

Appendix 9: User and Operations Manuals for the Landfill Gas to Electricity Project at the SLS

User and operations manuals that are referred to in this environmental management plan include:

- Biogas Technical manual - attached;
- Cat Engine user manual – to be supplied on delivery;
- Generator operations manual – to be supplied on delivery; and
- Ener-G Site Operations Manual – Confidential document.



**Biogas
2000m³h⁻¹ Enclosed
Ground Flare System and
Booster Set

Technical Manual**

**Prepared by
Biogas Technology Ltd**

Biogas Technology Project No: 3092

Site: Chloorkop

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Section 1 Introduction

PURPOSE OF THIS MANUAL

This manual is intended to assist the user in the safe and efficient installation, operation and maintenance of the Biogas enclosed flare and booster set. It is divided into the following sections:

- **Introduction** (this chapter)
- **Safety** details the safety procedures users should employ to enable the safe installation, operation and maintenance of the system.
- **System Description** provides the information required to explain to the user the function of the product.
- **Options** provides information on options and accessories that are available
- **Installation** gives detailed instructions about all operations necessary to install the system and to bring it up to full working condition.
- **Commissioning** gives detailed initial setting-up procedures and any special tools, test and calibration equipment required.
- **Operation** contains instructions for the complete operation of the system under normal, emergency and special conditions
- **Maintenance** includes routine maintenance tasks; tests, checks and inspections; fault diagnosis and rectification; overhaul instructions.
- **Technical Data** includes all data that the user may need to install, operate and maintain the system.

THE BIOGAS ENCLOSED FLARE

The gas extraction fan and flare stack provide a fully integrated system to extract and flare gas at a variable rate. The whole system conforms to the Environment Agency Guidance on Landfill Gas Flaring Version 2.1(November 2002) and TGN05 Guidance for monitoring enclosed landfill gas flares (2004). The whole system also satisfies the following South African Bureau of Standards (SABS).

Wind Speed: 40m/s as specified in SABS 0160-1989

Seismic Classification: Zone 2 as specified in SABS 0160-1989, peak ground acceleration of 0.16g with a 10% probability of being exceeded in a 50 year period.

TRAINING

Biogas provides expert training courses for installation, operation and maintenance of the enclosed flare and booster set. Training can be provided at Biogas offices in the UK, or at a customer's premises. To discuss your requirements, please contact Biogas:

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MAINTENANCE AND SUPPORT

Full maintenance can be provided for the enclosed flare and booster set by Biogas on either a contract or call-out basis. Having equipment maintained by Biogas ensures maximum reliability and availability, and prevents the warranty being invalidated through inadequate maintenance.

Please contact Biogas at the above address to discuss your maintenance requirements.

Section 2 Safety

GENERAL SAFETY

This manual is intended to assist the user in the safe and efficient installation, operation and maintenance of the Biogas enclosed flare and booster set. This equipment must be used in accordance with all safety procedures described in this manual. The equipment must not be used for purposes other than those for which it was designed.

Installation, operation and maintenance of the Biogas enclosed flare are restricted to personnel who have the necessary qualifications to do so within the jurisdiction(s) in which the installation is located. Nothing in this manual should be taken as contradicting any applicable laws and regulations that have the force of law within the jurisdiction(s) in which the installation is located.

This manual describes the complete Biogas enclosed flare and booster set installation. Documentation for components of the installation may also contain safety and operating information and can be found in the Technical Information File.

Before installing, operating or maintaining the Biogas enclosed flare and booster set, this manual must be read thoroughly, paying particular attention to all **WARNINGS**, **Cautions** and **Notes**.



WARNINGS ARE USED TO ALERT THE READER TO A PROCEDURE OR PRACTICE, WHICH IF NOT FOLLOWED CORRECTLY, COULD RESULT IN PERSONAL INJURY.



Cautions are used to alert the reader to a procedure or practice, which if not followed correctly, could result in damage to the equipment or ancillary equipment being damaged or there is risk of environmental damage.



Notes are used to highlight important information that may assist the reader in carrying out a procedure or in understanding the text.

Incorrect installation or operation, or failure of the user to maintain the equipment in accordance with the Maintenance information given in this manual, may relieve the Biogas Technology Limited from any or all responsibility for consequent non-compliance, damage or injury.

The Biogas enclosed flare and booster set must not be used in combination with other equipment unless such equipment has been expressly designated as compatible equipment by Biogas Technology Limited. Changes and/or additions to the equipment should only be carried out by Biogas Technology Limited or by third parties expressly approved by Biogas to do so. Such changes and/or additions must comply with all applicable laws and regulations that have the force of law within the jurisdiction(s) in which the installation is located.



DO NOT ATTEMPT TO OPERATE THE BIOGAS ENCLOSED FLARE AND BOOSTER SET UNLESS YOU HAVE READ AND FULLY UNDERSTOOD THE EMERGENCY STOP PROCEDURE IN THE OPERATING SECTION OF THIS MANUAL.



BEFORE OPERATING THE BIOGAS ENCLOSED FLARE AND BOOSTER SET MAKE SURE THAT THE TASKS LISTED IN THE MAINTENANCE SECTION OF THIS MANUAL HAVE BEEN FULLY COMPLETED. IF THEY HAVE NOT, DO NOT USE THE EQUIPMENT UNTIL THE MAINTENANCE PROGRAMME HAS BEEN BROUGHT UP TO DATE. OPERATING THE EQUIPMENT WHEN IT HAS NOT BEEN FULLY MAINTAINED RISKS PERSONAL INJURY.



IF ANY PART OF THE BIOGAS ENCLOSED FLARE AND BOOSTER SET IS KNOWN TO BE DEFECTIVE OR MALADJUSTED, DO NOT USE THE EQUIPMENT UNTIL REPAIRS HAVE BEEN MADE. OPERATING THE EQUIPMENT WITH DEFECTIVE OR MALADJUSTED COMPONENTS RISKS PERSONAL INJURY.



THE PLANT MAY CONTAIN POTENTIALLY EXPLOSIVE ATMOSPHERES. THE PLANT MAY GENERATE POTENTIALLY EXPLOSIVE ATMOSPHERE DUE TO GASES PASSING THROUGH ITS PARTS. PRIOR TO ANY TASKS PERFORMED ON THE FLARE, THE OPERATOR SHOULD CARRY OUT RISK ASSESSMENT IN ACCORDANCE WITH CURRENT LEGISLATION AND REGULATIONS. MAINTENANCE TASKS MAY REQUIRE ISOLATION OF GAS SUPPLY AND ELECTRICAL ISOLATION OF THE PLANT. ALL ELECTRICAL AND NON-ELECTRICAL EQUIPMENT USED AROUND THE FLARE SHOULD BE APPROPRIATELY RATED TO RELEVANT AREA CLASSIFICATION ZONES AND THE POTENTIAL IGNITION SOURCES SHOULD BE EXCLUDED OR CONTROLLED.

THE PLANT HAS BEEN DESIGNED WITH DUE CONSIDERATION TO THE GUIDANCE GIVEN IN: IGE/SR/25 "HAZARDOUS AREA CLASSIFICATION OF NATURAL GAS INSTALLATIONS" ISSUED BY THE INSTITUTE OF GAS ENGINEERS, AND THE ATEX 95 DIRECTIVE 94/9/EC AND DSERA IMPLEMENTATION FOR THE WASTE MANAGEMENT INDUSTRY (RELEVANT ENVIRONMENTAL SERVICES ASSOCIATION (ESA) INDUSTRIAL CODES OF PRACTICE). THE PLANT, WITH EXCLUSION OF THE CONTROL PANEL THAT IS LOCATED IN THE SAFE ZONE, IS CLASSIFIED AS:



ELECTRICAL SAFETY



THE PIPE SECTIONS MAY CONTAIN A FLAMMABLE MIXTURE OF GAS AND AIR. PRIOR TO ANY TASKS PERFORMED ON THE FLARE, THE OPERATOR SHOULD CARRY OUT RISK ASSESSMENT IN ACCORDANCE WITH CURRENT LEGISLATION AND REGULATIONS.

MAINTENANCE TASKS MAY REQUIRE ISOLATION OF GAS SUPPLY AND ELECTRICAL ISOLATION OF THE PLANT. ALL ELECTRICAL AND NON-ELECTRICAL EQUIPMENT USED AROUND THE FLARE SHOULD BE APPROPRIATELY RATED TO RELEVANT AREA CLASSIFICATION ZONES AND THE POTENTIAL IGNITION SOURCES SHOULD BE EXCLUDED OR CONTROLLED.

