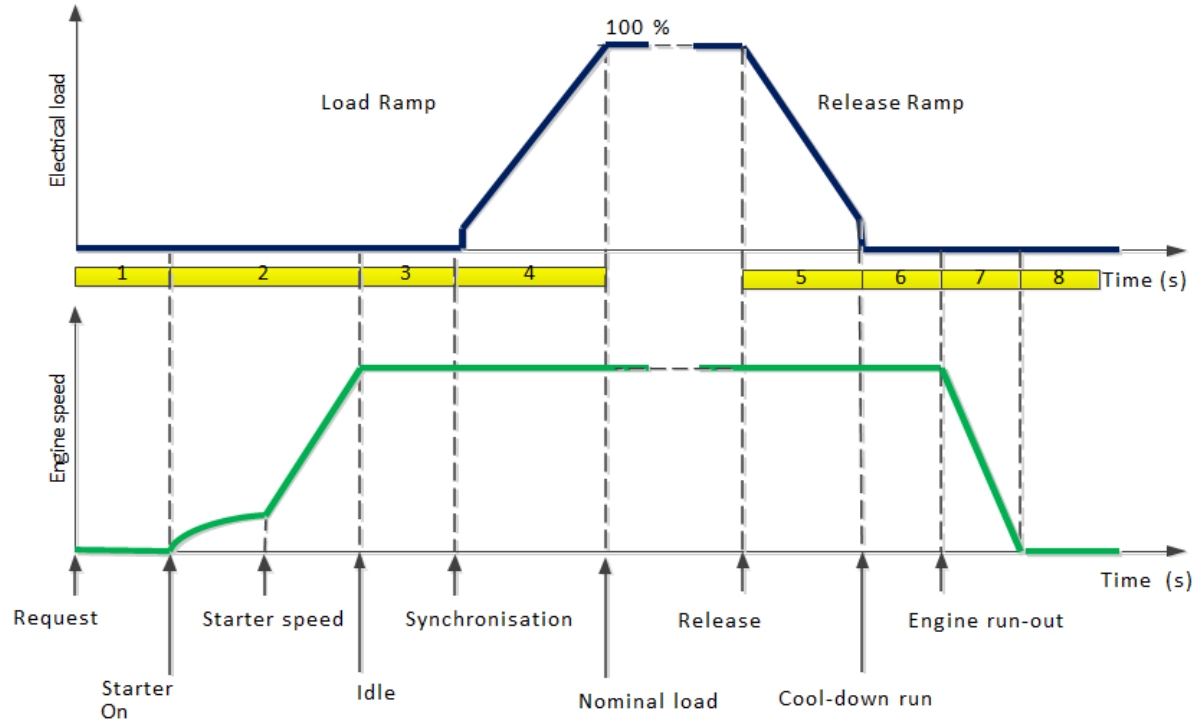
Island operation is not available in this case!

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

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

Basic boundary conditions for engine start:

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



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

Deviations are possible for special designs.

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

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

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

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

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

0.30 General information for connection to the public mains

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

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

0.30.10 Generator operating range in mains parallel operation

Frequency:
Normal operation fn +/-2% - without power output reduction
Extended operation: fn +4/-6%- with power output reduction between 2 – 10%/Hz
Frequency-measurement resolution: <= 10mHz (resolution)
Generator - voltage range: +/-10% of generator Un
Generator power factor cos phi at the generator terminals: as specified in "0.03 Generator technical data"

FRT (Fault Ride Through) – capability: at mains connection point
Profile 1: 150ms/30%Un (applies to natural gas and biogas)
Profile 2 (150ms/5%Un) and Profile 3 (250ms/5%Un) upon request.

Requirement:
- mains short-circuit power must be at least 5 x SrE or 50MVA

- FRT capability of the onsite auxiliaries

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

0.30.20 Possible mains operator requests

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

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

- Selectivity assessment, protection tests and recurring tests: on-site by the system operator
- Control power provision via pool operator: on request e.g., primary, secondary, tertiary
- Black start capability and countering in own use: on request
- Power generation system (EZA) controller or central control: on-site or possible on request
- Process data scope / remote control:
  - System data must be provided by the connectee for the mains operator.
  - Remote control interface to the mains operator: on-site
  - Interface specification!

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

Models of genset and generator: simplified models executed as effective value models for mains parallel operation optionally available.
Model formats: Powerfactory, or PSS/E (as of PP23)
Validated genset models in Powerfactory according to FGW TR3, TR4 and TR8 by a body accredited for this purpose according to DIN EN ISO/IEC 17065

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

0.30.20.01 Active power adjustment in the event of overfrequency and underfrequency

The following functions are available:
- LFSM-U: Limited Frequency Sensitive Mode - Underfrequency
- LFSM-O: Limited Frequency Sensitive Mode - Overfrequency
- FSM

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

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

Power increase in the event of underfrequency (LFSM-U function) – (OPTIONAL as of XT4.5)
activated according to the mains operator's specifications
The frequency-sensitive active power feed-in has the effect that the generating plant
also moves permanently up and down on the frequency characteristic curve ("driving on the characteristic curve") in the frequency range between fn - 200mHz (unless otherwise specified by the mains) and fn - 2.5Hz with regard to its maximum possible active power feed-in.
The prerequisite for this is a corresponding power setpoint.

Reduced power output at underfrequency:
below 98% of fn, reduction by standard 10% of maximum capacity per Hz. Reduction up to maximum fn - 6%.
Lower reduction ramps of 2 - 10%/Hz on request
The FSM function is available as an option

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

1.00 Scope of supply - module

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

1.01 Spark ignited gas engine

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

LEANOX® LEAN-BURN COMBUSTION SYSTEM

developed by JENBACHER.

1.01.01 Engine design

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

Crankshaft and main bearings

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

Vibration damper
Maintenance free viscous damper

Flywheel
With ring gear for starter motor

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

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

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

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

Crankcase breather
Connected to combustion air intake system.

