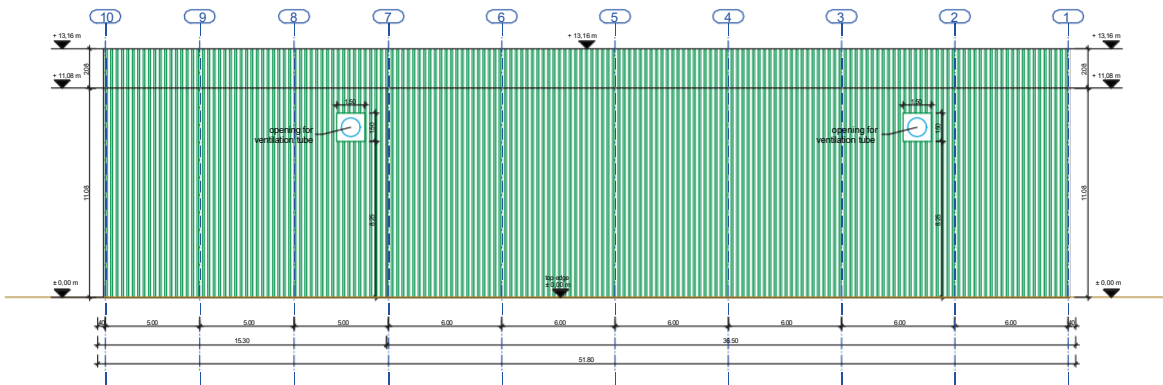
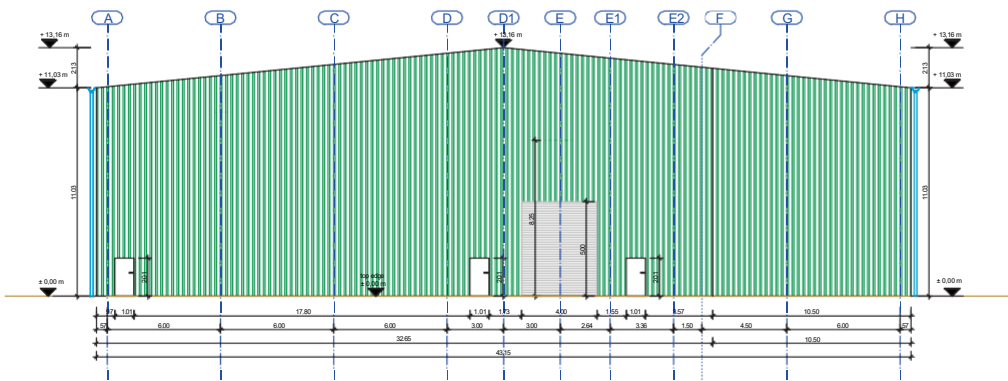