MECHANICAL SAFETY



DURING VENTING (IF SUCH A MODE IS INCLUDED), A POTENTIALLY EXPLOSIVE MIXTURE OF GAS AND AIR PASSES THROUGH THE VENT STACK (IF FITTED) AND/OR FLARE STACK . YOU MUST ENSURE THAT NO SPARKS OR FLAMES ARE PRESENT, AND YOU MUST MONITOR THE EMISSIONS CONSTANTLY. AS SOON AS GAS QUALITY IS RESTORED, RETURN THE ENCLOSED FLARE TO GAS DELIVERY OR FLARE MODE. DURING OPERATION IN THE VENT MODE THE EXTENT OF THE POTENTIALLY EXPLOSIVE ZONE IS MUCH LARGER IN COMPARISON TO NORMAL FLARING AND ALL NECESSARY PRECAUTIONS IN ACCORDANCE WITH DSEAR AND END USER RISK ASSESSMENT NEED TO BE OBSERVED.

ALL ELECTRICAL AND NON-ELECTRICAL EQUIPMENT USED AROUND THE FLARE SHOULD BE APPROPRIATELY RATED TO RELEVANT AREA CLASSIFICATION ZONES AND THE POTENTIAL IGNITION SOURCES SHOULD BE EXCLUDED OR CONTROLLED.

THERE MAY BE NOXIOUS GAS AND DUST WITHIN THE PIPELINE. YOU SHOULD DO WHATEVER IS POSSIBLE TO AVOID EXPOSURE AND/OR INHALATION OF THESE. WEAR PROTECTIVE CLOTHING AND A FACE MASK TO AVOID INJURY, IRRITATION AND INHALATION OF GAS WHENEVER MAINTENANCE PROCEDURES ARE PERFORMED ON THE SYSTEM.



THERE ARE A NUMBER OF SAFETY CRITICAL COMPONENTS ON THE SYSTEM. UNAUTHORISED MAINTENANCE OR ADJUSTMENT OF THESE COMPONENTS MAY AFFECT THE SAFE OPERATION OF THE SYSTEM WHICH COULD RESULT IN DEATH OR INJURY TO PERSONNEL.THE FOLLOWING COMPONENTS ARE DESIGNATED AS SAFETY CRITICAL:

FLAME ARRESTERS

UV SENSOR (FLAME DETECTOR)

THERMOCOUPLES

SAFETY INSPECTIONS, TESTING, CALIBRATION AND CERTIFICATION

It is the responsibility of the user of all equipment obtained from Biogas Technology Ltd., to ensure compliance with all current legislation regarding the requirement for safety inspections, examinations, testing, calibration and certification. Biogas Technology Ltd., will not be liable for either the cost or provision of such services unless contractually agreed.

Biogas Technology Limited plant has been designed to meet the requirements of EC Directive 94/9/EC, the appropriate EC ATEX Declaration of Conformity is enclosed in the Technical Information File, together with a copy of the ATEX plate that is mounted on the plant.

Certification applicable to bought out components is enclosed with the suppliers' information in the Technical Information File.

Section 3 Description

GENERAL

Refer to Figure 7-1

The Biogas enclosed flare and booster set system uses sophisticated burner technology to achieve low noise, low emission burning of landfill gases across a wide range of gas flows from 50 Nm³h⁻¹ to a maximum standard capacity of 2000 Nm³h⁻¹ with typical minimum turn down ratio 5:1.

A typical system comprises an inlet manifold, a knock out pot with demister, a gas extraction fan, a main gas burner train, a pilot gas burner train, a power generation gas train, a burner stack and a control and monitoring system.

Options include GPRS telemetry system, emissions monitoring probe, inlet and stack gas analysis system, and data logging.

The following describes the enclosed flare system and booster set.

SYSTEM DESCRIPTION

Refer to Figure 7-2.

The following describes the operation of the enclosed gas flare and booster set.

The gas flare has the following modes of operation:

- Flare Mode
- Power Generation Mode (future provision)
- Ignition
- Shutdown

Flare Mode

Flare mode is the normal operating mode of the gas flare. Gas from the field is drawn by the extraction fan/booster through a butterfly valve, a Knock Out Pot (KOP), a slam-shut valve and a butterfly valve. Total gas flow is measured by the flow meter. The KOP has a wire mesh mist eliminator that removes liquid from the gas stream. The liquid is collected and drained in the bottom of the KOP. Two level switches in the KOP monitors the liquid level. If the first level switch is activated then an alarm is shown on the control panel, if the second switch is activated the alarm will shut down the plant. Vacuum gauges either side of the wire mesh mist eliminator provide an indication of any blockage in the mesh.

The gas from the extraction fan discharge is fed via a non-return valve and a butterfly valve and is monitored for gas quality before being fed to the main burner gas line and the power generator gas line. The main gas burner is fed via a slam shut valve and a flame arrester to the main burner in the flare stack. Gas flow to the flare is measured by a flow meter, The slam-shut valve opens after a successful ignition sequence to allow gas flow to the main burner. The flame arrester prevents flame flashback from the main burner into the gas train. Pressure gauges either side of the flame arrester provide an indication of any blockage in the flame arrester.

The flame in the flare stack is monitored by an Ultra Violet (UV) sensor and three thermocouples. The UV sensor provides a flame present signal to the control panel. The thermocouples provide flare temperature signals to the control panel. The temperature of the flare is maintained by louvres in the base of the flare stack. Coarse control is provided by manual louvres that are set up during installation. Fine control is provided by a motorised louver that is controlled by the control panel according to the flare temperature signal from the thermocouples.

Power Generation Mode (Future Provision)

Power generation mode provides gas to drive a power generator. Gas is drawn from the field in the same way as flare mode, but the gas is fed through the power generation gas train and not to the burner. Gas flow to the engines is measured by a flow meter,

Ignition

When gas first flows the main burner slam shut valve is closed and the pilot burner piston valve is opened allowing a restricted gas flow through to the pilot burner in the flare stack. A gate valve is set during commissioning to adjust the gas flow rate to the pilot burner.

The pilot burner is ignited by a spark from the igniter. Verification that the pilot is alight is provided by the UV sensor which sends a flame present signal to the control panel. After a short delay to allow the pilot burner flame to stabilise the main burner slam shut valve is opened allowing gas to flow to the main burner. The pilot flame ignites the main burner and when the temperature of the main flare reaches a pre-determined level the pilot burner slam shut valve closes and the pilot burner is extinguished.

If high methane content in the landfill gas creates a too rich mixture that is difficult to ignite, a small volume of compressed air is injected into the pilot line immediately prior to the pilot burner gas via a flame arrester and pressure control valve. Compressed air is only added during the ignition cycle. This feature is optional.

Should the pilot burner fail to ignite within 5 seconds the igniter will be switched off for five seconds before another ignition attempt is made. This 5 second on/5 seconds off sequence of ignition attempts will continue up to a maximum of 5 minutes. A maximum of 3 ignition cycle attempts is allowed before an auto shutdown will be activated.

Shutdown

There are 3 ways of shutting the gas flare:

- Manual
- Automatic
- Emergency

Manual Shutdown

When the gas flare is stopped by selecting **OFF** on the HMI screen the gas inlet and main burner slam-shut valves will close and the extraction fan will be switched off cutting off the gas supply to the main burner.

Auto Shutdown

The following conditions will cause the gas flare to shutdown automatically:

- High stack temperature
- Ignition cycle fail
- Extraction fan trip
- High high liquid level in KOP
- Gas inlet slam-shut valve failure
- Main burner slam-shut valve failure
- Thermocouple 1 failure
- Thermocouple 3 failure

When an auto shutdown is invoked the gas inlet and main burner slam shut valves will close and the extraction fan will be switched off cutting off the gas supply to the main burner and the generator engine.

Following an auto shutdown a manual restart is required. The alarm must be acknowledged and the system reset on the HMI screen before a restart can be attempted. The temperature of the flare stack must be less than 300°C before a restart is enabled.

If the gas flare is stopped manually (off or emergency stop pressed) the gas flare will have to be restarted manually.

Emergency Stop

When any of the emergency stop buttons are pressed the gas inlet and main burner and power generation slam shut valves will close and the extraction fan will be switched off cutting off the gas supply to the main burner and the generator engine.

