Contaminated Land
Air Quality
Environmental Audit

#

SMITH GRANT Environmental Consultancy LLP

Partnership No: OC 00776

CHP PLANT,

BLAZERS FUELS,

BRICKFIELD LANE,

RUTHIN

ENVIRONMENTAL PERMIT VARIATION APPLICATION

SUPPORTING INFORMATION DOCUMENT

PERMIT PAN-005141

for: NEWBRIDGE ENERGY LTD

January 2021

R2298E-R03-v1

Smith Grant LLP, Station House, Station Road, Ruabon, Wrexham, LL14 6DL
tel: 01978 822367 fax: 01978 824718 e-mail: consult@smithgrant.co.uk web: www.smithgrant.co.uk
Members: K E Hawkins (Chairman), B J Thomas, A F Smith, D Wayland

DOCUMENT CONTROL SHEET

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Environmental Permit Variation Application: Supporting Information Document

Client: Newbridge Energy Ltd

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CHP PLANT, BLAZERS FUELS, RUTHIN

ENVIRONMENTAL PERMIT VARIATION APPLICATION: SUPPORTING INFORMATION DOCUMENT

For: Newbridge Energy Ltd

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Non-Technical Summary

Introduction

Newbridge Energy Limited (NEL) holds an Environmental Permit (PAN-005141) under the Environmental Permitting (England and Wales) Regulations 2016, as amended ('EPR').

The Permit allows the Operator, NEL, to operate *'one or more small waste incinerator plant that is also a Tranche B Specified Generator aggregated to <50MW$_{th}$'* at a site at Brickfield Lane, Ruthin, Denbighshire.

This application to vary the Environmental Permit has been prepared by Smith Grant LLP (LLP) on behalf of the NEL. The application is made to operate a second Tranche B Generator / Medium Combustion Plant at the site. The additional plant would also have a thermal capacity of 5.2 MW$_{th}$. Operations will be for up to 8,000 hours per annum.

The additional plant would use the same fuel as the existing plant, namely biomass (virgin wood chip). The existing plant is also permitted to use clean, untreated waste wood and hence is also permitted as a small waste incineration plant. It is not proposed to use this material in the second plant. As such a variation to the existing Environmental Permit is being applied for the addition of a generator / medium combustion plant.

Site Location

The site is located within on Brickfield Lane, Ruthin, centred at National Grid reference SJ 11576 59054.

Operations

The second CHP plant would be served by a single exhaust stack of 20m. Information provided by the technology provider and monitoring of the existing equivalent CHP plant at the site has confirmed the stack emissions would meet the required ELV of 190 mg/Nm^3 (at 15% O_2, dry conditions).

Management of Activities

The facility as a whole is operated in accordance with an Environmental Management System (EMS). This includes aspects such as management and control, maintenance and monitoring, staff training and record keeping.

1 Introduction

1.1 Background

1.1.1 This document and appendices form the supporting documentation for an Environmental Permit variation application to operate an additional generator / medium combustion plant under the Environmental Permitting (England and Wales) Regulations 2016, as amended ('EPR').

1.1.2 The application is made by Newbridge Energy Ltd (NEL) in relation to its' operations at Brickfield Lane, Ruthin.

1.2 Existing Activity

1.2.1 NEL currently operates a solid biomass combined heat and power (CHP) unit at its' Ruthin site. The Uniconfort Boiler unit is utilised to provide heat to dry woodchip to a desired moisture content in a belt dryer prior to processing into wood pellets or briquettes. The boiler is served by a single exhaust stack of 20m.

1.2.2 The plant predominantly utilises virgin woodchip. Some clean untreated wood waste arising from an aboricultural source is also utilised. The applicable European Waste Classification (EWC) codes are:

Table 1.1: Applicable Waste Codes

European Waste Classification Codes	Description
02 01 03 02 01 07	Plant tissue waste from agriculture, horticulture and forestry

1.2.3 The plant has a thermal input capacity of 5.2 MW_{th} and electrical output of 1 MW_{e}. All the thermal energy is utilised within the manufacturing process along with ~300 kW of electrical energy. The remainder is available for export to the grid.

1.2.4 Due to the use of clean untreated wood waste within an individual unit input capacity of ≥1 MW_{th} but less than 3 tonnes per hour (~13.33 MW_{th} input) the plant forms a SWIP under Schedule 1, Part 2, Chapter 5, Section 5.1 Part B(a)(v). The plant is used for the purposes of generation of electricity and heat and is also a Specified Generator under Schedule 25B of the EPR and a Medium Combustion Plant (MCP) as defined in Schedule 25(A).

1.2.5 As the plant was an existing MCP on the basis it was operational before 20th December 2018 it has been permitted as a Tranche B Specified Generator.

1.2.6 The operation was granted an Environmental Permit (PAN-005141) on 17th December 2019. The Permit allows the Operator, NEL, to operate *'one or more small waste incinerator plant that* *is also a Tranche B Specified Generator aggregated to* $<50MW_{th}$*'* at a site at Brickfield Lane, Ruthin, Denbighshire.

1.2.7 The existing permit does not include the storage of waste; accordingly no more than 125 tonnes of waste wood is stored on site at any one time prior to incineration.

1.3 Proposed Activity

1.3.1 Proposals are to operate a second Uniconfort Boiler unit at the site. The unit will have the same input capacity of $5.2MW_{th}$ and electrical output of MW_e and be served by a single 20m exhaust stack.

1.3.2 The total combined rated thermal input capacity at the site would therefore be $10.4MW_{th}$ with a combined electrical output of 2MWe.

1.3.3 The plant will utilise the same virgin wood chip as the existing plant. It is not proposed to use the clean untreated waste wood in this second plant; this material will continue to be used in the current installed plant. It would remain that no more than 125 tonnes of waste wood would be stored on site at any one time.

1.3.4 The variation application therefore relates to the proposed operation of a second Generator as defined in Schedule 25B of the EPR and a Medium Combustion Plant (MCP) as defined in Schedule 25A of the EPR. The total combined rated thermal input capacity of the resulting Specified Generator would remain less than 50 megawatts.

1.3.5 The site was granted planning permission by Denbighshire County Council (DCC; reference number: 02/2018/0497/PS) on 7th August 2018 allowing variation to Condition 2 of the original permission for the site (02/2015/1095) to permit the installation and operation of the second CHP unit.