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

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

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

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

Engine cooling system
Jacket water pump complete with distribution pipework and manifolds.

Exhaust system
Turbocharger and exhaust manifold

Exhaust gas temperature measuring
Thermocouple for each cylinder

Electric actuator
For electronic speed and output control

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

Starter motor
Engine mounted electric starter motor

1.01.03 Engine accessories

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

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

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

1.01.04 Standard tools (per installation)

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

1.02 Generator-low voltage 400V – Stamford CG 634 H

The 2-bearing generator consists of the main generator (built as rotating field machine), the exciter machine (built as rotating armature machine) and the digital excitation system.
The digital regulator is powered by an auxiliary winding at the main stator or a PMG system

Main components:
- Enclosure of welded steel construction
- Stator core consist of thin insulated electrical sheet metal with integrated cooling channels.

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

Option:
Current transformer for protection and measuring in the star point
xx/1A, 5P10 15VA, xx/1A, 1FS5, 15VA

Electrical data and features:

- Standards: IEC 60034, EN 60034, ISO 8528-3, ISO 8528-9
- Voltage adjustment range: +/- 10 % of rated voltage (continuous)
- Frequency: -6/+4% of rated frequency
- Overload capacity: 10% for one hour within 6 hours, 50% for 30 seconds
- Asymmetric load: max. 8% I2 continuous, in case of fault I2 x t=20
- Altitude: < 1000m
- Max permitted generator intake air temperature: 5°C - 40°C
- Max. relative air humidity: 90%
- Voltage curve THD Ph-Ph: <4% at idle operation and <5% at full load operation with linear symmetrical load
- Generator suitable for parallel operating with the grid and other generators
- Sustained short circuit current at 3-pole terminal short circuit: minimum 3 times rated current for 5 seconds.
- Over speed test with 1.2 times of rated speed for 2 minutes according to IEC 60034

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

- Compact and robust Digital Excitation system for Continuous output current up to 10 A (20A Overload current 10s)
- Fast AVR response combined with high excitation voltage improves the transient stability during LVRT events.
- The system has free configurable measurement and analog or digital I/Os. The configuration is done via the local human machine interface or CMT1000
- Power Terminals
  3 phase excitation power input from PMG or auxiliary windings
  Auxiliary power input 24VDC
- Excitation output
- Measurement terminals: 3 phase machine voltage, 1 phase network voltage, 1 phase machine current
- Analog I/Os: 2 outputs / 3 inputs (configurable), +10 V / -10 V
- Digital I/O: 4 inputs only (configurable), 8 inputs / outputs (configurable)

- Serial fieldbus: RS485 for Modbus RTU or VDC (Reactive power load sharing for up to 31 JENBACHER engines in island operation), CAN-Bus for dual channel communication
- Regulator Control modes: Bump less transfer between all modes
  Automatic Voltage Regulator (AVR) accuracy 0,1% at 25°C ambient temperature
  Field Current Regulator (FCR)
  Power Factor Regulator (PF)
  Reactive Power Regulator (VAR)
- Limiters: Keeping synchronous machines in a safe and stable operation area
  Excitation current limiter (UEL min / OEL max)
  PQ minimum limiter
  Machine current limiter
  V / Hz limiter
  Machine voltage limiter
- Voltage matching during synchronization
- Rotating diode monitoring
- Dual channel / monitoring: Enables the dual channel operation based on self-diagnostics and setpoint follow up over CAN communication. As Option available
- Power System Stabilizer (PSS) is available as option. Compliant with the standard IEEE 421.5-2005 2A / 2B, the PSS improves the stability of the generator over the highest possible operation range.
- Computer representation for power system stability studies: ABB 3BHS354059 E01
- Certifications: CE, cUL certification according UL 508c (compliant with CSA), DNV Class B,

- **Commissioning and maintenance Tool CMT1000** (for trained commissioning/ maintenance personal)
- With this tool the technician can setup all parameters and tune the PID to guarantee stable operation. The CMT1000 software allows an extensive supervision of the system, which helps the user to identify and locate problems during commissioning on site. The CMT1000 is connected to the target over USB or Ethernet port, where Ethernet connection allows remote access over 100 m.
- Main window
  - Indication of access mode and device information.
  - Change of parameter is only possible in CONTROL access mode.
  - LED symbol indicates that all parameter are stored on none volatile memory.
- Setpoint adjust window
  - Overview of all control modes, generator status, active limiters status and alarms.
  - Adjust set point and apply steps for tuning of the PID.
- Oscilloscope
- 4 signals can be selected out of 20 recorded channels. The time resolution is 50ms.Save files to your PC for further investigation.
- Measurement
  - All measurements on one screen.

Routine Test

Following routine tests will be carried out by the generator manufacturer

- Measuring of the DC-resistance of stator and rotor windings
- Check of the function of the fitted components (e.g. RTDs, space heater etc.)
- Insulation resistance of the following components
  Stator winding, rotor winding
  Stator winding RTDs
  Bearing RTDs
  Space heater
- No Load saturation characteristic (remanent voltage)
- Stator voltage unbalance
- Direction of rotation, phase sequence

- High voltage test of the stator windings (2 x Unom. + 1000 V) and the rotor windings (min. 1500 V)

1.03 Module equipment

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

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

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

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

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

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

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

Paintwork: RAL 7035

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

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

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

Control current supplied from the battery charger.

Power supply to the auxiliaries: (from the supplier of the power supply systems for the auxiliaries)
3 **x 400** / **230** V, **50** Hz, 16 A

Contains:
- Terminal strip
- Decentralised input/output modules connected via a data bus interface to the central engine control system in the module control cabinet
- Speed detection
- Relays, fuses, miniature circuit breakers, engine emergency circuit breaker for controlling valves and auxiliaries
- Air-conditioning unit **(optional)**

1.03.01 Engine jacket water system

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

1.03.02 Automatic lube oil replenishing system incl. extension tank

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

Oil drain
By set mounted cock

Oil sump extension tank 300 **l**
To increase the time between oil changes

Aftercooling oil pump:
Mounted on the module base frame; it is used for the aftercooling of the turbocharger; period of operation of the pump is 15 minutes from engine stop.
Consisting of:
- Oil pump 250 W, **400**/**230** V
- Oil filter
- Necessary pipework

1.04 Heat recovery

The heat exchangers are mounted to the engine and/or to the module base frame, complete with interconnecting pipe work.