Alarms

Alarms are provided on the HMI screen on the control panel. For full information on the HMI screen refer to the Technical Information File. The following alarms also generate an auto shutdown:

- High/low stack temperature
- Ignition cycle fail
- Extraction fan trip
- High high liquid level in KOP
- Gas inlet slam-shut valve failure
- Main burner slam-shut valve failure
- Thermocouple 1 failure
- Thermocouple 3 failure
- Flare off and flame detected

The following alarms are provided on the HMI screen but do not generate an auto shutdown.

- Thermocouple 2 failure
- High liquid level in KOP
- Gas analyser low flow

COMPONENT DESCRIPTION

Refer to Figure 7-2.

Knock Out Pot

The KOP removes liquid from the gas stream. Gas from the field is fed to the KOP via a manual butterfly valve, a flow conditioning plate and a flow meter. The butterfly valve is set during commissioning. Vacuum gauges measure the vacuum either side of the wire mesh mist eliminator. A significant difference between the readings (15 – 20 mbar g) would indicate a blockage in the mesh. Manual ball valves allow for isolation of the gauges for maintenance. An analysis point is provided for connection of sampling equipment. Two manual ball valves in the drain line allow the coalesced liquid collected in the base of the KOP to be drained without venting gas.

Flowmeters

Flowmeters are fitted to the gas inlet, the main burner gas train and the power generation gas train. The flowmeters measure the flow rate of the gas. They comprise a flow conditioning plate in the pipeline with a thermal mass flow meter for flow measurement.

Extraction Fan

The extraction fan draws gas from the field at maximum 2000 Nm³h⁻¹. Flexible connections to the main pipeline reduce vibration effects on the pipeline. A pneumatic slam-shut valve and manual butterfly valve are fitted to the inlet of the extraction fan. A non-return valve and a manually butterfly valve are fitted to the outlet of the extraction fan.

Gas Analysis

The gas data analyser is connected to the system at this point for gas sampling. Concentrations of methane, carbon dioxide and oxygen are measured and fed into the HMI screen.

Main Burner Gas Line

Gas flow to the main burner is controlled by a pneumatic slam shut valve (SSV). The SSV is opened by a control signal from the Control Panel when gas flow to the main burner is required and safety conditions are satisfied. Compressed air is provided by the compressor. A flame arrester, a safety critical component, prevents the transmission of flames from the main burner while permitting the gas to flow. Pressure gauges upstream and downstream of the flame arrester are provided to indicate blockages in the flame arrester element.

Pilot Burner Gas Line

Gas flow to the pilot burner is controlled by a manual control (gate) valve and a pneumatic slam shut valve (SSV). The manual control valve controls the amount of gas flow tapped from the main burner line. The SSV is opened by a control signal from the Control Panel when gas flow to the pilot burner is required during the ignition sequence. Compressed air is provided by the compressor. A flame arrester, a safety critical component, prevents the transmission of flames from the main burner while permitting the gas to flow. Pressure gauges upstream and downstream of the flame arrester are provided to indicate blockages in the flame arrester element. Two manual ball valves in the drain line allow the liquid to be drained from the burner lines without venting gas. If required compressed air can be added to the pilot burner gas during ignition via a manually adjusted control valve and a flame arrester. The control valve is set up during installation to achieve the correct methane/O₂ mix.

Flare Stack

The flare stack contains the main and pilot burner, igniter, UV sensor, thermocouples, manually adjusted louvres, automatically adjusted louvre and emission monitoring ports. The louvres provide flame temperature control. The manual louvres are set up during installation and the automatic louvre is set by the control panel according to the output from Thermocouple 2. The UV sensor and the thermocouples are safety critical components. The UV sensor detects the presence of a flame and thermocouple 3 monitors the flame temperature. All thermocouples provide a high temperature shutdown signal.

Control Panel

The power and control components are contained in an air conditioned IP55 cabinet with a hinged and lockable outer door. An emergency stop switch is located on the outer door.

Telemetry Panel

The telemetry components are contained in the control panel cabinet. The following telemetry data is transmitted:

- Flare temperature
- Exhaust gas sample temperature
- Gas flow rate (flare)
- Gas temperature (flare)
- Gas flow rate (power generation)
- Gas temperature (power generation)
- Gas flow rate (total)
- Gas temperature (total)
- CH₄ concentration (inlet gas)
- CO₂ concentration (inlet gas)
- O₂ concentration(inlet gas)
- N₂ concentration (inlet gas)
- CH₄ concentration (exhaust gas)
- CO₂ concentration (exhaust gas)

Gas Analyser Cabinet

The gas analysis equipment is contained in an air conditioned IP65 cabinet with a hinged and lockable door.

Compressor

The compressor is started when the main electrical isolator on the control panel is set to **ON**. The compressor provides compressed air to the slam shut valves.

Safety Critical Components



THERE ARE A NUMBER OF SAFETY CRITICAL COMPONENTS ON THE SYSTEM. UNAUTHORISED MAINTENANCE OR ADJUSTMENT OF THESE COMPONENTS MAY AFFECT THE SAFE OPERATION OF THE SYSTEM WHICH COULD RESULT IN DEATH OR INJURY TO PERSONNEL.

The following components are designated as safety critical:

- Flame arresters: prevents transmission of flames from the burner back into gas line
- UV sensor: provides a flare present signal
- Thermocouples: measure the flare temperature at various points in the flare stack

Section 4 Installation and Commissioning

INTRODUCTION

The Biogas enclosed flare will be installed by Biogas personnel.



DO NOT ATTEMPT TO INSTALL THE BIOGAS ENCLOSED FLARE AND BOOSTER SET UNLESS YOU HAVE READ AND FULLY UNDERSTOOD THE SAFETY INFORMATION IN SECTION 2 OF THIS MANUAL.

SITE PREPARATION

Before the enclosed flare and booster set can be installed, a reinforced concrete base must be prepared to support the assembly. As the requirements vary between sites and systems, the specifications of this base will be supplied by Biogas.

The system will also require a three-phase electricity supply and pipework for the gas supply. The specifications of electricity supply will be advised by Biogas prior to installation.

If a telemetry system is fitted, an appropriate connection from the control panel to a telephone line, GPRS, satellite or any other communication device will be required.

Details of all these requirements will be given by Biogas after the initial site survey.

SITE INSTALLATION

Biogas personnel will install and connect the enclosed flare. If the system has to be moved or reinstalled, please contact Biogas for advice.

COMMISSIONING

The Biogas installation team will perform all final checks and commissioning to ensure that the system is functioning correctly. They will also configure the system to perform within specification.



Any unauthorised adjustment of the system or operating the plant prior to commissioning and handover may invalidate the Biogas warranty.

Section 5 Operation

GENERAL



ALL OPERATORS MUST HAVE ATTENDED A FULL TRAINING COURSE SUPPLIED BY BIOGAS, AND MUST POSSESS A CERTIFICATE TO CONFIRM THIS. DO NOT ATTEMPT TO OPERATE THE BIOGAS ENCLOSED FLARE UNLESS YOU HAVE READ AND FULLY UNDERSTOOD THE SAFETY INFORMATION IN SECTION 2 OF THIS MANUAL AND THE EMERGENCY STOP PROCEDURE BELOW.



If the system is not properly commissioned, operated and maintained, the manufacturer's warranty may be voided or limited. Operating the system outside of the design parameters may invalidate Biogas warranty and affect the performance of the flare.

CONTROLS AND INDICATORS

All the controls and indicators necessary to operate the flare are on the control panel. The emergency stop button is located on the front of the access door to the control panel. An emergency stop button is also located on the flare stack. Figure 5-1 shows the controls and indicators.