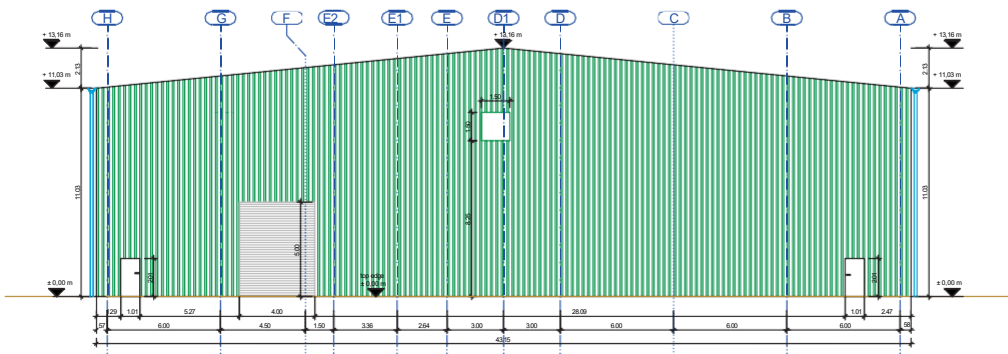
View D - D




View G - G



View F - F

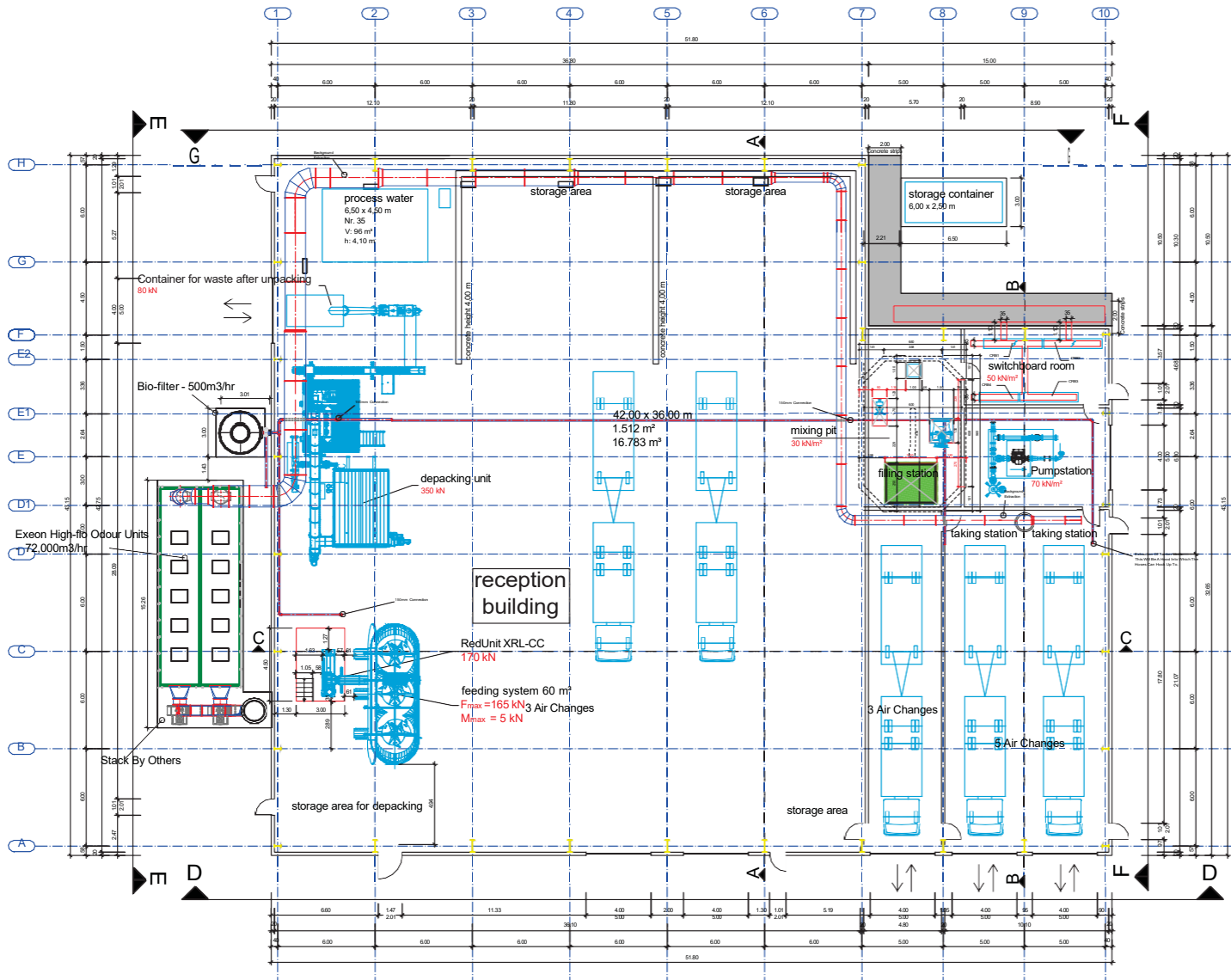


View E - E



green energy. grey. vibes.

<p><b>Bauherr (n):</b> TCE Developments Ltd 35 Ballard Lane London, England N3 1XW</p>	<p><b>Planverfasser (in):</b> bioconstruct GmbH Wellingsstraße 66 D-49328 Melle Tel: +49 (0)5226 5932-0 Fax: +49 (0)5226 5932-11</p>																																												
<p><b>Bauort:</b> Land off Weighbridge Road, Deeside Industrial Park, Deeside, CH5 2LL</p>																																													
<p><b>Construction of a biogas plant in Flintshire</b></p> <p>reception building elevations</p>																																													
<p><b>Datenname:</b> reception building_Flintshire_AmA_250131.dwg</p>																																													
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<p><b>Bauherr (in):</b> TCE Developments Ltd 35 Ballards Lane London, England N5 1XW</p>	<p><b>Planverfasser (in):</b> bioconstruct GmbH Wellingtonstraße 66 D-40226 Melle Tel.: +49 (0)5226 / 5932-0 Fax: +49 (0)5226 / 5932-11</p>
<p><b>Bauort:</b> Land of Weighbridge Road, Deeside Industrial Park, Deeside, CH6 2LL</p>	
<p><b>Construction of a biogas plant in Flintshire reception building</b></p>	
<p><b>Dateiname:</b> reception_building_Flntshire_AmA_250131.dwg</p>	
<p><b>Projekt-Nr. / Zeichn.-Nr.:</b> B202312 / A13</p>	<p><b>Maßstab:</b> 1:100</p>
<p><b>Zeichnungsgröße:</b> DIN A0</p>	
<p><b>Gezeichnet:</b> Ankerung</p>	<p><b>Datum:</b> 03.04.24</p>
<p><b>Titel:</b></p>	<p><b>Name:</b></p>
<p><b>Art der Änderung:</b></p>	<p><b>Datum:</b></p>
<p><b>Name:</b></p>	<p><b>Name:</b></p>



## **Leak Detection and Repair**

**Prepared for: Bioconstruct Newenergy Ltd**

**By:**

ENVIROSOLUTION LTD

Suite 53

3a Bridgewater Street

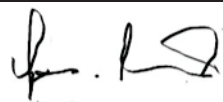
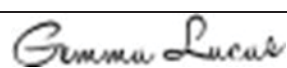
Liverpool

LI OAB

**Date:**



## EnviroSolution Ltd Document Verification

<b>Site Address</b>	Arrow Bio Waste Recycling Facility, Weighbridge Road, Deeside Industrial Park, Deeside, CH5 2LL		
<b>Report Title</b>	Leak Detection and Repair		
<b>Job Number</b>	ES2520	<b>Document Ref.</b>	ES2520-3
<b>Date Issued</b>	February 2025	<b>Report Version</b>	VI
<b>Prepared by</b>	James Meredith	<b>Signature</b>	
<b>Checked by</b>	Gemma Lucas	<b>Signature</b>	

### Disclaimer

This report has been prepared by EnviroSolution Ltd who has exercised such professional skill, care and diligence as may reasonably be expected of a properly qualified and competent consultant experienced in preparing reports of a similar scope.

However, to the extent that the report is based on or relies upon information contained in records, reports or other materials provided to EnviroSolution Ltd, which have not been independently produced or verified, EnviroSolution Ltd, gives no warranty, representation or assurance as to the accuracy or completeness of such information.

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## 1 Introduction

This Leak Detection and Repair Plan (LDAR Plan) applies to the Arrow Bio Waste recycling facility at Deeside industrial estate. This LDRP outlines the management arrangements for leak detection and repairs at the facility and has been prepared with reference to BS EN15446:2008.

The purpose of this LDAR Plan is to prevent significant leaks and fugitive emissions to water, land or air which could which cause pollution, impact the local amenity or human health and the environment.

## 2 Policy

BioConstruct NewEnergy Limited will apply a tailored approach to the facility design and operation to achieve BS EN 15446:2008. To accord with BS EN15446:2008, the operator will consider any emission from a gas tight component of greater than 1,000 ppm v/v CH<sub>4</sub>, to be a leak for the purposes of this plan.

## 3 Potential Emission Sources

A register of all potential leak sources will be provided following an initial LDAR survey. It will not be possible to carry out the initial LDAR survey until the plant is fully commissioned and operational. The completed register of potential leak sources will be identified in relation to the site plan and a pipework plan included in Appendix A and an accompanying list of relevant features included as completed Appendix B once available. Appendix B also includes a snapshot of the site asset register which will form the basis of the items assessed for identification/listing in the table in Appendix B..

The facility includes a number of activities involving fluid handling which could give rise to occasional leaks. The principal fluids handled at the facility are

- Biogas
- Biomethane
- Digestate
- Sulphuric Acid
- Diesel
- Propane
- Condensate

A leak may occur at any infrastructure discontinuity including:

- Valve stems
- Pressure relief valves
- Open ended lines or valves
- Sampling points
- Flange or other pipework connectors
- Pump or compressor seals
- Process drains
- Access doors and seals

Liquid leaks can be detected by visual inspection but gas leaks are generally not detectable without specialist equipment. If left unchecked, gas leaks may become significant emission points to atmosphere.