1.3.6 A 'substantial' variation is being applied for.

1.3.7 The application is made based on correspondence with NRW on the 15th August 2019 and review of available guidance.

1.4 Site Location

1.4.1 The site is located within an industrial area on the northern outskirts of Ruthin. The CHP plant is located within the wider site as follows:

Table 1.1: Site Details

Address	Blazer Fuels, Brickfield Lane, Ruthin, Denbighshire LL15 2TN
National Grid Reference	Site: centred on: SJ 11576 59054 Existing MCP / Generator: stack (identifier 2766): SJ 311633 59010

	Proposed additional MCP / Generator stack (identifier 2885) : SJ 311602 359022
Local Authority	Denbighshire County Council (DCC)

1.4.2 Other industrial / commercial premises lie to the east, northwest and north. The surrounds to the west and south consist of undeveloped land. The premises of Ruthin Livestock Market are located 110m to the southwest. An area of residential development is located 175m to the southeast beyond the Ruthin North Link Road, adjacent to which is the Glasdir School, the buildings of which lie 385m to the south of the site.

1.4.3 The closest residential properties are located about 175m to the southeast off Stryd Yr Wennol and Stryd Yr Alarch at the edge of a residential development that extends further to the southeast and south. Golf Links Farm is located 405m to the west.

1.4.4 A public footpath lies 270m to the east of the site.

1.4.5 The site and existing and proposed MCP / Generator locations are provided in the Site Plan in Drawing D01 and in detail in plans in Appendix A.

1.5 Supporting Documentation

1.5.1 The supporting documentation has been prepared with reference to the specific activities that form part of the application, namely the MCP / Generator, and not the wider site activities. With reference to the requirements of the EPR in relation to MCP and generators, the documentation considers potential air emissions; associated emissions and monitoring; and management to manage and operate the activity. Consideration is not made of other aspects such as odour, noise, waste, water and energy efficiency and BAT does not apply.

1.5.2 This document and accompanying appendices provide the following supporting information to the application:

- Site Plans: detailing the site location and the specific location of the MCP / Specified Generator within the site;
- Technical Information: technical information and data provided by the technology provider (Uniconfort);
- Existing Emissions Monitoring Data: results of monitoring of stack emissions;
- Management, Operations and Monitoring: outline of existing management system and monitoring proposals;
- Environmental Risk Assessment: assessment of potential environmental risks, with reference specifically to air emissions;
- Air Quality Assessment: detailed air quality assessment (AQA) and addendum
- MCP / Generator Checklist

2 Technical Information and Emissions Monitoring

2.1 Technical Information

2.1.1 As noted above the CHP Plant is to be provided by Uniconfort and has a thermal input capacity of 5.2 MW_{th} and electrical output of 1 MW_e. Technical information is provided in Appendix B.

2.1.2 The plant is of the same design by Uniconfort as the existing plant at the site.

2.1.3 Summary information on the MCP / Generator is provided in Appendix G.

2.2 Emissions Monitoring

2.2.1 Monitoring of the existing biomass boiler stack emissions was undertaken during the commissioning period in October 2017. The monitoring was undertaken by Exova Catalyst, an MCERTS accredited company, on 5th October 2017. Subsequent emissions monitoring was undertaken by Exova Catalyst on 13th June 2018. The full results are included within Appendix C.

2.2.2 Monitoring in October 2017 was undertaken for oxides of nitrogen (as NO_2), total particulate matter, PM_{10}, $PM_{2.5}$, and CO and in June 2018 for oxides of nitrogen (as NO_2) and total particulate matter.

2.2.3 The existing permit specifies Emissions Limit Values (ELVs) for NO_2, CO, dust, TVOC and dark smoke as summarised below in Table 2.1.

Table 2:1: Existing Environmental Permit Emission Limit Values

Parameter	Limit[1]	Monitoring frequency
Oxides of nitrogen (NO and NO_2, expressed as NO_2)	475 mg/Nm^3	Annual
Carbon Monoxide	225 mg/Nm^3	Annual
Dust (Particulate Matter)	50 mg/Nm^3	Annual
TVOC	30 mg/Nm^3	Annual
Dark smoke	No visible dark smoke	Annual

1: Defined at a temperature of 273.15K, a pressure of 101.3 kPa and after correction for the water vapour content of the waste gases at a standardised O_2 content of 6%

2.2.4 ELVs are included in the existing permit for CO, dust, TVOC and dark smoke, due to the operation of the plant as a SWIP. The specified ELV of 475 mg/Nm^3 for NO_2 (273K, 101.3 kPa, dry gas, 6% oxygen) is however consistent with that required for a Generator / MCP.

2.2.5 The results of the existing plant for NO_2 are provided below in Table 2.2.

Table 2.2: Summary of Monitoring Data

Date	Lab Ref	NO_2 Emission Concentration (as quoted)(mg/Nm^3)[1]	NO_2 Emission Concentration (as adjusted)(mg/Nm^3)[2]	Comment
05.10.17	CAT-3701	82.1	131[3]	well below required ELV
23.05.18	CAT-4237	155	232	well below required ELV

1: Oxides of nitrogen (as NO_2) concentration quoted in laboratory analysis results

2: Oxides of nitrogen (as NO_2) concentration as adjusted to reference conditions of 273K, 101.3 kPa, dry gas and 6% O_2

2.2.6 The monitored NO_2 emissions are below the required ELV.

2.2.7 The proposed second CHP is of the same make and model and hence would similarly be designed to meet the required ELVs.

3 Management, Operations and Monitoring

3.1 The site is operated in accordance with an Environmental Management System (EMS) that has been developed to meet the requirements of the International Standard ISO 14001:2015. The EMS details organisational responsibilities, procedures for communication, maintenance procedures, emergency preparedness and response, training and awareness, performance evaluation, record management and nonconformities. Details on environmental controls, requirements, information and instructions are included in the plant operating instructions, visual work instruction training and administration procedures which are prepared by the CHP Manager. The EMS is currently undergoing review; a copy of the existing overarching EMS Manual is provided in Appendix D.

3.2 The EMS would be developed to ensure it covers all the elements required by the Permit variation in relation to the specific operation of the MCP / Generator and associated emissions.