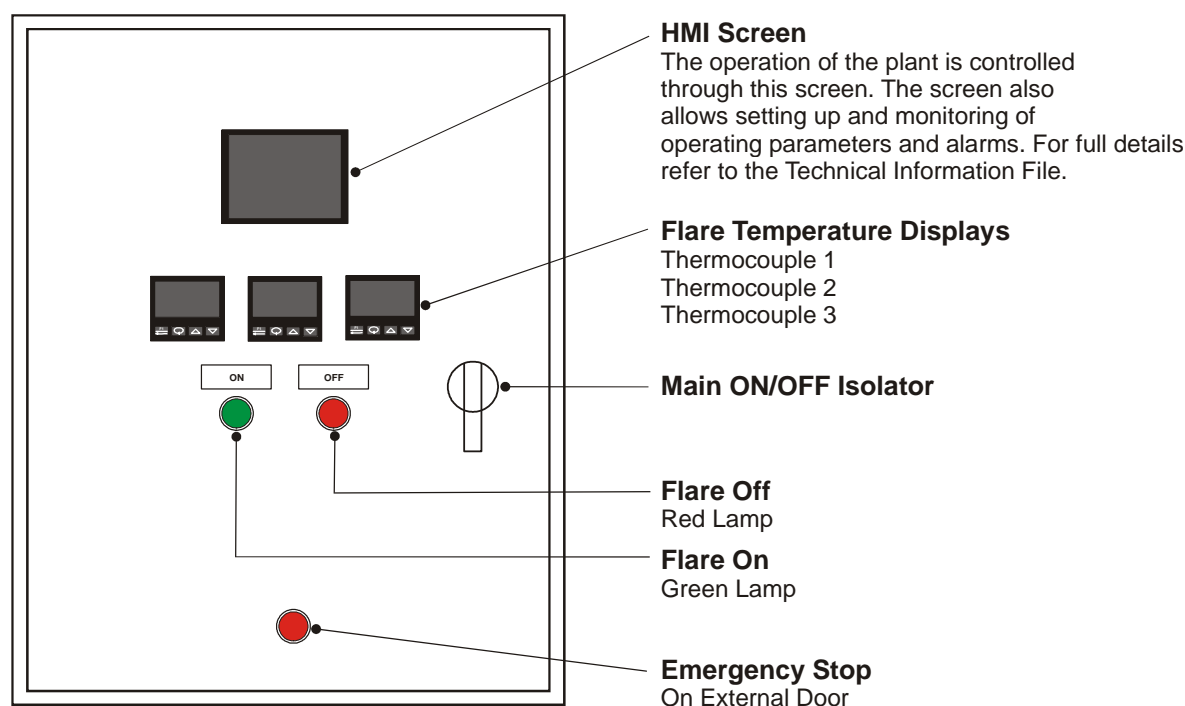


Figure 5-1 Controls and Indicators

HMI Screen

The HMI screen provides the following status information:

- Flare start-up status
- Landfill gas concentrations
- Pilot re-light count
- Pilot gas ON/OFF status
- Igniter ON/OFF status
- Pilot proved status
- Extraction fan status
- Slam-shut valve status
- Flame proved status
- Extraction fan hours run
- Flare operating temperature
- Temperature controller output status
- Gas inlet flow rate

The HMI screen provides the following control functions:

- System control (Local – Off – Remote)
- Extraction fan control (Hand – Off – Auto)
- Temperature control loop for louvre automation
- Temperature controller setpoint
- Reset switch
- Alarm acknowledge

The following auto shutdown alarms are displayed on the HMI screen:

- High stack temperature
- Ignition cycle fail
- Extraction fan trip
- High high liquid level in KOP
- Gas inlet slam-shut valve failure
- Main burner slam-shut valve failure
- Thermocouple 1 failure
- Thermocouple 3 failure
- Flare off and flame detected

The following alarms are provided on the HMI screen but do not generate an auto shutdown.

- Thermocouple 2 failure

- High liquid level in KOP
- Gas analyser low flow

OPERATION

Starting

1. Check that there is no maintenance work being carried on the system.
2. Inspect the system for signs of damage and that it is safe to operate. Any damage must be rectified before start-up.
3. Ensure the field gas supply is connected
4. Set the system main electrical isolator to **ON**.
5. Check the compressor is running and there is an air supply to the system.
6. Ensure that the gas quality is within the flare operating range (25 – 60% vol. methane and < 5% vol. oxygen).

Local Operation

1. On the HMI screen system control select **LOCAL**.
2. Select **START FLARE** and observe start sequence. Check the green **ON** lamp is lit.
3. If the system fails to ignite check line gas quality is within the operating quality range:
(CH₄ : 25 – 60% v/v, O₂ < 5% v/v)

Ignition Failure

1. If the ignition sequence fails to ignite the pilot gas or the flare fails to reach operating temperature within a preset time the system will shut down. The HMI screen will indicate an ignition failure.
2. Reset the system by pressing the **STOP** function on the HMI screen and the cancel the alarm.
3. Press the **START** function on the HMI screen to restart the ignition sequence.
4. If the system still fails to ignite check that the gas quality is within the operating quality range.

Automatic Restart

If the system shuts down automatically (high stack temperature, ignition cycle fail, fan trip, high-KOP level) the system will restart automatically after a 30 minute shutdown period.

Three automatic restarts will be attempted before a reset is required. To reset the system press the **STOP** function on the HMI screen.

To prevent an automatic restart after an automatic shutdown, press the **STOP** function on the HMI screen.

Remote Operation

1. The system can be operated remotely by telemetry. On the HMI screen system control select **REMOTE**.
2. The flare will start when a remote start signal is received via the telemetry system.

Shutting Down

1. To stop the system in a controlled manner (not an emergency), on the HMI screen select **STOP FLARE**. The system will run down and the gas inlet and main burner slam-shut valves will close
2. Set the system main electrical isolator to **OFF**.
3. Check the compressor has stopped and the extractor fan has stopped rotating.

Emergency Stop

1. To stop the system in an emergency press one of the **EMERGENCY STOP** buttons (control panel or flare stack).

Section 6 Maintenance

INTRODUCTION

The Biogas enclosed flare is a high performance gas delivery and disposal system that requires controlled maintenance if it is to operate at peak performance. All maintenance and servicing must be performed by staff who have been trained and certified as competent by Biogas.

If the system is not properly maintained, the manufacturer's warranty may be invalidated or limited. This may also affect the performance of the flare.



ALL MAINTENANCE AND SERVICE STAFF MUST HAVE ATTENDED A FULL TRAINING COURSE SUPPLIED BY BIOGAS, AND MUST POSSESS A CERTIFICATE TO CONFIRM THIS. DO NOT ATTEMPT TO MAINTAIN THE BIOGAS ENCLOSED FLARE UNLESS YOU HAVE READ AND FULLY UNDERSTOOD THE SAFETY INFORMATION IN SECTION 2 OF THIS MANUAL AND THE EMERGENCY STOP PROCEDURE IN SECTION 5.



BEFORE ANY MAINTENANCE IS CARRIED OUT ON ANY PART OF THE SYSTEM, IT IS ESSENTIAL THAT THE FLARE AND BLOWER OPERATIONS ARE STOPPED AND THE CONTROL PANEL ELECTRICAL ISOLATION SWITCH SET TO OFF.



THE PIPE SECTIONS MAY CONTAIN A FLAMMABLE MIXTURE OF GAS AND AIR.



MAINTENANCE TASKS MAY REQUIRE ISOLATION OF GAS SUPPLY AND ELECTRICAL ISOLATION OF THE PLANT. ALL ELECTRICAL AND NON-ELECTRICAL EQUIPMENT USED AROUND THE FLARE SHOULD BE APPROPRIATELY RATED TO RELEVANT AREA CLASSIFICATION ZONES AND THE POTENTIAL IGNITION SOURCES SHOULD BE EXCLUDED OR CONTROLLED.



PRIOR TO ANY TASKS PERFORMED ON THE FLARE, THE OPERATOR SHOULD CARRY OUT RISK ASSESSMENT IN ACCORDANCE WITH CURRENT LEGISLATION AND REGULATIONS.



If the system is not properly maintained, the manufacturer's warranty may be voided or limited. This may also affect the performance of the flare.

MAINTENANCE SCHEDULES

The following schedules detail the routine preventative maintenance that must be carried out to ensure efficient and trouble free operation of the enclosed flare.

The maintenance tasks and frequency are detailed in Table 6-1. Refer to the Maintenance Procedures for procedures on carrying out the maintenance tasks.

Reference should be made to the component manufacturer's data in the Technical Information File for component maintenance and replacement instructions.