This LDAR plan will assess the likelihood of leaks occurring from different aspects of the site, and the resultant potential fugitive emissions to atmosphere to determine overall risk. Components targeted by this LDAR procedure are designed to be leak tight when correctly installed and maintained. Under normal operating conditions component leaks should be nominal.

## 4 Assessment of environmental risk

This LDAR plan utilises a risk-based framework for the assessment of environmental risk arising from leaks or fugitive emissions. The risk assessment framework is based upon the likelihood of a leak occurring in a particular component category combined with the quantity of fluid potentially being handled, and the environmental consequence of a leak occurring. The risk assessment framework is outlined in Table 1 and is based upon the approach and correlation factors outlined in BS EN15446:2008.

Capacity	Low	Medium	High
Component type	<= 50mm dia	50-100mm dia	>100mm dia
Connector	Low	Low	Medium
Pipe Flange	Low	Low	Medium
Sampling connections	Low	Medium	Medium
Open ended lines	Medium	High	High
Valves	Medium	High	Very high
Seals	High	Very high	Very high

**Table 1 - Component Type Risk Assessment methodology**

## 5 Objectives and targets

In accordance with EN15446:2008, all potential leak sources will be screened during each leak detection survey visit, wherever practical.

Any leak detected at a concentration in excess of 1,000 ppm v/v CH<sub>4</sub> from a component designed to be tight will be documented. A summary report will be prepared following the leak detection survey to document any detected leaks, and to estimate the overall level of fugitive emissions arising. A register of all potential leak sources will be provided at this point.

Any leak detected at a concentration below 1,000 ppm v/v CH<sub>4</sub> will also be recorded, and used to trigger a repair, but will not feature in the site's fugitive emissions estimate, in line with the approach of EN15446:2008.

Where a leak is detected (whether greater than, or less than 1,000ppm v/v CH<sub>4</sub>), the affected component will be clearly marked. Any leaking components encountered will be scheduled for repair or replacement within 7 days of the survey. All repairs and equipment changes will be assessed in accordance with the repair and change management procedures to ensure that maintenance schedules and staff training schedules remain up to date.

## 6 Survey methodology

All LDAR surveys will accord with EN15446:2008 (Section 6) and the following procedure. Where required, the calculation methods outlined in Annex B and Annex C of EN15446:2008 will be used.

This will be carried out by suitably trained staff or by specialist contractors.

1. Obtain a list and plan showing all the potential leak locations (Appendix A and B on completion).
2. Check that the prevailing weather conditions are suitable for the survey, and in particular the wind speed. Where necessary, wind shielding may be required to minimise survey disturbance.
3. Carry out an initial survey of each registered potential leak location using suitable equipment, and example is included in Appendix D.
4. Mark the location of any leak points identified which require further investigation with high visibility weatherproof tape.
5. Systematically survey each leak identified with suitable equipment.
6. Place the probe inlet of the instrument <1cm above of the identified point where leakage could occur.
7. Move the probe along the interface periphery while observing the instrument readout. Ensure the probe remains in place for sufficient time to allow the instrument to take an accurate reading. The instrument response time is a critical part of that assessment.
8. When an increased gas reading is observed, resurvey the location until a maximum meter readout is obtained.
9. Re-survey the maximum readout location until twice the instrument detector's response time has elapsed (up to 10 seconds).
10. If the maximum readout is  $\geq 1,000\text{ppm v/v CH}_4$  or  $0.1\% \text{ v/v CH}_4$ , record the instrument readout and the component name or number, where known. The high visibility tape should remain in place at all locations where a leak of  $\geq 1,000\text{ppm v/v CH}_4$  or  $0.1\% \text{ v/v CH}_4$  has been recorded until such time as the leak is repaired or the leaking component is repaired.
11. If the reading is  $< 1,000\text{ppm v/v CH}_4$  or  $0.1\% \text{ v/v CH}_4$ , the tape should be removed.
12. Repeat steps 5 to 12 inclusive until all the remaining potential leak locations have been surveyed and the results recorded.

An example of a LDAR Survey Results record is included as Appendix C.

Any leaks identified will be repaired in a timely fashion and as soon as practically possible. Any delays in repair of leaks beyond 14 days for leaks  $\geq 1,000\text{ppm v/v CH}_4$  or  $0.1\% \text{ v/v CH}_4$  will result in internal review of management systems that are in place to support timely repair (e.g. staff training, accident management plan, critical spares etc.).

While leaks are awaiting repair their location will be clearly labelled and staff made aware of any additional risk management measures that need to be undertaken until repair can be made.

All repairs undertaken will be documented in the operator's EMS according to the specified methodology for maintenance and repair records.

## 7 Survey equipment

To comply with EN15446:2008's, the operator will either employ the services of a specialist subcontractor to manage the whole leak detection exercise, or should the exercise be carried out by the operator, the equipment used will be in accordance with that specified in BS EN 15446:2008 and its calibration and servicing will be carried out by a suitable third-party specialist contractor.

## 8 Survey equipment evaluation

To comply with BS EN15446:2008's requirements, the following performance evaluation procedures will be undertaken on the equipment to be used:

- Where required, equipment response factors will be determined prior to the LDAR survey which requires them.
- A calibration precision test will be completed prior to using an instrument detector as part of an LDAR survey. All instrument detectors to be used for LDAR surveys will undergo a further calibration precision test at three-month intervals or at the next use, whichever is later.

A response time test will be undertaken prior to using an instrument detector for an LDAR survey for the first time. Where any modification is made to the instrument detector's sample pumping system or flow configuration, a new response time test will be required prior to any further use for LDAR surveys.

## 9 Equipment calibration

The equipment used during LDAR surveys will be maintained and calibrated in line with the manufacturers' recommendations and the principles outlined below. Records of this will be maintained in the operator's management system for the required retention time.

## 10 Determining mass emission rates

Using the results of the LDAR survey, the mass emission rates associated with any leaks encountered will be estimated.