3.3 All monitoring required under the Permit to demonstrate compliance with an emission limit value for NO_x of 495 mg/Nm^3 ((273K, 101.3 kPa, dry gas, 6% oxygen) would be undertaken in accordance with the required methodology and recorded and reported to NRW as necessary.

4 Environmental Risk Assessment

4.1 An Environmental Risk Assessment (ERA) was undertaken for the original permit application through reference to the requirements of the generic risk assessments provided by NRW for the standard rules for Generators. Accordingly, it was only necessary to assess emissions to air, and specifically releases of NO_x within the ERA.

4.2 A detailed air quality assessment (AQA) has been undertaken incorporating atmospheric dispersion modelling. A copy of the AQA is included in Appendix E. The AQA incorporated modelling of the existing and proposed new CHP Plant stack emissions, in addition to other sources on site, namely the dryers. Additional information on ecological receptors is also provided in an Addendum[1] to the original AQA and provided in Appendix E.

4.3 The AQA (and Addendum) included consideration of potential impacts at human health and ecological receptors in the area. The site is not located within, or near an Air Quality Management Area (AQMA) or any identified areas of potential poor air quality.

4.4 The AQA concludes that significant adverse impacts on local relevant human health and ecological receptors are not predicted.

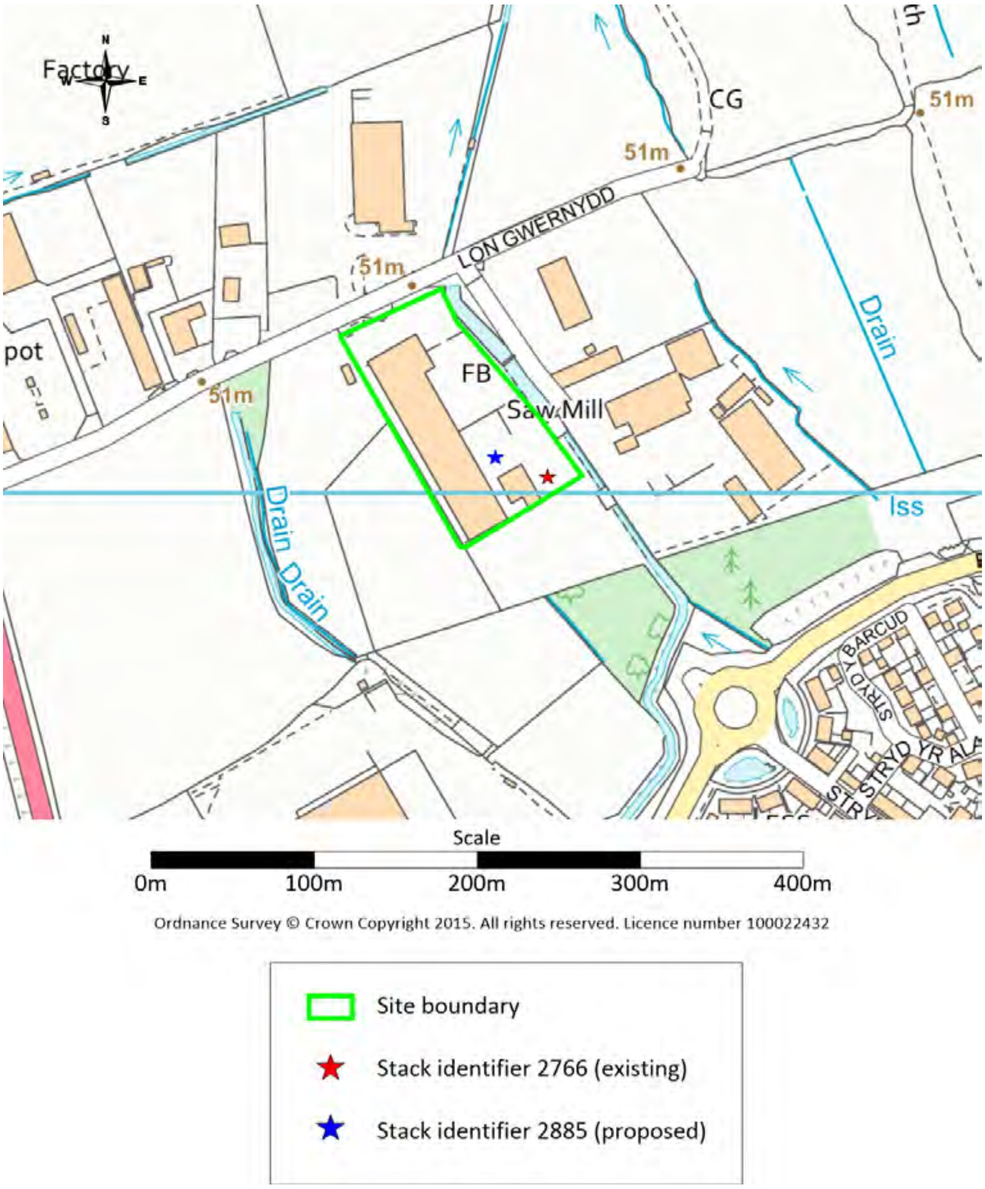
4.5 The CHP activities shall be managed and operated in accordance with the EMS which includes procedures for inspection and maintenance of equipment, accident prevention and management, staff competence and training, complaints procedure, records and monitoring.

4.6 The summary ERA is provided in Appendix F.

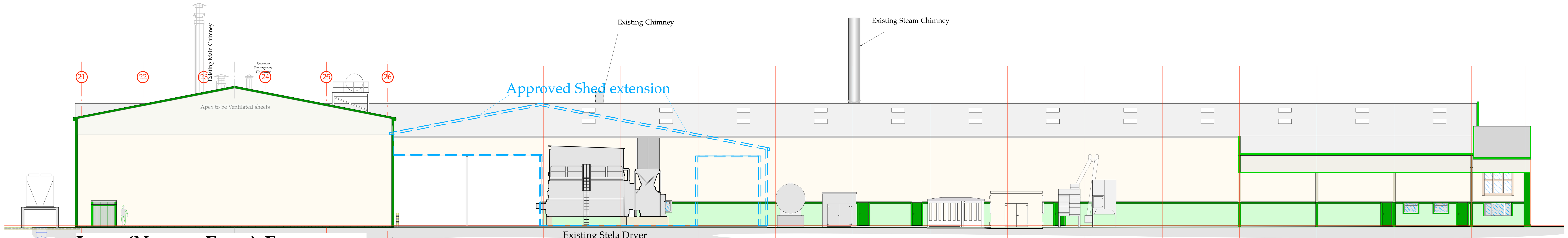
[1] Smith Grant LLP, Wood Drying Facility and Associated CHP Plant, Brickfields Lane, Ruthin, Air Quality Assessment Addendum, R2298D-R06-v1, 14th February 2020