The enclosed flare will require a complete overhaul after prolonged operation, and it is recommended that this should be carried out at least once every three years. This can be performed by Biogas.

| Daily Maintenance | |
|-------------------------|---|
| Item | Procedure |
| Condensate drain valves | Check and drain as detailed in the manufacturer's instructions. |

| Weekly Maintenance | |
|---|--|
| Item | Procedure |
| Knock out pot (KOP) | Check the vacuum reading on the vacuum gauges on the KOP. There should be no (or minimal) difference between the gauges. Clean the wire mesh element if there is any significant vacuum difference. Refer to the maintenance procedures for cleaning instructions. |
| Main and pilot flame arrester pressure gauges | Check the pressure readings on the flame arrester pressure gauges. There should be no (or minimal) pressure drop across the flame arrester. Clean the flame arrester if there is any significant pressure drop. Refer to the maintenance procedures for cleaning instructions. |
| Extraction fan | Check that there is no excessive heat being generated by the extraction fan assembly. Ensure the fan is running smoothly with no excessive noise or vibration. Carry out the weekly servicing detailed in the manufacturer's instructions. |
| Pneumatic valves | Check the pneumatic valves are free from air leaks. |
| Compressor | Carry out the weekly servicing detailed in the manufacturer's instructions. |

| Three Monthly Maintenance | |
|--|--|
| Item | Procedure |
| Flame arresters | Inspect and clean the flame arrester. Refer to the maintenance procedures for cleaning instructions. |
| Extraction fan | Carry out the three monthly servicing detailed in the manufacturer's instructions. |
| Compressor | Carry out the three monthly servicing detailed in the manufacturer's instructions. |
| Gas inlet, main burner and pilot burner slam shut valves | Inspect the seals for signs of wear or damage as detailed in the manufacturer's instructions. Check the air supply and actuator for leaks. Check for correct operation in accordance with the manufacturer's instructions. |
| Flare stack cables and connectors | Check integrity of connections. Check cables and connectors for signs of damage. Replace any damaged items. |
| Ignition electrode | Check condition. Refer to the maintenance procedures for removal, inspection and replacement instructions |
| Thermocouples | Check calibration functionality. Refer to the maintenance procedures for calibration instructions. |
| UV Sensor | Check for correct operation and calibration in accordance with the manufacturer's instructions. |
| Manual louvres | Check for correct operation and free from obstructions and blockages. |
| Automatic louvres | Check actuator for correct operation. Check louvres are free from obstructions and blockages. |
| Pipework | Check and tighten all pipework bolts. Refer to the Technical Data section for bolt torques. |
| System | Check the gas flare for correct function in all modes of operation. If there are any faults, stop the gas flare and contact Biogas. |

| Six Monthly Maintenance | |
|-------------------------|---|
| Item | Procedure |
| Wiring | Check continuity of all system wiring including all earth points. Replace any defective wiring. |
| Cables and connectors | Check the condition of all cables and connectors. Replace any defective items. |

Table 6-1 Maintenance Schedule

MAINTENANCE PROCEDURES

Checking pneumatic valves for air leaks

Any major leak will allow pressurised gas to escape from the line. Manually check the circumference of the valve for escaping gas.

To check the valves for smaller leaks, apply a liberal volume of leak detector liquid around the whole circumference of the valve housing. If a bubble forms at any point, there is a small leak at that location.

Cleaning flame arresters

The flame arresters are bolted between pipe sections as shown in the layout drawings in the Technical Data section of this manual. Before the arrester elements can be cleaned, they must be removed from the pipeline.



THE PIPE SECTIONS MAY CONTAIN A FLAMMABLE MIXTURE OF GAS AND AIR.



PRIOR TO ANY TASKS PERFORMED ON THE FLARE, THE OPERATOR SHOULD CARRY OUT RISK ASSESSMENT IN ACCORDANCE WITH CURRENT LEGISLATION AND REGULATIONS.



THERE MAY BE NOXIOUS GAS AND DUST WITHIN THE PIPELINE. WEAR PROTECTIVE CLOTHING AND A FACE MASK TO AVOID INJURY, IRRITATION AND INHALATION OF GAS.



The flame arrester elements contain components that can be damaged if exposed to liquids. You must use only dry air to clean them. Please refer to manufacturer's instructions.



Refer to the Flame Arrester manufacturer's Installation and Maintenance Instructions in the Technical Information File, including the Torque settings and Torquing Sequence – excessive tightening of the bolts may damage the flame arrester element.

To remove and clean the flame arrester elements:

1. Turn off both the Flare and Blower by setting the Main Isolator on the control panel to **OFF**.
2. Ensure that the inlet slam-shut valve is close and that no gas is flowing through the pipeline.
3. Purge the system of all residual gas.
4. Slacken all the nuts and bolts securing the pipe sections that hold the elements in position.
5. Vent the gas from the pipe safely, eliminating ignition sources from the classified area.
6. Leaving one nut and bolt in position, remove and save all the other nuts and bolts.
7. For each flame arrester, you will now need to release the pipe section furthest from the blower (gas booster). Slacken all the nuts and bolts securing this pipe section.
8. Leaving the nut and bolt corresponding to that left in step 5, remove and save all the other nuts and bolts.
9. Rotate the released pipe section so that the flame arrester elements are accessible.
10. Remove the flame arrester elements from the pipeline.

11. Remove and check the gaskets from the pipes on both sides of the elements; replace any damaged gasket(s).
12. Carefully refit all gaskets, ensuring they are correctly located within the pipe sections.
13. Clean the flame arrester element as described in the manufacturer's instructions. If this is not detailed, use a compressed air line to clean the flame arrester elements by directing air from the cleaner side of the element.
14. Carefully refit the flame arrester elements into the pipeline, ensuring that they are correctly located.
15. Rotate the displaced pipe section back to its operational position and refit all the removed nuts and bolts.
16. Tighten all slackened nuts and bolts. See Caution above.
17. After gas flow is reinstated, check for leaks and rectify them if necessary.

Draining the KOP

1. Turn off both the Flare and Blower by setting the Main Isolator on the control panel to **OFF**.
2. Ensure that the inlet valve is closed and that no gas is flowing through the pipeline.
3. If the drain valve is not connected to a drainage system, place a suitable container below the drain valve to collect the fluid. Open and close the KOP drain valves in turn, and allow to drain, avoiding venting gas. Dispose of the fluid in accordance with local instructions.
4. Close the drain valves, open the inlet valve, and set the Main switch to the **ON** position.

Cleaning the KOP demister element

1. Turn off both the Flare and Blower by setting the Main Isolator on the control panel to **OFF**.
2. Ensure that the inlet valve is closed and that no gas is flowing through the pipeline.
3. Undo and remove all the nuts and bolts securing the lid of the KOP. Retain the nuts and bolts.
4. Remove the lid of the KOP.
5. Vent the gas safely, eliminating ignition sources from the classified area.
6. Check the inside KOP for presence of gas.
7. If safe, carefully remove the wire mesh demister element from the KOP.
8. Clean the demister element as detailed in the manufacturer's instructions.
9. Refit the element into the KOP, ensuring that it is correctly located and is a close fit within the pot.
10. Refit the KOP lid and secure with the nuts and bolts retained during disassembly. Refer to Bolt tightening torques table contained in Technical Data.
11. After gas flow is reinstated, check for leaks and rectify them if necessary

Checking the ignition electrode

It is necessary to remove the electrode housing, complete with the electrode, from the flare stack to examine condition of both the housing and electrode.

1. Turn off both the Flare and Blower by setting the Main Isolator on the control panel to **OFF**.
2. Ensure that the burners are turned off and no gas is flowing in the flare stack.



WAIT UNTIL THE FLARE STACK COOLS DOWN. BE AWARE OF POSSIBILITY OF CONTACT WITH HOT SURFACES. USE PROTECTIVE GLOVES.

3. Disconnect the electrical connector from the electrode.
4. Remove and retain the electrode housing bolts.
5. Carefully withdraw the electrode housing from the flare stack.
6. Examine the condition of the electrode. If the ceramic casing has cracked replace the electrode. Any deposits or spikes on the electrode tip should be removed carefully with a small fine file or similar abrasive tool; ideally the tip of the electrode should be squared off.
7. The electrode gap is not adjustable, but should be between 3mm and 5mm, nominally. If there have been ignition problems, which have not been cured as a result of cleaning the electrode, and the electrode gap appears excessive, the electrode should be replaced.
8. Examine the electrode housing. Any deposits creating a spike on the housing should be removed carefully with a fine file (or similar abrasive tool), to leave a smooth surface on the housing, adjacent to the electrode tip.
9. Carefully locate the electrode housing into the flare stack and secure using the fixing bolts.
10. Reconnect the electrical connector to the electrode.

Thermocouple functionality check



This operation should only be carried out by a suitably trained and qualified engineer approved by Biogas.

The thermocouple functionality can only be checked by comparison with a known calibrated instrument, which is inserted in an adjacent port in the Flare Stack. This check should be conducted in accordance with the Biogas Work Instruction.