The connection design of the heat exchangers is determined on a project specific basis. The connection design, temperatures and flow rates are shown on page 10 of this document. Interfaces to the customer circuit are shown as connection points A and B (see page 5).

Heat exchanger - exhaust gas to warm water
Single duct, tube-type heat exchanger, provided as a component of the heat recovery system

Consisting of:
- Inlet chamber
- Tube type heat exchanger
- Outlet chamber with condensate drain

Thermocouple for monitoring of exhaust gas outlet temperatureThe exhaust gas heat eschanger is delivered loose..

The insulation of heat exchangers and pipe work is not included in JENBACHER scope of supply and should be provided locally if needed.

1.05.01 Gas train 80-200mbar

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

The gas train complies with DIN - DVGW regulations.

1.07 Painting

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

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

Dimensions:

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

Protection class:

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

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

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

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

TN- S (L1/2/3, N, PE)

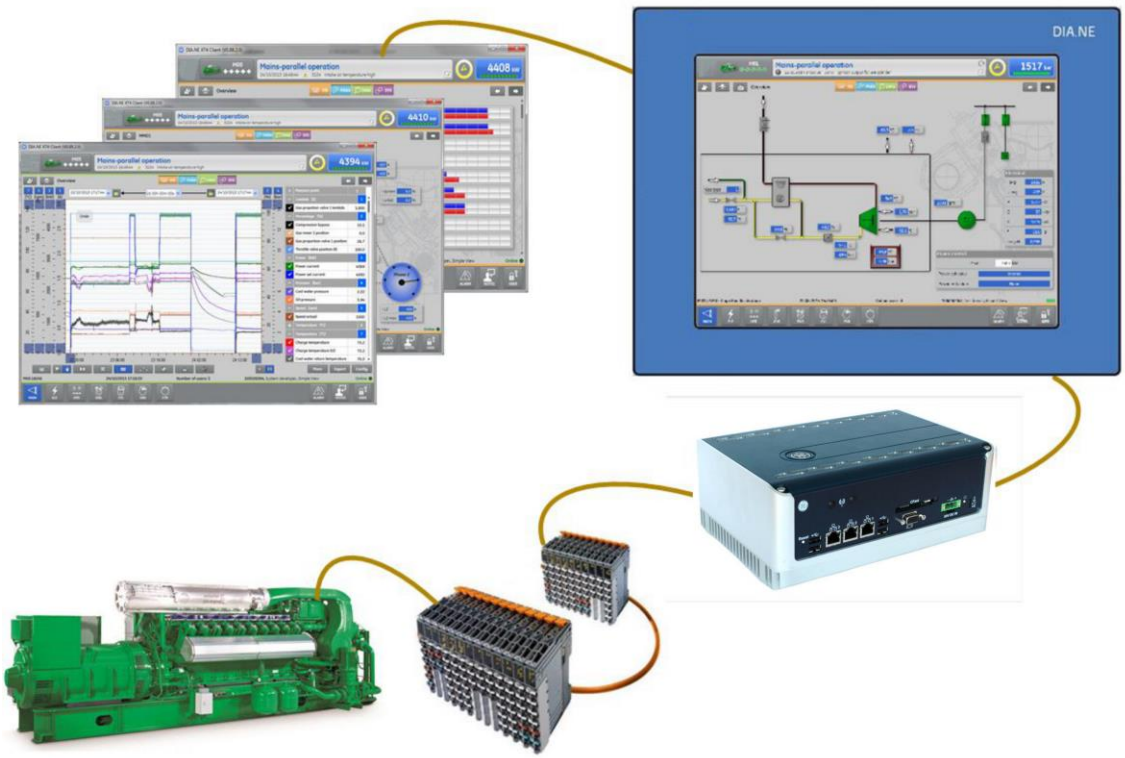
- Power supply via the module control cabinet via connection terminals or directly at the 3-pole mains disconnection unit. Protection against electric shock by automatic disconnection with miniature circuit breaker or fuse.
- Additional protection for sockets with fault current breaker (RCD) type A, 30 mA
- Option:
  - According to national requirements or customer wishes, a 4-pole mains disconnecting device can also be used. Especially if the neutral conductor is not considered to be reliably earthed.
  - Downstream outputs for auxiliary equipment with neutral conductors are fused using 2 or 4 poles.

3 x **400**/**230** V, **50** Hz

Consisting of:
Motor - Management - System DIA.NE

Setup:

- Touch display visualization
- Central engine and unit control



Touch Display Screen:

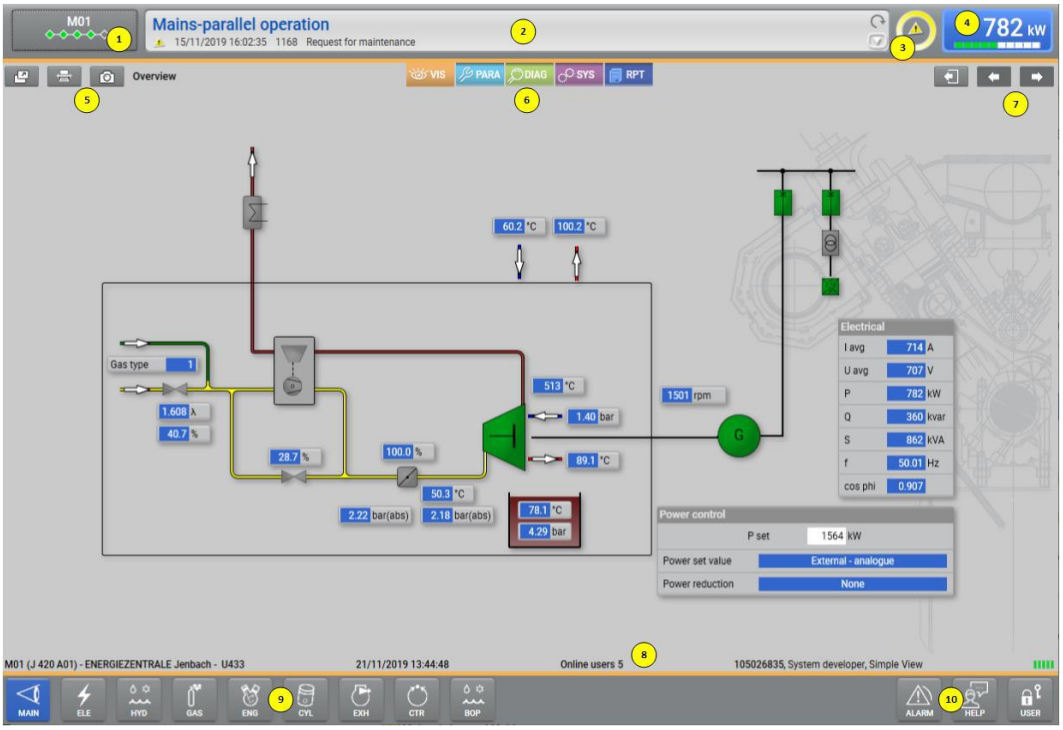
15“Industrial color graphic display with resistive touch.

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

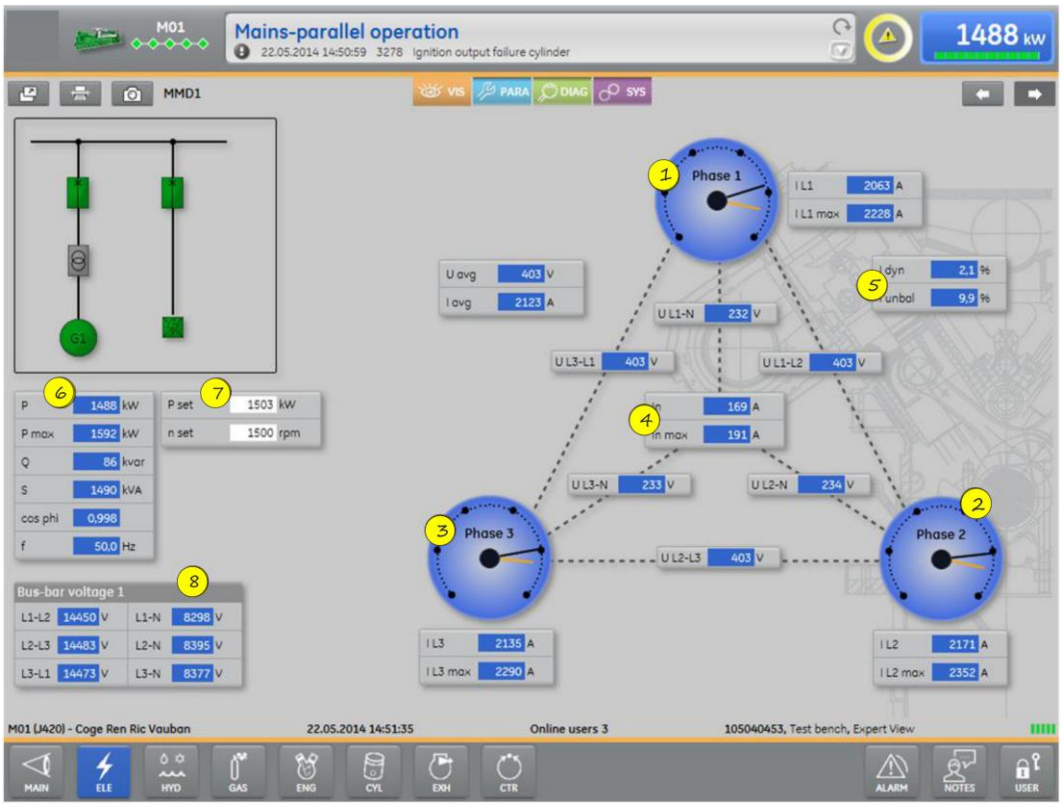
The screen shows a clear and functional summary of the measurement values and simultaneously shows a graphical summary.

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

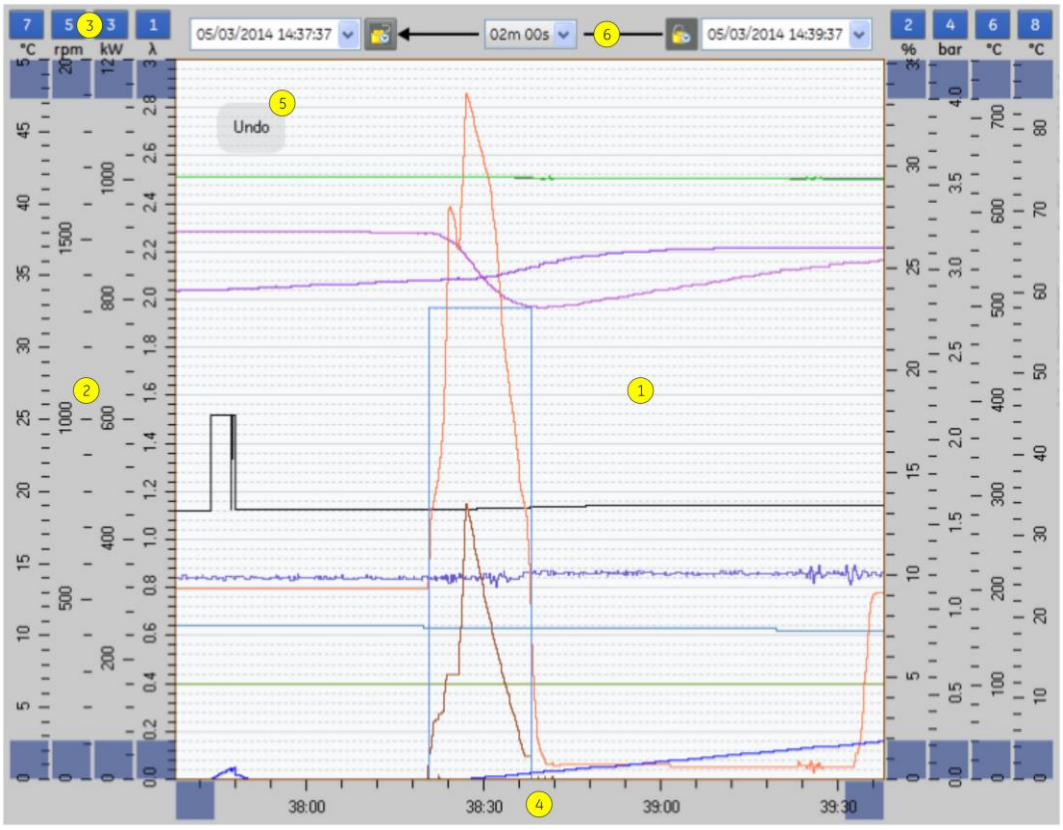
Main screens (examples):
Main: Display of the overview, auxiliary's status, engine start and operating data.