APPENDIX A

SITE PLANS

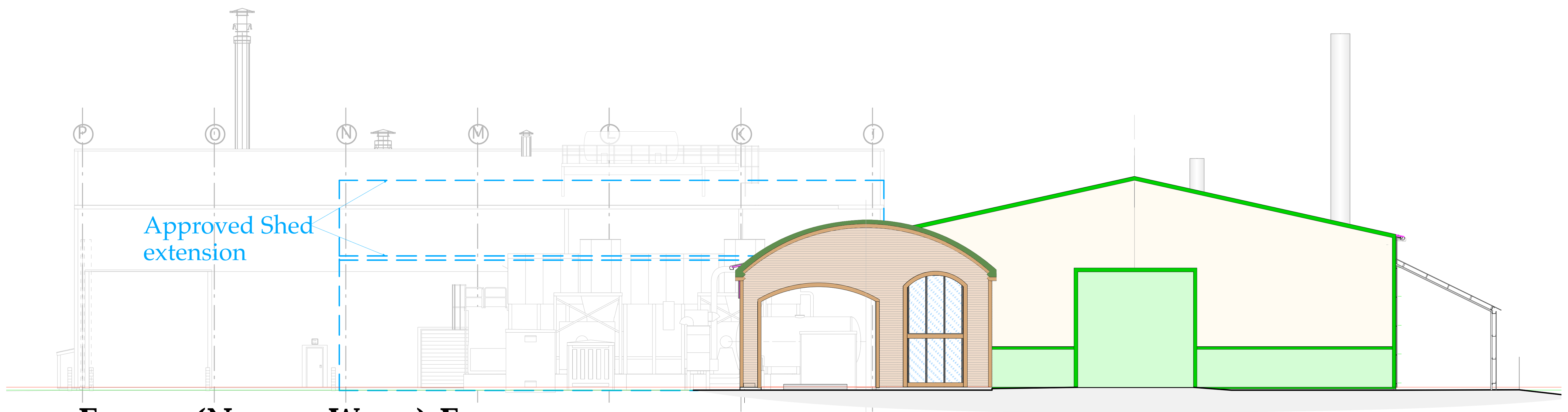


Drawing D01: Site and MCP / Specified Generator Location

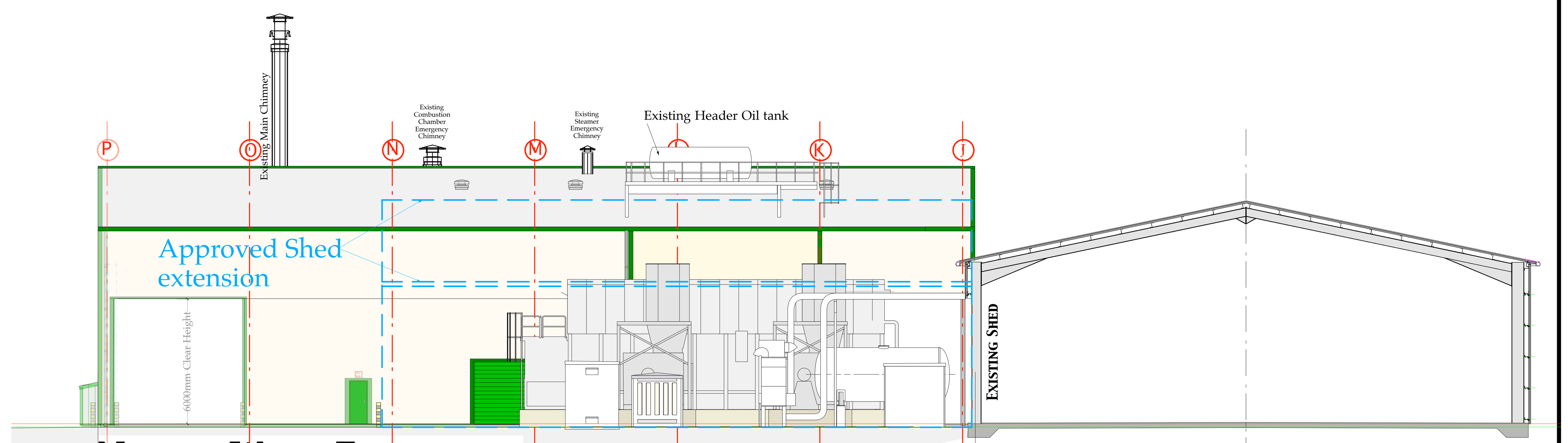


Left (North East) Elevation

Recently completed shed extension Housing CHP Plant & ORC

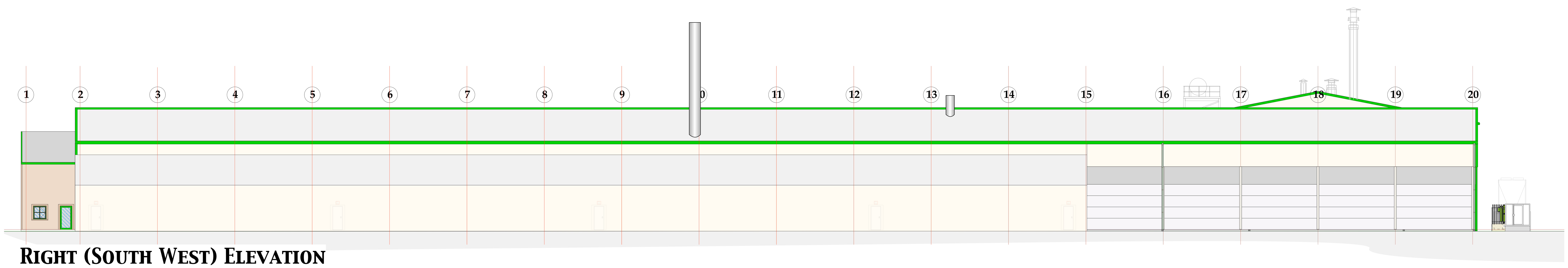


Front (North West) Elevation

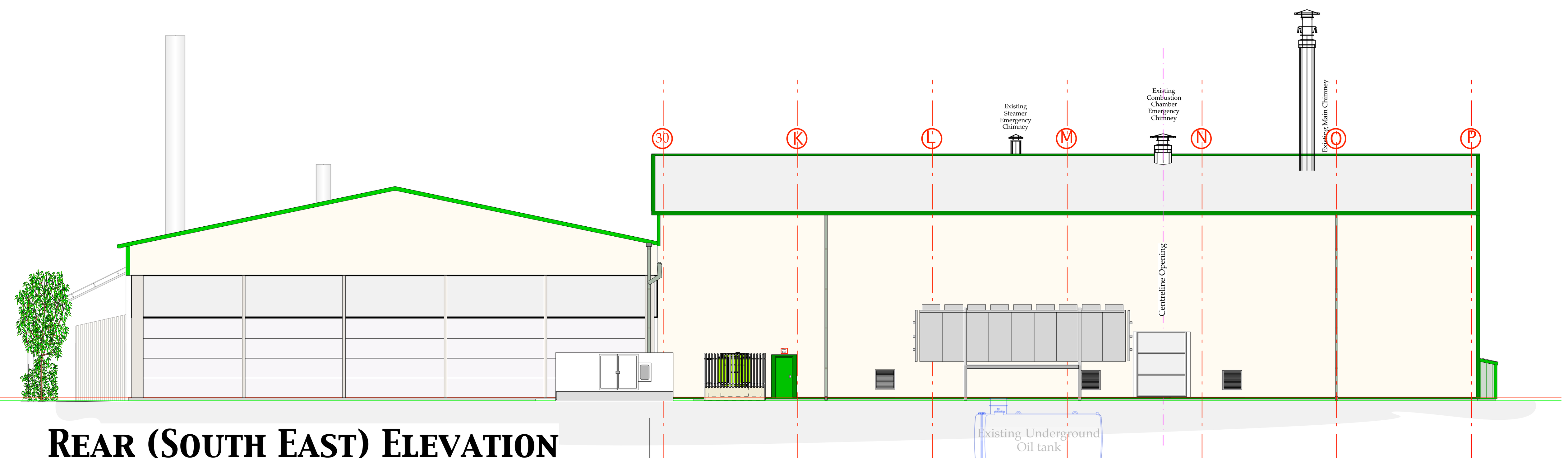


North West Elevation

Recently completed shed extension Housing CHP Plant & ORC



Right (South West) Elevation



Rear (South East) Elevation

Recently completed shed extension Housing CHP Plant & ORC

NB4

R. Arwel Davies & Co
Chartered Building Surveyors
Llwyn Derw, Prion, Denbigh, Denbighshire Tel 01745 890 635

Property: Newbridge Energy
Brickfield Lane
Ruthin, Denbighshire LL15 5TN

Clients: Newbridge Energy Ltd

Project Title: Combined Heat & Power Plant

Drawing Title: As Existing Elevations

Drawing No.	Sheet No.	Version	Revision
2018/02/	AE2/	c	Rev B - 12th April 2018 - Approved Shed Outline Added; Rev C - 18th April 2018 - Minor additions