Checking louvre control actuators

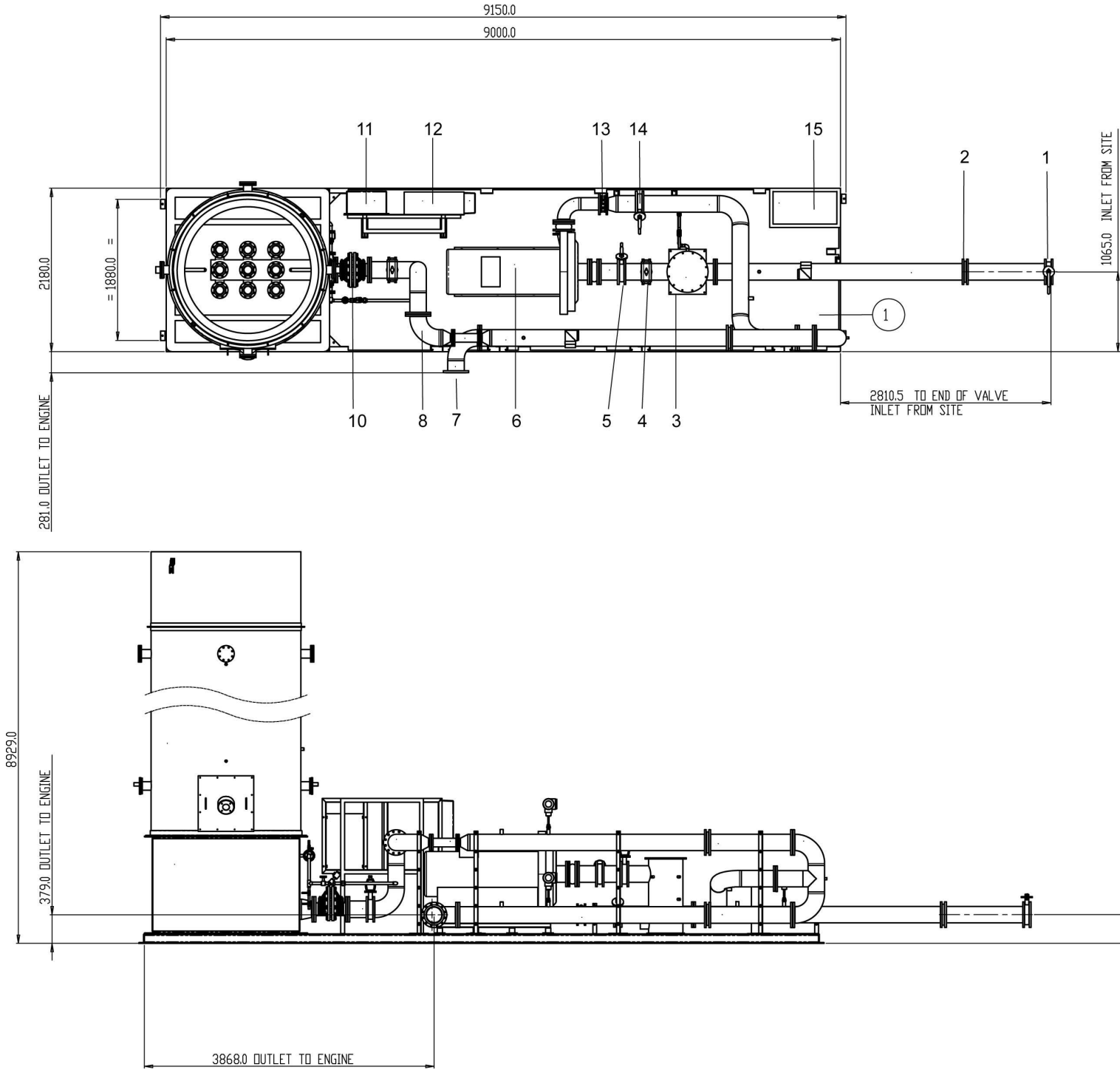


This operation requires specialist electrical equipment and should be carried out by qualified electricians only

The louvres are designed to operate automatically as gas is flared. To check the operation of the louvre actuators, a voltage has to be applied to the control connector of the actuator and confirm that the louvre operates. Refer to the manufacturer's instructions in the Technical Information File.

Section 7 Technical Data

GENERAL ARRANGEMENT AND DIMENSIONS



| | | | |
|---|---|----|--------------------------|
| 1 | Gas inlet manifold/manual butterfly valve | 10 | Flame arrester |
| 2 | Flowmeter | 11 | Control Panel |
| 3 | Knock out pot (KOP) | 12 | Gas Analyser |
| 4 | Pneumatic slam shut valve | 13 | Non-return valve |
| 5 | Manual butterfly valve | 14 | Manual butterfly valve |
| 6 | Extraction fan | 15 | Compressor and enclosure |
| 7 | Gas outlet manifold to engine | 16 | Sight glass |
| 8 | Main burner line | 17 | Flare stack |
| 9 | Pilot burner line | | |

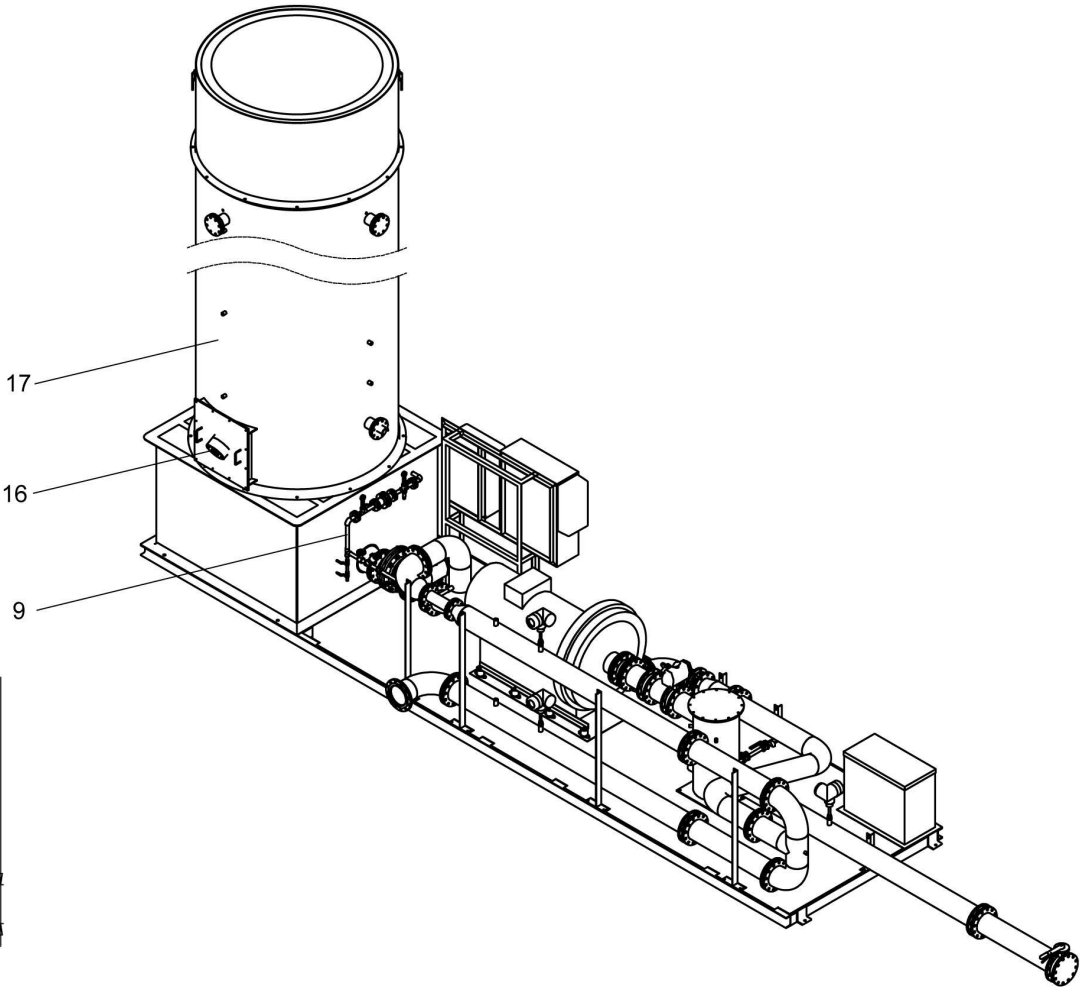
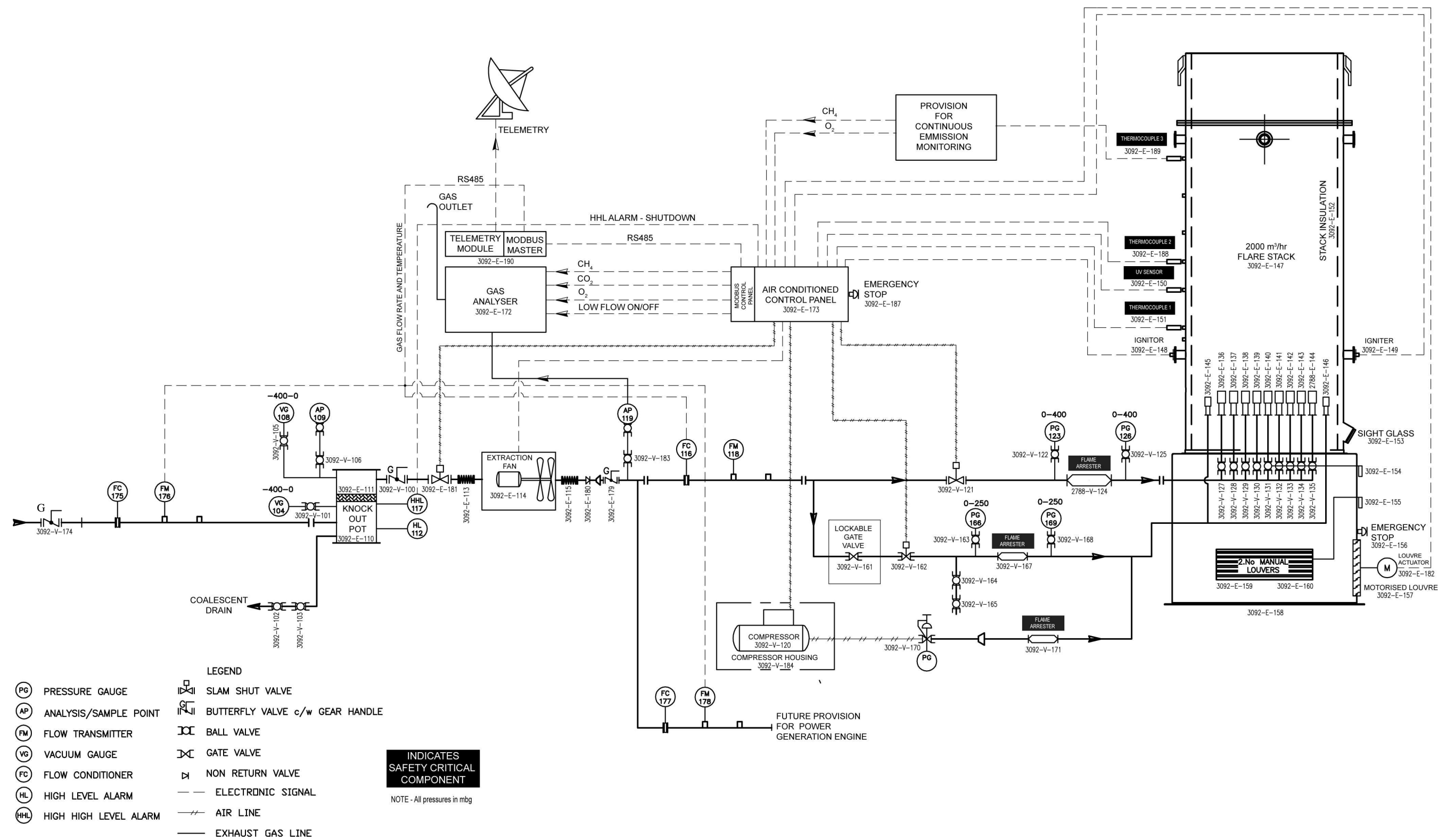