For each leak detected, the screening value (Max concentration observed, in ppm v/v) will be converted into a mass leak rate estimate (in kg hr<sup>-1</sup>) using the US EPA SOCMI and Petroleum Industry correlations detailed in Annex C of EN15446:2008. Significant background VOC concentrations are not anticipated, so no background adjustment is required. Where background levels of VOCs are encountered during a survey and additional procedures will be introduced to discriminate between background concentrations and genuine leaks.

Where required, response factors for compounds other than methane will be calculated for the instrument detector used prior to undertaking an LDAR survey. Gas compositional analysis of the biogas gas produced at the facility will be used to estimate mass emission rates for compounds other than methane. Speciation will be undertaken using compound weight ratios.

Where it has not been possible to screen individual components during a reporting period, an estimate will be made for such components based on the risk profile of the component type in question and the observed results from similar sources.

All equipment calibration records and checks will be retained and made available for inspection.

## 11 LDAR plan review

The operator will review of this LDAR plan annually. A review will be undertaken of the ongoing pattern of leaks evident at the site and this will be used to inform assessment of risk and evaluation of frequency of checks for individual components.

## 12 Reporting

A six monthly annual leak detection report will be prepared which will include an estimate of fugitive emissions based on the LDAR monitoring undertaken since the last monitoring period, as required by the environmental permit.

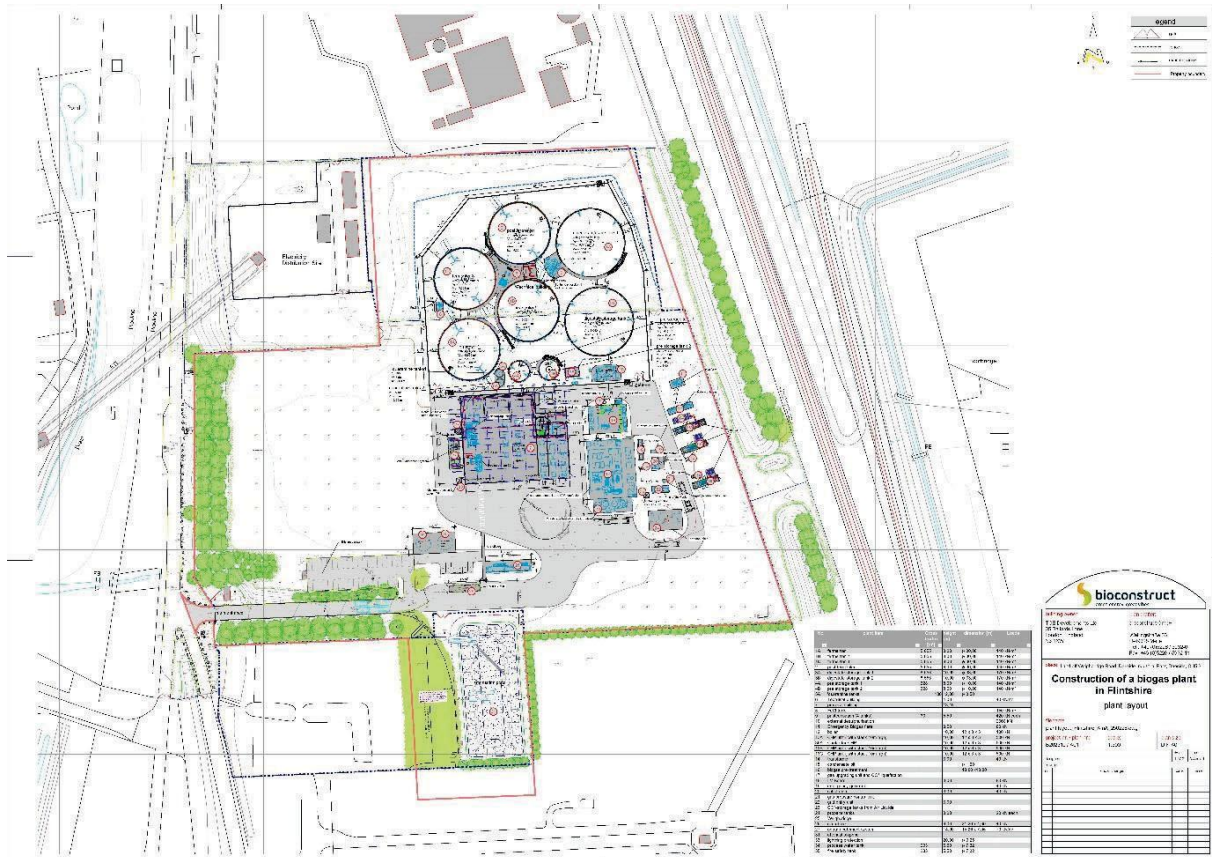
## 13 Staff Training

A training program will provide LDAR personnel with the technical knowledge to make the written LDAR program effective. It also will ensure members of the LDAR team understand their individual responsibilities. The training programme will include the following elements;