Scale	Date	Drawn on A1 sheet by
1/200	18th March 2018	R. Arwel Davies

NB4 - As Proposed

R. Arwel Davies & Co
Chartered Building Surveyors
Llwyn Derw, Prion, Denbigh, Denbighshire Tel 01745 890 635

Property: Newbridge Energy
Brickfield Lane
Ruthin, Denbighshire LL15 5TN

Clients: Newbridge Energy Ltd

Project Title: Combined Heat & Power Plant

Drawing Title: As Proposed Site Plan

Drawing No.: 2018 / 02 / AP1 / a

Revision: Rev A - 18th April 2018 - Site Plan Created

Scale: 1 / 300

Date: 12th April 2018

Drawn on A1 sheet by R. Arwel Davies

NB1 As Existing

R. Arwel Davies & Co
Chartered Building Surveyors
Llwyn Derw, Prion, Denbigh, Denbighshire Tel 01745 890 635

Property	Newbridge Energy Brickfield Lane Ruthin, Denbighshire LL15 5TN
Clients	Newbridge Energy Ltd
Project Title	Combined Heat & Power Plant
Drawing Title	As Existing Site Plan

Drawing No.	Sheet No.	version	Revision
2018 / 02 /	AE1 /	e	Rev C - 18th April 2018 - Site Plan Created Rev D - 24th April 2018 - Approved extension shown Rev E - 17th May 2018 - NB1 As Existing Added