Figure 7-1 General Arrangement

PROCESS AND INSTRUMENTATION DIAGRAM



COMPONENT DESIGNATION

The following table identifies the components shown on the P&ID.

| Tag No | Description | Tag No | Description |
|-----------------|--|-----------------|--|
| 3092 - V - 100 | Butterfly Valve | 3092 - E - 146 | Burner - pilot |
| 3092 - V - 101 | Ball Valve | 3092 - E - 147 | Flare Stack |
| 3092 - V - 102 | Ball Valve | 3092 - E - 148 | Ignitor - Removable |
| 3092 - V - 103 | Ball Valve | 3092 - E - 149 | Ignitor - Removable |
| 3092 - VG - 104 | Vacuum Gauge (Bottom Mounted) | 3092 - E - 150 | UV Flame Detector - UVS6 |
| 3092 - V - 105 | Ball Valve | 3092 - E - 151 | Thermocouple |
| 3092 - V - 106 | Ball Valve | 3092 - E - 152 | Stack Insulation |
| 3092 - S - 107 | Plant Sign-Plant specification+atex sign | 3092 - E - 153 | Sight Glass |
| 3092 - VG - 108 | Vacuum Gauge (Bottom Mounted) | 3092 - E - 154 | Valve Extensions |
| 3092 - AP - 109 | Sample / analysis point | 3092 - E - 155 | Louvre Extensions |
| 3092 - E - 110 | Demister Pot | 3092 - E - 156 | Emergency Stop |
| 3092 - E - 111 | Demister Pot Filtration Element | 3092 - E - 157 | Motorised Opposed Blade Louvre |
| 3092 - E - 112 | KOP High Level Switch | 3092 - E - 158 | Flare Cube Assembly |
| 3092 - E - 113 | Flexible | 3092 - E - 159 | Opposed Blade Louvre |
| 3092 - V - 114 | 2 Stage Gas Booster | 3092 - E - 160 | Opposed Blade Louvre |
| 3092 - E - 115 | Flexible | 3092 - V - 161 | Gate Valve - locable |
| 3092 - FC - 116 | Flow Conditioning Plate | 3092 - V - 162 | Piston Valve |
| 3092 - V - 117 | KOP High High Level Switch | 3092 - V - 163 | Ball Valve |
| 3092 - FM - 118 | Mass Flow Meter | 3092 - V - 164 | Ball Valve |
| 3092 - AP - 119 | Sample / analysis point | 3092 - V - 165 | Ball Valve |
| 3092 - V - 120 | Compressor | 3092 - PG - 166 | Pressure Gauge (Bottom Mounted) |
| 3092 - V - 121 | Slam shut Valve - Pneumatically operated | 3092 - E - 167 | Flame Arrestor |
| 3092 - V - 122 | Ball Valve | 3092 - V - 168 | Ball Valve |
| 3092 - PG - 123 | Pressure Gauge (Bottom Mounted) | 3092 - PG - 169 | Pressure Gauge (Bottom Mounted) |
| 3092 - E - 124 | Flame Arrestor | 3092 - V - 170 | Self Regulating Pressure Control Valve |
| 3092 - V - 125 | Ball Valve | 3092 - E - 171 | In Line Flame Arrestor |
| 3092 - PG - 126 | Pressure Gauge (Bottom Mounted) | 3092 - E - 172 | Inlet gas analyser |
| 3092 - V - 127 | Ball Valve | 3092 - V - 173 | Main Control Panel |
| 3092 - V - 128 | Ball Valve | 3092 - V - 174 | Butterfly Valve |
| 3092 - V - 129 | Ball Valve | 3092 - FC - 175 | Flow Conditioning Plate |
| 3092 - V - 130 | Ball Valve | 3092 - FM - 176 | Mass Flow Meter |
| 3092 - V - 131 | Ball Valve | 3092 - FC - 177 | Flow Conditioning Plate |
| 3092 - V - 132 | Ball Valve | 3092 - FM - 178 | Mass Flow Meter |
| 3092 - V - 133 | Ball Valve | 3092 - V - 179 | Butterfly Valve |
| 3092 - V - 134 | Ball Valve | 3092 - V - 180 | Wafer Check Valve |
| 3092 - V - 135 | Ball Valve | 3092 - V - 181 | Slam shut Valve - Pneumatically operated |
| 3092 - E - 136 | Burner - Main | 3092 - V - 182 | Louver actuator |
| 3092 - E - 137 | Burner - Main | 3092 - V - 183 | Ball Valve |
| 3092 - E - 138 | Burner - Main | 3092 - E - 184 | Lockable compressor housing |
| 3092 - E - 139 | Burner - Main | 3092 - E - 185 | Plant Sign - Biogas logo & address |
| 3092 - E - 140 | Burner - Main | 3092 - E - 186 | Zoning Diagram |
| 3092 - E - 141 | Burner - Main | 3092 - E - 187 | Emergency Stop |
| 3092 - E - 142 | Burner - Main | 3092 - E - 188 | Thermocouple |
| 3092 - E - 143 | Burner - Main | 3092 - E - 189 | Thermocouple |
| 3092 - E - 144 | Burner - Main | 3092 - E - 190 | Netrix telemetry module |
| 3092 - E - 145 | Burner - pilot | | |