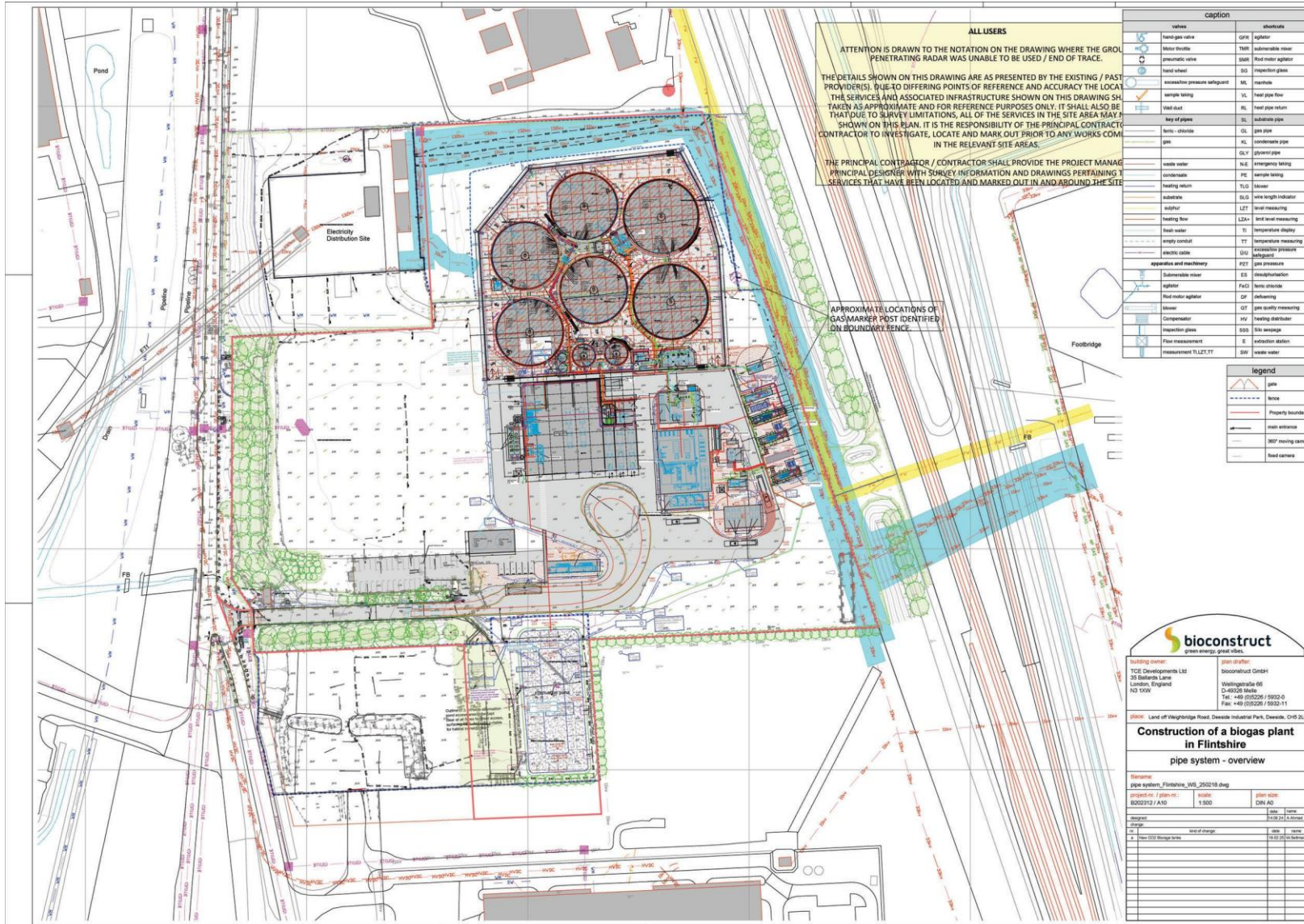
- Provision of initial training and annual LDAR refresher training for all facility employees assigned LDAR compliance responsibilities, such as monitoring technicians, database users, trained personnel, and the LDAR Coordinator.
- For other operations and maintenance personnel with responsibilities related to LDAR, provision of an initial training program that includes instruction on aspects of LDAR that are relevant to their duties (e.g., operators and mechanics performing valve packing and unit supervisors that approve delay of repair work). Provision of “refresher” training in LDAR for these personnel at least every three years.
- Collect training data and records/evidence of competence of contractors, if used, as part of the permits to work system.

Training records will be retained as part of the facility management systems and subject to periodic audit to ensure ongoing compliance.

# 14 Appendix 1 -Site Layout and



# Pipework Plan



**ALL USERS**

ATTENTION IS DRAWN TO THE NOTATION ON THE DRAWING WHERE THE GROUND PENETRATING RADAR WAS UNABLE TO BE USED / END OF TRACE.

THE DETAILS SHOWN ON THIS DRAWING ARE AS PRESENTED BY THE EXISTING / PAST PROVIDER(S), DUE TO DIFFERING POINTS OF REFERENCE AND ACCURACY THE LOCATIONS OF THE SERVICES AND ASSOCIATED INFRASTRUCTURE SHOWN ON THIS DRAWING SHALL BE TAKEN AS APPROXIMATE AND FOR REFERENCE PURPOSES ONLY. IT SHALL ALSO BE UNDERSTOOD THAT DUE TO SURVEY LIMITATIONS, ALL OF THE SERVICES IN THE SITE AREA MAY NOT BE SHOWN ON THIS PLAN. IT IS THE RESPONSIBILITY OF THE PRINCIPAL CONTRACTOR TO INVESTIGATE, LOCATE AND MARK OUT PRIOR TO ANY WORKS COMMENCING IN THE RELEVANT SITE AREAS.

THE PRINCIPAL CONTRACTOR / CONTRACTOR SHALL PROVIDE THE PROJECT MANAGER / PRINCIPAL DESIGNER WITH SURVEY INFORMATION AND DRAWINGS PERTAINING TO ALL SERVICES THAT HAVE BEEN LOCATED AND MARKED OUT IN AND AROUND THE SITE.

APPROXIMATE LOCATIONS OF GAS MARKER POST IDENTIFIED ON BOUNDARY FENCE

values	caption	shortcuts
hand-gas valve	GNP	aglator
motor throttle	TMR	submersible mixer
pneumatic valve	SNR	Rod motor aglator
hand wheel	SG	inspection glass
recessed pressure safeguard	ML	machine
sample taking	VL	heat pipe flow
blast dust	BL	heat pipe return
<b>key of pipes</b>		
ferro - oxidise	OL	gas pipe
gas	AL	condensate pipe
glycol	GLY	glycol pipe
waste water	W	emergency taking
condensate	PE	sample taking
heating return	TLS	blower
substrate	ELG	view length indicator
airput	LET	level measuring
heating flow	EDM	heat meter measuring
fresh water	TI	temperature display
empty conduit	TT	temperature measuring
electric cable	DU	EXHAUSTION PRESSURE safeguard
<b>apparatus and machinery</b>		
Submersible mixer	PET	gas pressure
aglator	PaC	ferro oxidise
Rod motor aglator	OP	dephosphating
blower	OT	gas quality measuring
Compensator	HV	heating distributor
inspection glass	SSS	Silo message
Flow measurement	E	exhaustion station
measurement T.L.Z.T.T	SW	waste water

legend	
	gas
	fence
	Property boundary
	main entrance
	360° moving camera
	fixed camera

green energy. good jobs.