Scale	Date	
1 / 300	18th March 2018	Drawn on **A1** sheet by *R. Arwel Davies*

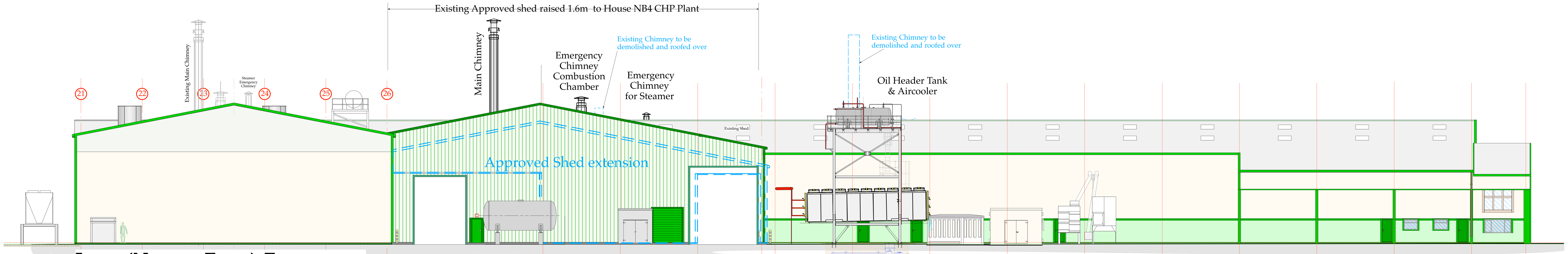
NB4

R. Arwel Davies & Co
Chartered Building Surveyors
Llwyn Derw, Prion, Denbigh, Denbighshire Tel 01745 890 635

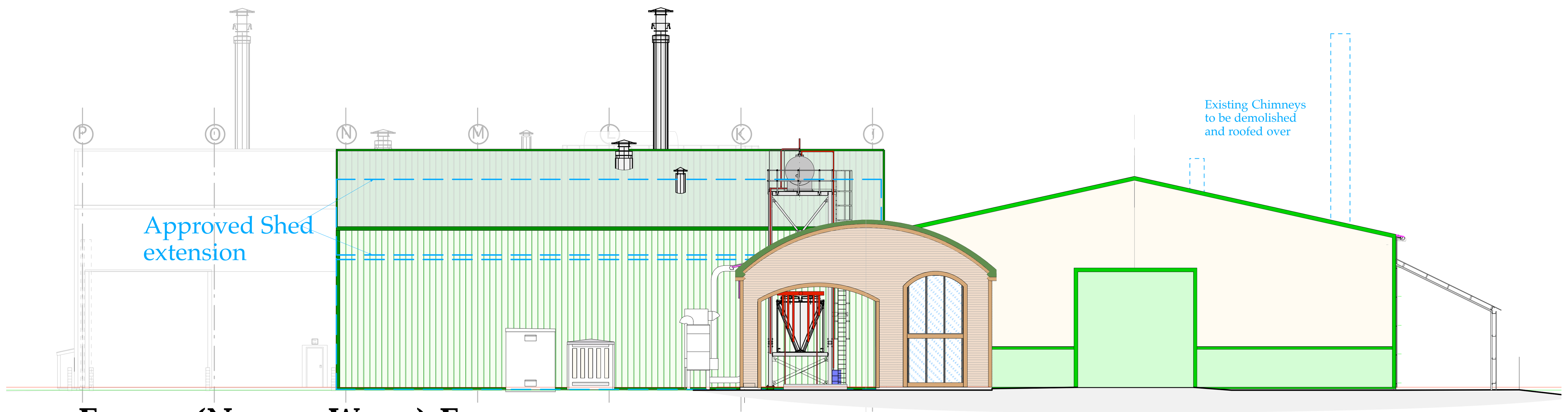
Property	Newbridge Energy Brickfield Lane Ruthin, Denbighshire LL15 5TN
Clients	Newbridge Energy Ltd
Project Title	Combined Heat & Power Plant
Drawing Title	As Existing Floor Plan

Drawing No.	Sheet No.	version	Revision
2018 / 02 /	AE3 /	c	Rev B - 12th April 2018 - Approved Shed Outline Added Rev C - 18th April 2018 - Layout corrected

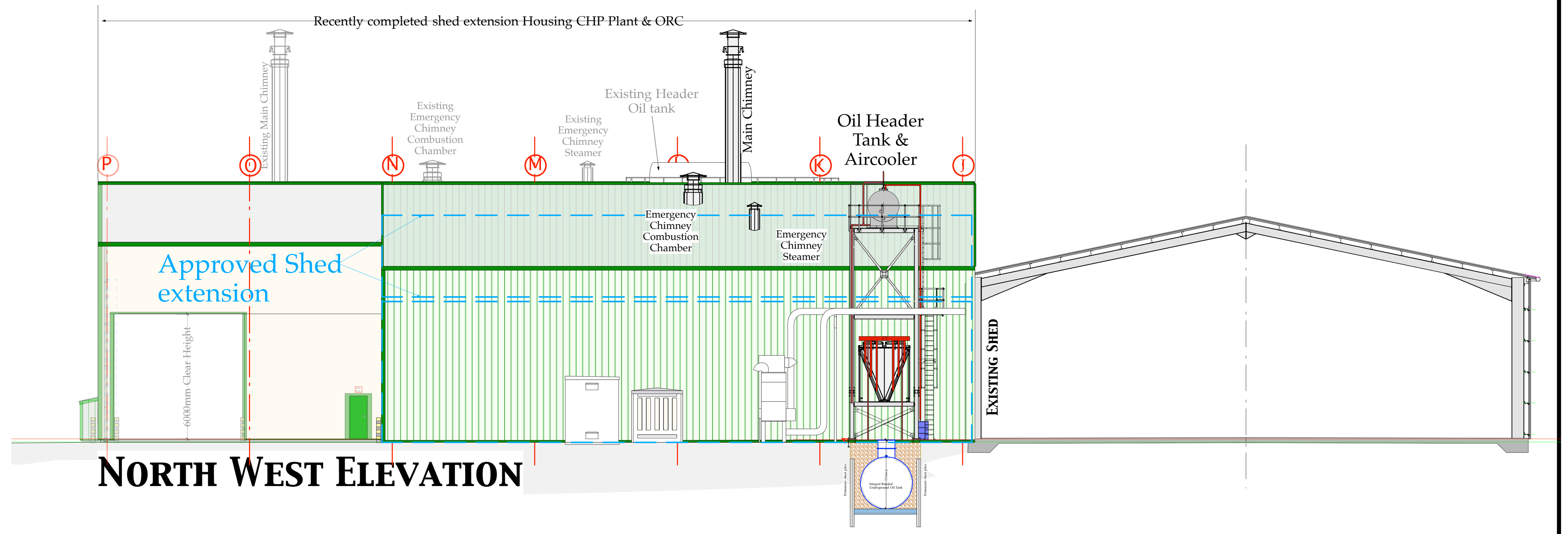
Scale	Date	
1 / 200	18th March 2018	Drawn on **A1** sheet by *R. Arwel Davies*