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



Trending
Trend with 100ms resolution



Measurement values:

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

Messages:
1.000.000 message events

Actions (operator control actions):
100.000 Actions

System messages:
100.000 system messages

Central engine and module control:

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

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

Connection to the local building management system according to the JENBACHER option list (OPTION)
- MODBUS-RTU Slave
- MODBUS-TCP Slave,
- PROFIBUS-DP Slave (120 words),
- PROFIBUS-DP Slave (192 words),
- ProfiNet Slave
- OPC DA Server

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

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

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

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

Lockable operation modes selectable via touch screen:

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

Demand modes selectable via touch screen:

- external demand off („OFF“)
- external demand on („REMOTE“)
- overide external demand („ON“)

Malfunction Notice list:

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

Surveillances

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

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

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

External (by others) provided command/status signals:

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

Single synchronizing Automatic

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

Consisting of:

- Hardware extension of the programmable control for fully automatic synchronization selection and synchronization of the module and for monitoring of the generator circuit breaker closed signal.
- Lockable synchronization selection via touch screen with the following selection modes:
  - "MANUAL" Manual initiation of synchronization via touch screen button followed by fully automatic synchronization of the module

- "AUTOMATIC" Automatic module synchronization, after synchronizing release from the module control
- "OFF" Selection and synchronization disabled
  Control of the generator circuit breaker according to the synchronization mode selected via touch screen.
- "Generator circuit breaker CLOSED/ Select" Touch-button on DIA.NE XT
- "Generator circuit breaker OPEN" Touch-button on DIA.NE XT
- Measurement Generator breaker closing time last synchronization

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

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

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

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

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

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

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

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

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

1.11.01 Remote messaging over MODBUS-TCP

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

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

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

JENBACHER limit of supply:
RJ45 socket at the interface module in the module control cabinet

1.11.06 Remote Data-Transfer with DIA.NE XT4

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

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

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

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

The DIA.NE XT4 is available in several languages.

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

Option2 – Remote Acknowledgement (remote reset)

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

Scope of supply

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

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

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

Customer requirements

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

2.) myPlant™

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

	BASIC	CARE	PROFESSIONAL
basic / advanced monitoring			
Liver operating status	✓	✓	✓
Historic and live data trending		✓	✓
Alarm management and notification	Alarm management only	✓	✓
Access to all engine documents	✓	✓	✓
Mobile app	✓	✓	✓
Daily status logbooks	✓	✓	✓
Remote access to engine controller		✓	✓
Fleet management		✓	✓
Engine status notifications (SMS/Email)		✓	✓
increased productivity / strong performance			
Recommended maintenance[1] (coming soon)	✓	✓	✓
Support case management[1]	✓	✓	✓

Predictive maintenance for spark plugs, oil and air filters[2]	Spark plugs lifetime prediction only	✓	✓
Oil & coolant quality monitoring[3]		✓	✓
Fleet emission monitoring[4]	Engine emission monitoring only	✓	✓
artificial intelligence & predictive analytics			
Operator analytics package			✓
Historic performance analysis			✓
User-defined monitoring			✓
On demand: Access to myPlant data via API (Application Programming Interface) service[5]			✓

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

Scope of supply

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

Equipment to be provided by the customer

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

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

3.) Mobile Internet (OPTION)
Connection Plant - Customer via secured Internet - connection
See also technical instruction **TA 2300 - 0006**