<b>building owner:</b> TCE Developments Ltd 25 Bellfields Lane London, England NO 30X	<b>plan drafter:</b> bioconstruct GmbH Wallingstraße 66 D-40228 Melle Tel: +49 (0)5228 / 5932-0 Fax: +49 (0)5228 / 5932-11
<b>address:</b> Land off Vaebridge Road, Deeside Industrial Park, Deeside, CH5 2LL	
<b>Construction of a biogas plant in Flintshire</b>	
<b>pipe system - overview</b>	
<b>filename:</b> pipe system_Flintshire_046_250218.dwg	
<b>project no. / plan no.:</b> 8202312 / A10	<b>scale:</b> 1:500
<b>designer:</b> bioconstruct	<b>plan size:</b> DIN A0
<b>date:</b> 12.02.21	<b>sheet:</b> 1 of 1
<b>change:</b>	<b>date:</b>
1. New O2 Storage tanks	18.02.21 (in backward)

**Appendix B**

Register of potential leak sources

<b>Component</b>	<b>Location</b>	<b>Component Reference Number</b>	<b>Supplier</b>	<b>Comments/Observations</b>

Continue on further sheets, as required.

A snapshot of the asset register for the site is below and will inform the items considered during the inspection.

1	Traps	KS1G	F300						
1	Grid Entry	GT6G	A300						
1	Gate valve handwheel vertical	SP1S	Y100						
1	Flap horizontal	GV1G	Y301						
1	Flap vertical	GV2G	Y300						
1	torch	GV1G	A300						
1	Shaft 2	KS1W	B100						
1	Chp	GT5G	A300						
1	Flap horizontal	GV1G	Y300						
1	Measuring point control	SP1S	GS121						
1	Pneumatic slider vertical	SP1S	Y120						
1	Measuring point control	HY1S	TT102						
1	Measuring point control	SP1S	GS120						
1	Pneumatic slider horizontal left	SP1S	Y160						
1	Gate valve handwheel vertical	SP1S	Y104						
1	Gate valve handwheel vertical	SP1S	Y101						
1	Measuring point control	SP1S	GS160						
1	Measuring point control	SP1S	GS161						
1	Measuring point control	HV1RL	TT420						
1	Measuring point control	HV1VL	TT420						
1	Flap vertical	HV1VL	Y421						
1	Flap vertical	HV1RL	Y421						
1	Liquid pump generally vertically downwards	HV1VL	P420						
1	Measuring point control	HV1RL	TT410						
1	Measuring point on site	HV1VL	PI410						
1	Flap vertical	HV1VL	Y420						
1	Flap vertical	HV1RL	Y420						
1	Measuring point control	KS1W	LS-700						
1	Measuring point control	KS1W	LS+700						
1	Check valve horizontal	KS1W	X700						
1	Measuring point control	KS1W	LA-700						
1	Measuring point control	KS1W	LA+700						
1	Flap vertical	HV1VL	Y430						
1	Flap vertical	HV1RL	Y430						
1	Liquid pump generally horizontal left	KS1W	P700						
1	Shut-off ball valve horizontally	KS1W	Y700						
1	Measuring point control	HY2S	TT102						
1	Measuring point control	SV4S	TA+100						
1	Measuring point control	SV4S	PI100						
1	Pneumatic slider horizontal right	BE7S	Y130						
1	Measuring point control	BE6S	LZA+100						
1	Measuring point control	SV4S	PZ1100						
1	Shut-off ball valve vertical	SV1S	Y109						
1	Shut-off ball valve vertical	SV1S	Y108						
1	Measuring point control	SV4S	PZA+100						
1	Gate valve handwheel horizontal	SV4S	Y100						
1	Shut-off ball valve vertical	BE8S	Y131						
1	Measuring point control	BE8S	GS130						
1	Measuring point control	BE1S	LZA+101						
1	Solenoid valve horizontal	BS1W	Y703						
1	Measuring point control	BE8S	GS131						
1	Measuring point control	BE7S	GS130						
1	Measuring point control	BE7S	GS131						
1	Pneumatic slider horizontal right	BE8S	Y130						
1	Shut-off ball valve vertical	BE7S	Y131						
1	empty	EA1A	A507						
1	Pressure reducing valve horizontal 2	EA1A	E502						
1	Pressure reducing valve horizontal 2	EA1A	E504						
1	empty	EA1A	A509						
1	flap	BE1G	Y301						
1	Driving silo	FS1S	B100						
1	Measuring point control	HY3S	TT102						
1	Measuring point control	GT1G	FT300						
1	Shut-off ball valve vertical	GT1G	Y306						
1	Measuring point on site	HV1VL	PI420						
1	Measuring point control	GT1G	QT300						
1	Measuring point on site	HV1VL	TI420						
1	Measuring point on site	HV1RL	TI420						

There are a total of 1168 items identified on asset register.

\*Not all detailed above

**Appendix C**

LDAR Survey Example Results Record

Surveyor name	Job title	Employer	Survey date

Instrument type	Instrument number	Last service date	Last calibration date	Pre-survey test gas results (ppm v/v CH <sub>4</sub> )

Location	Source ID Ref.	Measured Result (Peak / ppm v/v CH <sub>4</sub> )	Comments/Observations

Location	Source ID Ref.	Measured Result (Peak / ppm v/v CH <sub>4</sub> )	Comments/Observations

Continue on further sheets, as required.

**Appendix D Example LDAR equipment - OGI Camera**

**FLIR**



**GAS FIND IR SERIES**

**FLIR GF77-**

The FLIR GF77 is a portable, rugged, handheld optical gas leak detector camera with an integrated camera lens and a built-in LCD screen. It features a 1/2" sensor, 1080p resolution, and a 4-inch LCD. The camera is designed for use in a variety of applications, including industrial gas leak detection, power plant maintenance, and environmental monitoring. It is also compatible with a wide range of accessories, including lenses, filters, and mounting brackets.

flir.com/gm



**MAXIMIZE EFFICIENCY**

Locate gas leaks quickly and accurately with the FLIR GF77.

- Time-to-market: 10 weeks, 100% uptime, 100% reliability, 100% customer satisfaction.
- See far into the night with the FLIR GF77's night vision capabilities.
- Tabl 30: Ultra-compact, rugged, and easy to use. The FLIR GF77 is the perfect solution for gas leak detection in the field.
- Swirl ID: The FLIR GF77's swirl ID feature allows you to identify gas leaks by their shape and size.