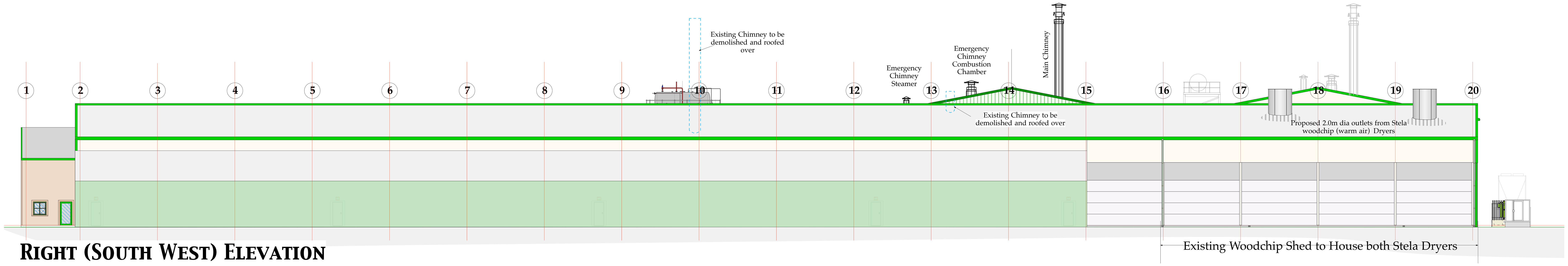
LEFT (NORTH EAST) ELEVATION



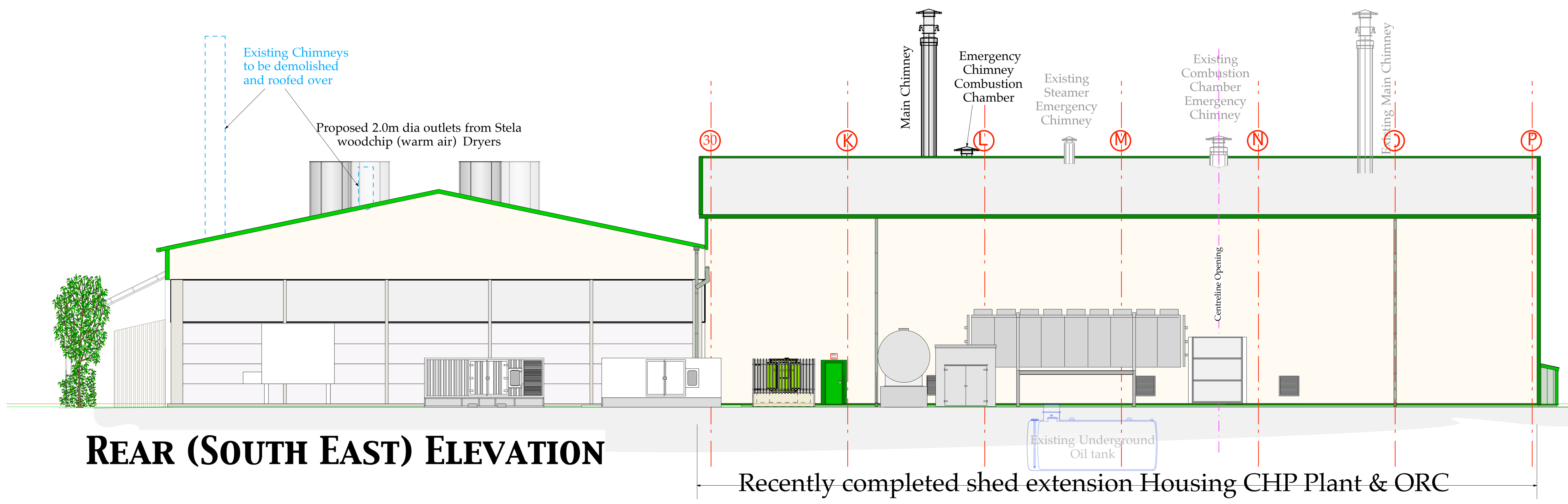
FRONT (NORTH WEST) ELEVATION



NORTH WEST ELEVATION



RIGHT (SOUTH WEST) ELEVATION



REAR (SOUTH EAST) ELEVATION

NB4 - AS PROPOSED

R. Arwel Davies & Co
Chartered Building Surveyors
Llwyn Derw, Prion, Denbigh, Denbighshire Tel 01745 890 635

Property: Newbridge Energy
Brickfield Lane
Ruthin, Denbighshire LL15 5TN

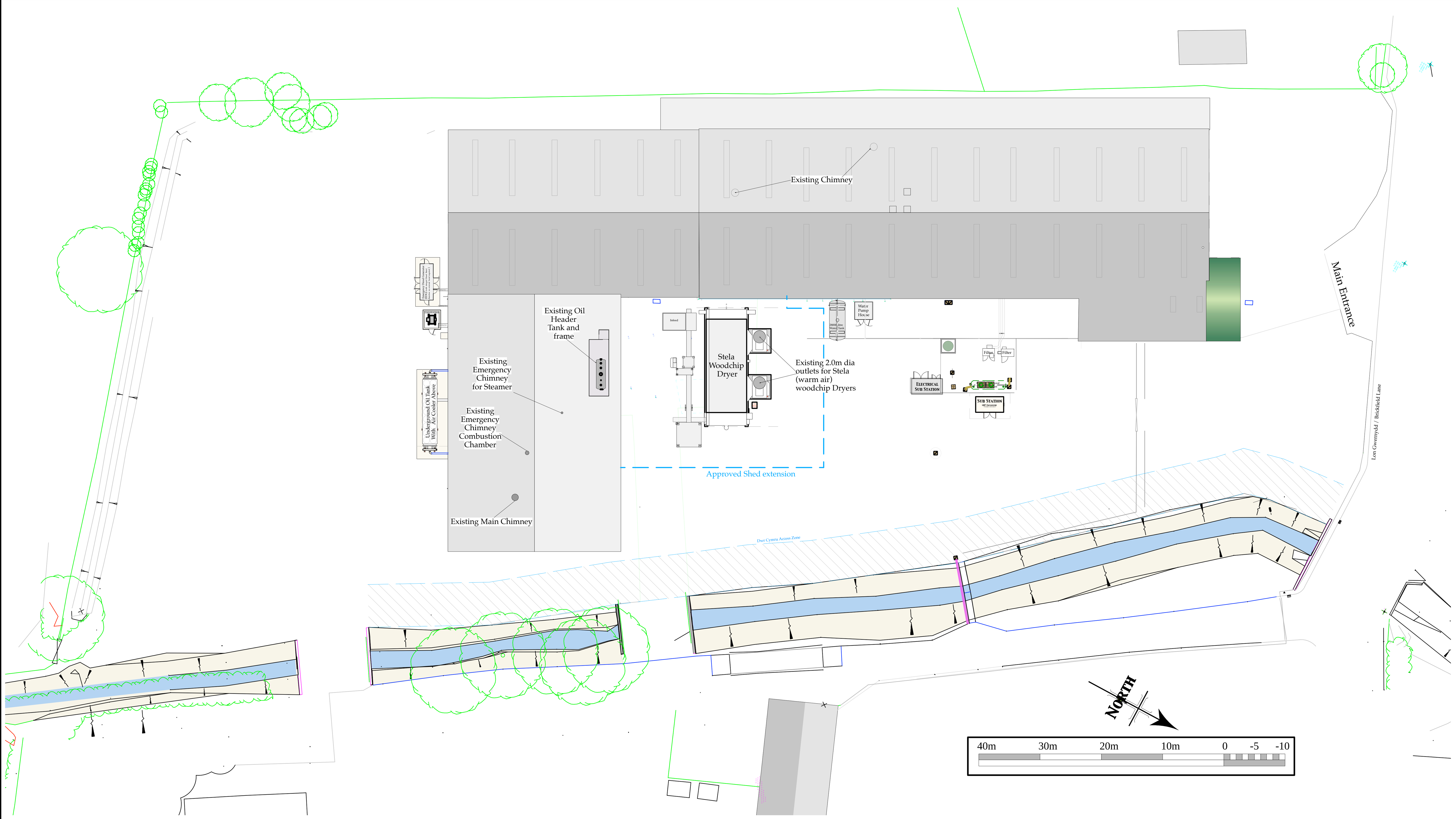
Clients: Newbridge Energy Ltd

Project Title: Combined Heat & Power Plant