OPERATING AND COMMISSIONING PARAMETERS

The following table details the operating parameters and commissioning/installation settings.

| Parameter | Design Value | PPC Relevant | Alarm Value | Value set at Commissioning |
|---|--|--------------|-------------|----------------------------|
| Physical Parameters | | | | |
| Internal stack orifice diameter (mm) | 1690 | Yes | | |
| Stack height (mm) | 8929 | Yes | | |
| Dimensions (approximate) W x L x H (mm) | 2461 x 10995 x 8929 | | | |
| Weight (approximate kg): | Stack - 3000 Plant - 6000 Total - 9000 | | | |
| Operational/Design Parameters | | | | |
| Flare maximum start temperature (°C) | 300 | | | |
| Fan / Booster motor | 2-stage, 45 kW Ex II 3 G [EXn type] | | | |
| Pressure rise across the fan / booster (mbar g) | 300 | | | |
| Power supply requirement | 3 phase, 415V, 32A | | | |
| Ignition flame detection | UV camera | | | |
| | Flame present for 10 seconds | | 10 | |
| Ignitor type | Spark plug | | | |
| Ignition cycle fail (min) | 5 | | 3 | |
| Flame failure detection | UV camera | | | |
| | Flame not present for 5 seconds | | 10 | |
| High temperature stack (°C) | 1200 | | 1200 | |
| Air intake | Natural aspiration | Yes | | |
| Flame flashback shutdown temperature (°C) | N/A | | N/A | |

| Parameter | Design Value | PPC Relevant | Alarm Value | Value Set at Commissioning |
|--|--------------|--------------|-------------|----------------------------|
| Technical Data | | | | |
| Gas flow rate (min / max) Nm ³ h ⁻¹ | 400 – 2000 | | | |
| Turn down ratio | 5:1 | | | |
| Gas quality range CH ₄ (% vol) | 27 – 65 | | | |
| Gas quality range O ₂ (% vol) | < 5 | | | |
| Methane destruction efficiency (%) | 99.9 | Yes | | |
| Hydrogen destruction efficiency (%) | 99.9 | Yes | | |
| Retention time [RT] at minimum flow rate (s) | 3.9 | Yes | | |
| Retention time [RT] at maximum flow rate (s) | 0.6 | Yes | | |
| RT min. EA requirement (s) | 0.3 | | | |
| Flare temperature [T] nominal operating range (°C) | 1000-1150 | Yes | | |
| T min. EA requirement (°C) | 1000 | | | |
| Emissions Field tests on similar flare at 273 K, 101.3 kPa, corrected for 3% O ₂ , dry gas in (mg m ⁻³) | | | | |
| VOC (THC) | 2 | Yes | | |
| Estimate of uncertainty | +/- 30% | | | |
| VOC max. EA limit | 10 | | | |
| CO | 10 | Yes | | |
| CO max. EA limit | 50 | | | |
| Estimate of uncertainty | +/- 10% | | | |
| NOx | 92 | Yes | | |
| NOx max. EA limit | 150 | | | |
| Estimate of uncertainty | +/- 15% | | | |

TROUBLESHOOTING

Troubleshooting should only be carried out by suitably trained and qualified personnel. If in any doubt about the operation of the plant contact Biogas.

| Fault | Symptoms | Action |
|---|--|--|
| Flare won't start | Operating start sequence doesn't start the flare | Visually check power availability. Contact Biogas or qualified electrician if flare still not operating to check connection. |
| Fan doesn't start | No movement of the motor | Check fan trip alarm and reset if needed. If symptoms persist contact Biogas. |
| | Motor moving, no gas flow | Check the belts (if fitted) Check shaft and coupling (if direct drive). Contact Biogas |
| Flare won't start or goes out quickly after start | No gas flow | Check flame arrester (differential pressure). Clean flame arrester in accordance with manufacturer's instructions or contact Biogas. |
| Flare won't start | SSV not operating | No air. Check compressor and air lines. If compressed is present and the flare won't start, contact Biogas |
| Leaving manual louver open | Pilot light ignites, but when main SSV opens, the flame flickers or dies. Or the flare ignites but the high temperature cannot be controlled due to motorised louver searching for stable control point. | Close manual louver |
| High methane concentration with low oxygen | High concentration methane. Pilot ignites ok but after opening the main burner(s) the flame is goes out. | Open manual louver |
| Low methane concentration | Pilot flame flickering on/off. Main burners flame flicking on/off. | Balance the field, wait for the gas concentration to recover. Refer to design operating parameters of the flare. |
| Weak igniter signal (spark) | Ignitor sparking, but not igniting the gas | Check for distance between the tip and the ignitor. Check for damp along the ceramic of the igniter. Check igniter settings are in accordance with manufacturer's instructions. |
| No igniter signal | No spark | Dry or replace transformer |
| Flashing flare or gas temperature display screens | Thermocouple or thermocouple cable damaged or disconnected | Check connections. Replace the thermocouple or cable. |
| Plant fails to start | Plant does not start after initiating start sequence. | Check emergency stop position and connections on the back of emergency stop switch. Check MCBs switch position. If OFF, get appropriately trained person to investigate and repair in accordance to BSM7671 regulations. |



| Fault | Symptoms | Action |
|-------------------------------------|---|---|
| UV sensor (flame detector) | Pilot light lighting, but not seeing the flame. No stable UV signal. | Debris, part of the lining obscuring the hole. Broken bulb, dirty lens. Remove the UV sensor and clean the hole in the ceramic liner. Check UV sensor in accordance with manufacturer's instructions. |
| No temperature control on the flare | Motorised louvre unserviceable. Wrong settings of manual louvres Thermocouple fault | Check operation of the motorised louvre (start and stop the flare). Check settings of the manual louvres – contact Biogas. Contact Biogas |
| Flare goes out | Sudden gas composition change not reflected in manual louvre settings. | |

TORQUE SETTINGS

The following table gives the bolt tightening torques for Biogas bolts.

Biogas bolts are normally Grade 8.8. Torques given are for dry, unlubricated and unplated bolts.

Refer to the manufacturers instructions in the Technical Information File for specific component torque settings.

| Bolt Diameter | Socket/ Spanner Size (mm) | Tensile Stress Area (mm ²) | Torque Setting Nm (ft.lbs) | | |
|---------------|---------------------------|--|----------------------------|------------------|------------------|
| | | | Grade 8.8 Bolts | Grade 10.9 Bolts | Grade 12.0 Bolts |
| M5 | 8 | 14.2 | 6.9 (5.0) | 9.4 (7.0) | 11.2 (8.0) |
| M6 | 10 | 20.1 | 11.7 (9.0) | 15.9 (12.0) | 18.1 (13.0) |
| M8 | 13 | 36.6 | 28.0 (21.0) | 38.0 (28.0) | 46.4 (34.0) |
| M10 | 17 | 58.0 | 56.0 (41.0) | 77.0 (57.0) | 92.0 (68.0) |
| M12 | 19 | 84.3 | 98 (72.0) | 134.0 (99.0) | 160.0 (118.0) |
| M16 | 24 | 157.0 | 244.0 (180.0) | 332.0 (245.0) | 397.0 (293.0) |
| M20 | 30 | 245.0 | 476.0 (646.0) | 646.0 (476.0) | 776.0 (572.0) |
| M24 | 36 | 363.0 | 822.0 (1120.0) | 1120.0 (826.0) | 1342.0 (990.0) |

COMPONENT MANUFACTURER'S DATA

The following component data can be found in the Technical Information File:

| Section | Component | Supplier |
|---------|----------------------------|----------------------------------|
| 2 | Control Panel | Control Systems Technology |
| 3 | Gas Analyser | HITECH |
| 4 | Telemetry Module | Dexdyne |
| 5 | Butterfly Valve | Bray UK |
| 6 | SSV, Pneumatic Actuators | Bray UK |
| 7 | Ignition Electrode | Lodge Ignition |
| 8 | UV Flame Detector | Krom Schroder |
| 9 | Louvres | Isolated Systems |
| 10 | Gas Booster | Fans and Blowers |
| 11 | Pressure Regulating Valves | Duncan |
| 12 | Stack Insulation | Thermal Ceramics |
| 13 | Flowmeter | Endress and Hauser |
| 14 | Air Compressor | Cooper Frier |
| 15 | Thermocouples | Thermocouple Instruments |
| 16 | Flame Arresters | Knitmesh Protego UK B.O.C. |
| 17 | KOP KOP Filter Element | Biogas Knitmesh |