**AFFORDABLE OPTICAL GAS IMAGING**

Prooia ei sitewh one armora GFn cime111E wh iou&1yie, idir1, J feilt11eE

- Improved: gas detection can be done with a 1-Touch lens. Spent a lot of money on other cameras.
- Increased: the FLIR GF77's gas detection capabilities are 10x better than other cameras.
- Practical: the FLIR GF77 is a compact, rugged camera that is easy to use in the field.
- Uoo dB1a from flle bLilt-in area me, imrament to: to cilwat8 tilt le/BI aid al11ne



**STREAMLINE INSPECTION AND REPORTING**

The FLIR GF77's built-in software allows you to capture and report gas leak data directly from the camera.

- Define roll 1115 000 il1p'DYB n oian1awwith the optional add-01of FUR Thalm Studio Fra and FUR Rou1s Creatr
- Integrate with your existing software and hardware.
- Connect to your existing database and reporting system.

flir.com/gm



## **Supplier Assessment Form**

**Prepared for: BioConstruct  
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**Date: March 2025**



## EnviroSolution Ltd Document Verification

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## 1 Supplier Assessment Form

Reference/Date:	
Supplier name:	
Assessment carried out by:	
Supplier address:	
Supplier point of contact:	
Supplier email:	
Supplier web address:	
Contact number:	
SIC code:	
EWC Code:	
Waste name/classification:	
Waste composition and description:	
Waste production method:	
Potential for variation in feedstock consistency:	
Potential for physical contaminants to be present in the feedstock (list potential contaminants and origin in production process):	
Likely tonnages of waste available and variance in supply:	

Reference/Date:	
Any known chemical or biological hazards associated with this waste. If cleaning products or other chemicals are used on site, list these and request MS Data sheet:	
Number of samples required to characterise waste:	
Sample obtained:	Yes / No
Sample analysed:	Yes / No
Results:	
Handing requirements:	
Preferred haulier/carrier:	
Third parties (if involved) in the supply chain:	
Contingency for dealing with non-confirming waste and contingency in emergency	
Additional notes:	

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# BIOCONTROL

Intelligente Prozessleittechnik von  **BIOCONSTRUCT**

*WIR REGELN DAS*

Description of the Alarm and Reporting System

## **General**

The programmable logic controller (PLC) is the central control system / controller of the plant technology. The PLC controls all processes of the biogas plant. All process parameters are monitored by the controller. If the monitored parameters deviate from the parametrised set values (target values), the controller generates an alarm message for the operating personnel and takes all necessary steps in order to maintain the safe condition of the plant. The controller also monitors the state of all installed units. If a unit develops a fault, the controller also generates an alarm message and moves the affected plant part into a safe condition.

The set values for the process parameters can be adjusted by the operating personnel. The range, within which these values can be adjusted, is specified by BioConstruct. If the specified value is either not reached or is exceeded, the operating personnel are given a visual indication regarding the fact that the value is outside the specified range. BioConstruct specifies a recommended value for each set value. This recommendation as well as the permissible adjustment range are displayed to the operating personnel in the set value table.

This document describes the mechanism with which the plant controller processes a fault that has developed in coordination with the visualisation programme (software) and forwards it to the operating personnel.

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# 1 Cooperation between the controller and visualisation

A biogas plant uses various units for controlling and monitoring the plant process. The PLC is the superior controller, which communicates with all other units and monitors these units. The communication between the various units (e.g. a CHP or the gas analysis unit) is done via a Profibus. The monitoring of the process parameters is done via the analogue and digital interfaces of the decentralised PLC periphery.

The visualisation programme visually displays the process sequence in the PLC to the operating personnel. It allows the operating personnel to adjust the set values or switch the drives on and off. The visualisation displays a fault that has developed in clear text and also notifies the operating personnel of the fault. After the faults have been corrected, the operating personnel can acknowledge the faults on the visualisation.

Since the entire control logic is contained in the PLC, the plant can continue its operation without any problems in the event that the visualisation fails. However, the failure of the visualisation means that the operating personnel no longer have direct access to the process parameters and drives. Apart from using the visualisation for acknowledging faults, these can also be acknowledged by pressing a central "Reset" button at the main control cabinet.

## 2 Fault types

In general, faults can be classified into two categories:

### 2.1 Process faults

Process faults are all faults, which can be detected by a deviation of the process parameters from their permissible value range.

These faults include, for example:

- Permissible fill levels are not reached or are exceeded
- Permissible pressure levels are not reached or are exceeded
- Permissible temperatures are not reached or are exceeded

These faults are created by comparing the actual parameters with the set values in the set value table.

In addition, safety-relevant parameters are monitored by a physical device, which cannot be adjusted by the operating personnel.

The fill level in a tank, for example, is monitored by a measuring probe, which closes the pressure gate valve to the tank when contact with the medium is made, thereby preventing the overfilling of the tank.

The gas pressure in the tanks is also monitored by an additional measuring device. This device triggers an alarm if the parametrised minimum pressure in the device is not reached. This happens independently from the set value that has been parametrised in the controller by the operating personnel. If another absolute minimum pressure, which has been parametrised in the device, is not reached, the measuring device disconnects the gas compressors from their power supply. This function cannot be influenced by the operating personnel.

## 2.2 Faults in the controller

The state of all switching units and drives is monitored by the controller via reporting contacts. They include, for example:

- Fuses in the control cabinet
- Motor protection switches
- Thermal protection relays
- Fault reporting contacts from subordinate components (e.g. CHP)

If a reporting contact signals a fault of the associated component, the controller generates a fault message. All components, which depend on that particular component, are shut down in order to move the plant into a safe condition.

**For an overview of the interconnections and effects of various faults on other plant parts, please refer to the switching matrix.**

## 3 Signalling of fault messages

### 3.1 Display in the visualisation programme

In order for the operating personnel to be notified of a fault that has occurred, this fault must be displayed by the visualisation programme.

For this purpose, the controller stores the information regarding a pending fault for each possible fault, which may occur, in a pre-defined data space of the PLC.

The visualisation programme reads this data space at regular intervals to check if faults are currently pending. The visualisation uses the storage location of the displayed fault in order to determine, exactly which fault is pending.

All fault message texts are stored in a database. The visualisation programme loads the corresponding text from the database and then displays the fault.

The operating personnel are shown the date and time of the fault as well as the message text and status of the fault (K = just arrived, (K)Q = acknowledged, (KQ)G = gone).

Error number	Time	Status	Error message	Acknowledge
999	21.04.2010 11:11:11	K	Grenzfullstand Fermenter I (fill level limit digester I)	<input type="checkbox"/>

In addition, a red-and-yellow warning triangle notifies the operating personnel of pending faults. Inside the triangle, the actual number of faults is shown. If faults are pending, which have not yet been acknowledged, the warning triangle will flash red and yellow.