Scope of delivery

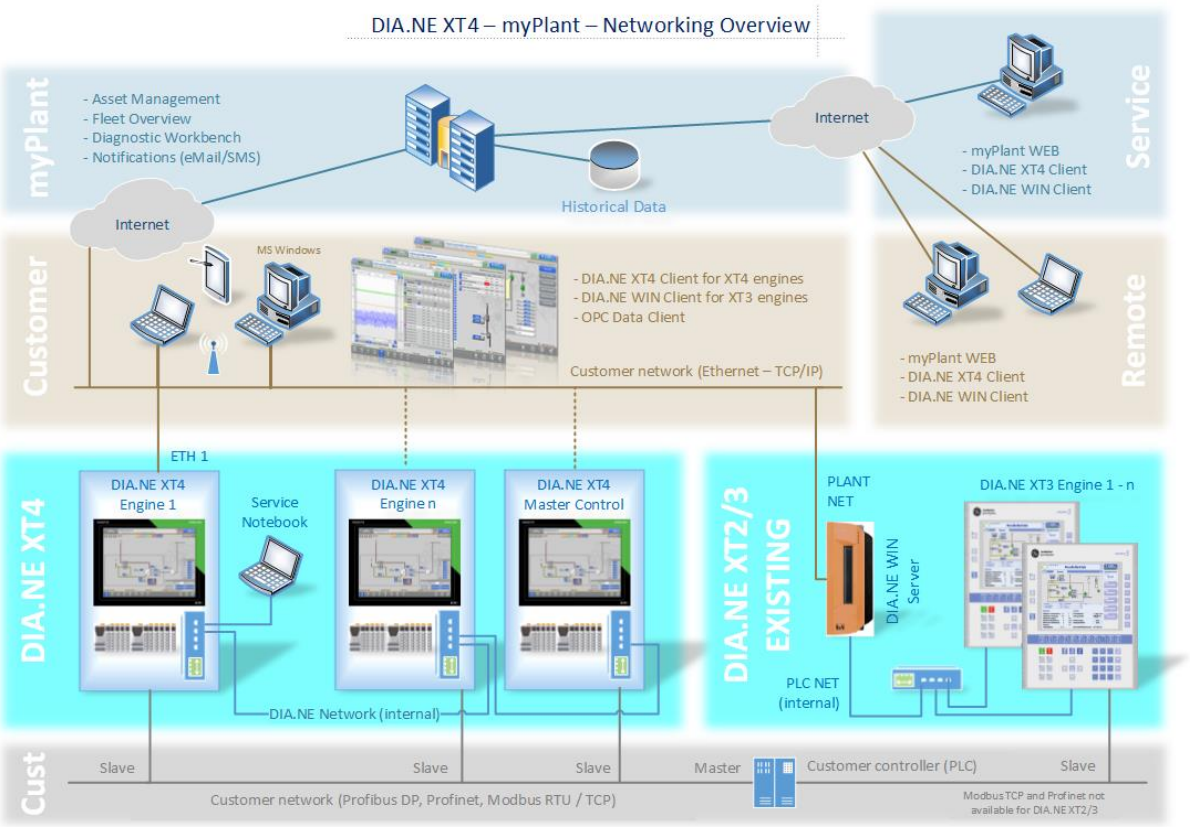
- Mobile Internet router with antenna to connect to the DIA.NE Server XT4

Customer requirements

- SIM card for 3G / 4G

4.) Network overview

For information only!



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

ANSI Function Code 78

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

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

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

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

1.11.14 Generator Overload / Short Circuit Protection

ANSI Function Code 50/51
- Digital protection relay, 3-phase, integrated into the module control panel.
- Connected to the protective current transformers in the generator star point
- Acting on the generator circuit breaker and on the generator de-excitation
- Alarm message on the DIA.NE screen

Characteristics / settings:
- Setting for overload: to 1,1 times of the generating set rated current,
- Dependent time characteristic acc. to IEC 60255-151: very inverse, time multiplier setting 0,6.
- Setting for short circuit: to 2,0 times of generating set rated current,
- Independent time characteristic: 300 ms (800 ms when dynamic network support).

1.20.03 Starting system

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

Battery voltage monitoring:
Monitoring by PLC.

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

- **General data:**

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

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

Control accumulator:
- Pb battery 24 VDC/18 Ah

1.20.05 Electric jacket water preheating

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

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

1.20.08 Flexible connections

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

No.	Connection	Unit	Dimension	Material
2	Warm water in-/outlet	**DN/PN**	**80/10**	Stainless steel
1	Exhaust gas outlet	**DN/PN**	**250/10**	Stainless steel
1	Fuel gas inlet	**DN/PN**	**80/16**	Stainless steel
2	Intercooler in-/outlet	**DN/PN**	**65/10**	Stainless steel
2	Lube oil connection	**mm**	**28**	Hose

Seals and flanges for all flexible connections are included.

2.00 Electrical Equipment

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

Protection:	IP 42 external IP 20 internal (protection against direct contact with live parts)	

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

Standard painting:	Panel:	RAL 7035
	Pedestal:	RAL 7020 (Rittal TS8) RAL 9005 (Rittal VX25)

2.02 Grid monitoring device for United Kingdom

Standard United Kingdom for generating plants connected to the low- or high-voltage network.

Function:
For disconnection of the generators from the grid in case of grid failures.

- Over-/under voltage monitoring
- Over-/under frequency monitoring
- Specially adjustable independent time for voltage and frequency monitoring

- df/dt (RoCoF) monitoring
- Indication of all reference dimensions for normal operation and at the case of disturbance over alphanumeric display and LED
- Adjusting authority through password protection against adjusting of strangers

Scope of supply:
Digital grid protection relay with storage of defect data, indication of reference dimensions as well as monitoring by itself.
Rated input voltages: 100 V / 110 V / 400 V / 415 V.
Rated input currents: 1 A / 5 A.
Test terminals (manufacturer WAGO, series 282) for the measurement inputs for the implementation of functional tests.
Out of standard scope of supply:
all necessary instrument transformers,
additional protection equipment acc. to network operator's specifications and guidelines.

Settings for the protection equipment acc. to "Engineering Recommendation G99":

Parameter	LV Protection (voltage reference from an LV source)		HV Protection (voltage reference from an HV source)		**Comments**
	Parameter-limit	Max. time delay	Parameter-limit	Max. time delay	
U< [ANSI 27]	80%	2,5s	80%	2,5s	Power reduction with 1%P /%U below 90%U
U> [ANSI 59]	114%	1,0s	110%	1,0s	Power reduction with 1%P /%U above 110%U
U>> [ANSI 59]	119%	0,5s	113%	0,5s	Power reduction with 1%P /%U above 110%U
f< [ANSI 81U]	47,5Hz	20s	47,5Hz	20s	Power reduction with 2%P /Hz below 49,5Hz
f<< [ANSI 81U]	47Hz	0,5s	47Hz	0,5s	Power reduction with 2%P /Hz below 49,5Hz
f> [ANSI 81O]	52,0Hz	0,5s	52,0Hz	0,5s	Power reduction with 20%P /Hz above 50,4Hz
df/dt (RoCoF) [ANSI 81R]	1,0Hz/s	0,5s	1,0Hz/s	0,5s	

2.03.01 Power control

Mains import/export - power control

Function:
The output is controlled via the mains power import/export set point.
This control system can for example reduce the consumption from the mains to a minimum (depending on the mains power import/export setpoint).

The measured value acquisition of the mains power consumption is performed by an on-site measuring transducer (0/4 - 20 mA, potential free measured signal).

Power adjustment:
The running unit perform within the load range of 50 - 100 % nominal load.

Start and stop of the engine in accordance of the module demand from the customer.

The client provides the following signals for JENBACHER control:
- 0(4) - 20 mA for mains import/export power
- Demand module (1 NO contact)

2.04 Generator circuit breaker panel TN-CS networks according to IEC/EN

Nominal voltage:	3x400/230V, 50Hz
Nominal current:	**1200A**
Earthing system:	TN-CS
Protection:	IP41 external, IP20 internal
Ambient temperature:	+5°bis 40°C (50°C with de-rating)
Standard:	IEC/EN61439-2 und IEC/EN60204-1
Color:	RAL 7035
Dimensions:	Height: 2000mm (+base)
With:	**600**mm
Depth:	600mm – 800mm (depends on cable connection)

Function:
The generator circuit breaker (CB) is the electrical connection between the generator and the grid. Closing of the generator circuit breaker is every time initiated by the gas engine control system. The breaker opens in case of engine shut down.
Cable length between generator CB panel and Module control panel: < 50m

Essential components installed in generator circuit breaker panel:
- 1 circuit breaker:
  - Mount type: Withdrawable CB
  - Motorized 3-phase
  - Integrated electronic trip unit consisting of:
    - Adjustable delayed release for overload protection
    - Adjustable selective short circuit protection
  - Under voltage trip coil, shunt trip coil, control coil: 24VDC

Status messages and command signals are connected to terminals
Lockable with up to 3 padlocks
CB closing time <70msec
CB opening time <60msec
Short circuit capability 65kA:

Short circuit breaking capacity Icu; Ics (440/690VAC):	65/50kA
Short circuit making capacity Icm (440/690VAC):	143105kA
Short time withstand current Icw (1 sec):	65kA

- 3 current transformers for measuring: **1200A**/1A, 1FS5, 30 VA (0,5FS5, 15VA)
- 1 copper busbar system (L1, L2, L3, PE, N + PEN bridge) for cable connection
- Terminals for control cables
- Panel fan, temperature controlled
- Surge arrestor type 2 EN 61643-11, Up <2,5kV. for auxiliaries
- Generator voltage for synchronizing and measuring, connected to terminals
- Busbar voltage for synchronizing, connected to terminals
- Auxiliaries power supply for gas engine (3 pol. xxx A, only with 3x230/400V,50Hz)

2.12 Gas warning device

Function:
The gas warning device continuously monitors the radiated air in the engine room and warns against gases which are injurious to persons' health and against explosive gas concentrations.
The measuring head (catalytic sensor) is attached on the covering or nearby the ground, dependent upon the gas source.

Scope of supply:
- Alarm unit voltage: 24VDC
- 2 Gas sensor(s)

2.13 Smoke warning device

Function:
The smoke warning device in combination with the optical smoke detector (installed in the control room) and the thermal smoke detector (installed in the engine room) provide extensive early warning signal.

Design:
The device has an optical display for alarm and operation.
The smoke warning device is installed in a plastic housing.

Scope of supply:
- Alarm unit voltage: 24 VDC
- 3 Smoke detector(s)

2.99 UK Packages

2.99.04 Electrical Metering Package

- Metering CTs for parasitic load
- Metering Cts for alternator generated power

3.01 Lube oil system

Consisting of:
- **300** l fresh oil tank
- **300** l lube oil tank
- Combined electric driven fresh oil and waste oil pump
- Level switches
- Shut-off devices
- Complete pipework between oil tanks and module

Through simple switch over of the pumps following functions are given:
- Filling of the fresh oil tank from a cask
- Filling of the lube oil tank from a cask
- Filling of the oil pan from a cask
- Emptying of the oil pan into a cask
- Emptying of the waste oil tank into a cask

3.03.01 Exhaust gas silencer

Material:
Steel

Consisting of:
- Exhaust gas silencer
- Flanges, seals, fixings

Insulation:
The insulation for reducing surface irradiations (heat and sound) of the exhaust gas silencer is not included in our scope of supply and must be provided locally. The insulation (100 mm (4 inch) rock wool covered with 0,75 mm (0,03 inch) galvanized steel sheet) is required to keep the sound pressure level of the container (65 dB(A) in 10 m (32 ft)).

3.03.04 Pipe work for condensate

The pipe work for condensate is used to drain off the condensate from the exhaust gas system (exhaust gas silencer, exhaust gas heat exchanger).

Consisting of:

- Tank for condensate made of plastic
  The tank is constructed with two connections DN 15:
  1 connection for the condensate inlet and a second one which is built as an overflow
- Pipe works for condensate DN 15 made of stainless steel
  1 piece/condensate drain of the exhaust gas system. The connections are made of stainless steel (material: AISI 316)
- Thread connections, holding device for pipe work and equipment for the installation

If needed the pipe work has to be insulated and an additional trace heating has to be provided **on site** to prevent freezing of the condensate.