## 3.2 Acknowledging faults

After the user has corrected the cause of the fault, he can acknowledge the fault on the visualisation. The message window of the overview page offers the option to acknowledge the pending fault by clicking on the "Quittieren" (acknowledge) column.

Error number	Time	Status	Error message	Acknowledge
999	21.04.2010 11:11:11	K	Grenzfullstand Fermenter I (fill level limit digester I)	<input type="checkbox"/>
999	21.04.2010 11:19:00	(K)Q	Grenzfullstand Fermenter I (fill level limit digester I)	<input checked="" type="checkbox"/>

The "Stormeldungen" (fault messages) page displays all faults to the operating personnel. This page also offers the option to acknowledge faults. In addition, the page provides a button, with which the operating personnel can acknowledge all pending faults at the same time. This is useful, for example, if the failure of a decentralised component of the controller has resulted in a large number of faults occurring simultaneously.

## 3.3 Sending fault messages

Since the operating personnel are not always sitting in front of the visualisation PC, they will be notified of a new fault either by text message or email.

### 3.3.1 Notification by text message

The visualisation programme uses the SMSTrade Internet portal for sending text messages. Every plant operator must create a user account and top it up with sufficient credit. The user account is identified by its own unique ID. Now, the visualisation uses this unique ID to send the fault message to the message recipients who are defined in the administration. If the credit drops under a certain level, the account holder will receive a message from SMSTrade, which will prompt him to top up the credit. This way it is guaranteed that there is always sufficient credit available for sending fault messages.

### 3.3.2 Notification by email

In addition to the notification by text message, there is an option to send fault messages by email. In contrast to the sending of text messages, the notification of the operating personnel by email is free of charge.

**Since it is not absolutely guaranteed that an email will always reach the intended recipient without delay, a text message recipient **MUST** be defined in the visualisation programme.**

## 4 Defining the recipients of fault messages

The visualisation programme offers the plant operator the option to define any number of recipients of fault messages. The respective page is located in the administration under the "Stormeldeempfänger" (fault message recipients) tab.

If a new recipient is created, a mobile phone number and an email address can be entered.

## 4.1 Managing the sending of fault messages

For each message recipient, a new column is created in the table for managing the sending of fault messages. In principle, one column for sending the text messages and one column for sending the emails is created, depending on which data was entered when the recipient was created.

The plant operator can now use the table in order to specify for each defined fault message the recipient who is to receive this message as well as the transmission method.

This is done by activating or deactivating the sending of the fault message in the respective column.

**When a new recipient is created, all messages are activated by default.**

The top line of each column offers the option of deactivating the entire column, for example if the respective employee is on holiday.

## 4.2 Priorities regarding the recipients of fault messages

The visualisation offers the option of classifying the fault message recipients into three priority levels. If a new recipient is created, his priority level **MUST** be stated. The priority level can be changed at any time.

Recipients of priority level 1 will receive the message immediately after the fault has occurred.

For priority levels 2 and 3, message delays can be specified. The recipients of these two priority levels will receive the message with the respective time delay. If the fault is confirmed before the time delay has elapsed, the recipients of priority levels 2 and 3 will no longer be notified.

If messages to recipients are queuing, the visualisation displays this queuing state below the administration table.

## 4.3 Administration restrictions

In order to make sure that a fault message will always reach at least one recipient, the administration of the fault message recipients is subject to a restriction:

**There must always be at least one recipient of priority level 1 who is activated for the receipt of all fault messages.**

If this is not the case, a warning is displayed and the operating personnel will be unable to exit the settings page until the condition has been fulfilled.

# 5 Backup alarm system

The standard sending of fault messages is entirely Internet-based and thereby depends on a medium whose functionality may be restricted by factors that are outside our control. For example, the Internet may break down due to a technical fault within the network operator's area of responsibility. Furthermore, it is possible that a hardware or software error of the visualisation computer may render the entire alarm system inoperable.

## 5.1 Telephone dialler

In order to ensure that the operating personnel are still notified in the event that the alarm system fails, a telephone dialler is installed in addition. The dialler has up to six reporting groups, which can be activated by the PLC. For each reporting group, up to four telephone numbers can be defined.

If a reporting group is activated, the dialler calls the first stored telephone number in the respective reporting group. If the call has not been answered within 90 seconds, the dialler calls the next telephone number in the reporting group.

The dialler continues to go through the telephone numbers of a group for a maximum of three times.

If a recipient answers the call, the dialler plays a notice text, which notifies the caller of the fault that has occurred. The recipient now has the option to cancel the reporting process by acknowledging the reporting group via the telephone. If the reporting group is not acknowledged, the dialler calls the next telephone number in the reporting group.

Since the options of the dialler are highly restricted because there are only six reporting groups, the messages are limited to two special events by default:

### **5.1.1 Monitoring the connection between the PLC and visualisation**

The visualisation and PLC are continuously monitoring the connection between each other.

If the visualisation detects the interruption of the connection to the PLC, it sends a fault message via the Internet.

If the PLC detects the interruption of the connection to the visualisation, it activates the respective reporting group in the dialler. This is done with a time delay of several minutes in order to minimise the number of false alarms, for example due to a restart of the visualisation computer.

### **5.1.2 Monitoring the Internet connection**

For each fault that has occurred, the visualisation checks if an Internet connection exists. If the connection exists, a message can be sent by text message or email.

If the visualisation detects that currently no Internet connection exists, it reports this status to the PLC. The PLC then activates the reporting group in the dialler, which will notify the operating personnel of the failed Internet connection.

If the operating personnel receive a message via the telephone dialler, they know that a problem with the biogas plant has occurred.

## **5.2 Optional use of the dialler**

Under certain circumstances it may be appropriate that all faults that occur are signalled by the dialler. This applies, for example, if there is poor network coverage in the recipient's home. There is also a general problem that many mobile phones only play a brief notification sound when a new text message is received - and that sound may not easily be heard.

In this case, initially all faults are collected in groups.

If a fault occurs, the respective group is activated at the telephone dialler.

Now the recipient merely knows, in which group a fault has occurred. In order to find out the exact type of fault that has occurred, the recipient needs to go to the biogas plant. Alternatively, he can try to remotely connect to the visualisation computer in order to identify the fault.