3.05 Air intake and outlet system

Function:
- Supply of the required combustion air for the gas engines
- Supply and exhaust of the required cooling air to purge the radiated heat, especially the heat of the engine and the generator

The air intake system (louver) consists of:
- Weather protection
  - With sloped plating and birdscreen.
  - Material: zinc-coated steel
- Air intake filter according to EN 779 class G4
- Louver damper
  Consisting of:
  - U-profile frame and opposing hollow fins installed in plastic bushings
  - Motor operated with position switch
  - Material: zinc-coated steel
- Noise attenuating system
  Consisting of:
  - Sheet steel cladding
- Attenuator (type: absorption or combination of resonance + absorption depending on sound level requirement)
- Air intake fan, including E-motor, **400**/**230** V, **50** Hz, frequency controlled

The air outlet system consists of:
- Weather protection
  - Material: zinc-coated steel
- Birdscreen, to protect against rain and/or inclement weather
  - Louver damper
  - Motor operated
- Noise attenuating system

The air intake jalousie flap opens automatically upon engine start.
The air outlet jalousie flap only opens if the room temperature reaches the setpoint at which the air intake fan must start.

3.10.03 Cooling system - dual-circuit radiator

The heat produced by the engine (jacket water, lube oil, intercooler) is dumped through a radiator, installed outside.

Consisting of:
- Radiator
- Pump
- Electrical control
- Expansion tank

The radiator is designed for an ambient temperature of 35°C (95°F). Special versions for higher ambient temperatures are available upon request.

3.20 Container

40' ISO STEEL CONTAINER, Module Installation

Dimensions:
- Length: 12192 mm (40 ft)
- Width: 2438 mm (8 ft)
- Height: 2591 mm (8 ft, 6 in)

Sound pressure level
65 dB (A) at 32 ft (10 m) (surface sound pressure level according to DIN 45635)
See comments under MC 3.03.01

Ambient temperature:
The container is designed for a ambient temperature from **-20°C (-4°F)** to **32°C (90°F)**.
Other temperatures are available upon request.

Base frame:
Self-supporting, i.e., the base frame is designed to withstand static loads from the installation of parts such as the engine, control panels, exhaust gas silencer and radiator.

To lift (to load) the container 4 screw able carrier lugs are mounted at the top of the container.

Construction:
Trapezoidal corrugated steel sheeting welded between the base frame and the top frame.
The sound absorbent surfaces are comprised of rock wool covered with perforated plating.
The container is of a weatherproof design and the roof is suitable for construction work.

A double door to bring in the engine is situated at the front of the container beside the air outlet.
There is a door into the control room at the front wall on the side of air inlet.
A door into the engine room is situated at the long side of the container.

The doors (engine room resp. control room) are designed with the same cylinder locks. The doors are design as emergency doors which could be opened in direction of the escape route. They are identified as such and can be opened from inside without other assistance (panic lock).

Dimension of door: appr. 1000 m (3.28 ft) x 2000 m (6.56 ft) (W x H)

Engine room:

The floor is made of steel sheet (checker – or diamond plate) and designed as a tightly sealed pan. This pan is used to collect any oil-leak of the lube oil circuit (engine and extension tank).
Connections from/to the engine room consist of:

- Top: Cooling water in/outlet; welded flange
  Exhaust gas outlet; tightly closed
- Roof:
  Suspensions for cable trough, gas train, gas pipes, ...
- Wall:
  Gas inlet; welded flange
  The wall between engine room and control room is design with recesses for the cables.

Control room:
The control room is ventilated by a lockable air intake opening. The air is aspirated by the fans of the engine room. For the cable's entry, a recess at the floor of the control room is planned. The control room is equipped with a plastic covering for shipment.

Engine and container installation are essentially performed as follows:

- Installation and setup of the module
- Installation of the control equipment in a separate control equipment room
- Installation of the gas train
- Installation of the lube oil equipment
- Installation of the air intake and outlet ventilation system
- Installation of the exhaust silencer on the roof
- Installation of the radiator on the roof
- Installation of lighting in the container
- Installation of the auxiliary electrical installations
- Completion of exhaust, fuel, oil and water piping, according to the defined scope of supply, including all necessary fittings, flexible connections and reinforcements.
- Footboard above the tubes
- Rain drains
- Total signposting

Fire protection classification:
The container is not classified for fire protection.

Coating:

- Installation:
  - Oil resistant base
  - Synthetic resin as coating varnish
- Colour Container:
  RAL6018 (green)

4.00 Delivery, installation and commissioning

4.01 Carriage

According to contract.

4.02 Unloading

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

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

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

4.05 Start-up and commissioning
Start-up and commissioning with the JENBACHER start-up and commissioning checklist is not included.
Plants with island operation require internet connection.

4.06 Trial run
After start-up and commissioning, the plant will be tested in an 8-hour trial run. The operating personnel will be introduced simultaneously to basic operating procedures.
Is not included in JENBACHER scope of supply.

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

5.01 Limits of delivery - Container

Electrical
- Module:
  At terminals of generator circuit breaker

Warm water
At inlet and outlet flanges on container

Exhaust gas
At exhaust gas outlet flange on top of the container; special stack provided locally

Combustion air
The air filters are set mounted, no external ductwork is necessary

Fuel gas
At inlet flange of the container

Lube oil
At lube oil connections on container

Condensate
At condensate drain on container.

Insulation
The insulation of the heat exchangers, pipes, exhaust-gas silencers and all components of the gas pressure control system installed outdoors is not included in our scope of supply and must be provided (on-site) by the customer.

First filling

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

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

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

5.02 Factory tests and inspections

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

5.02.01 Engine tests

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

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

5.02.02 Generator tests

Carried out on test bench of the generator supplier.

5.02.03 Module tests

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

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

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

5.03 Documentation

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

- Module drawing **1)**
- Technical diagram **1)**
- Drawings of the cabinet views **3**
- Electrical interface list **2)**
- Technical specification of the control system **2)**

Before delivery (depending on progress in ordering the components, on request)

- Technical drawings for BoP components/accessories supplied separately (if included in scope of supply of INNIO Jenbacher GmbH & Co OG) **1)**

Upon delivery

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

Delivered with the engine

- Brief instructions (transport, erection, moving) **1)**

For commissioning

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

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

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

This standard offer does not include:

- Approval documentation
- Design documentation
- Proof of testing documentation
- Printed copies and digital off-line versions (e.g. printed versions, CD, pdf, etc.) must be negotiated separately and ordered accordingly.

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

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

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