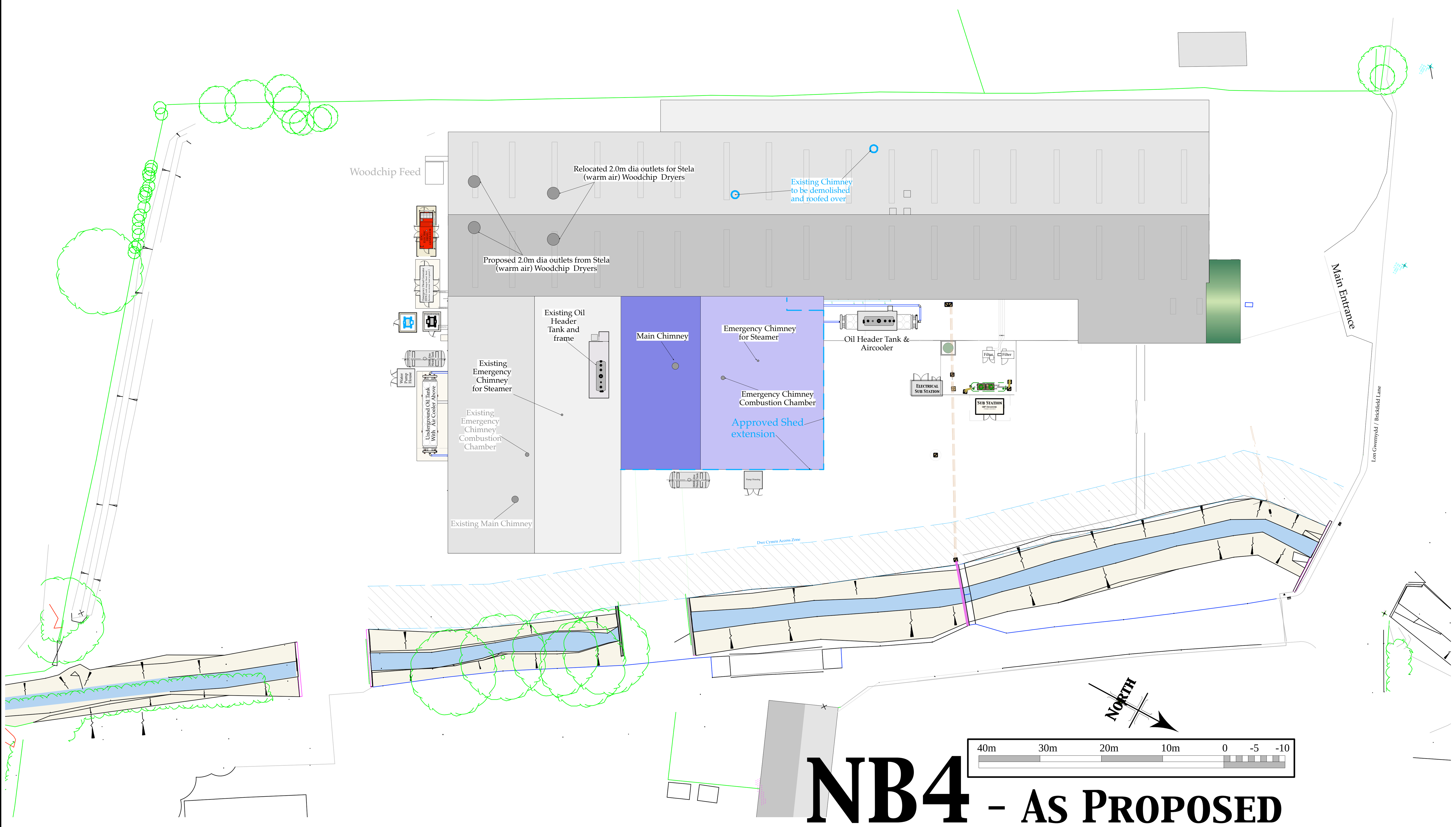
Drawing Title: As Proposed Elevations

Drawing No	Sheet No	Version	Revision
2018/02	AP2	a	Rev A - 18th April 2018 - Minor revisions

Scale	Date	Drawn on A1 sheet by
1/200	12th April 2018	R. Arwel Davies



NB1 - As Existing



NB4 - As Proposed

R. Arwel Davies & Co
Chartered Building Surveyors
Llwyn Derw, Prion, Denbigh, Denbighshire Tel 01745 890 635

Property: Newbridge Energy
Brickfield Lane
Ruthin, Denbighshire LL15 5TN

Clients: Newbridge Energy Ltd

Project Title: Combined Heat & Power Plant

Drawing Title: As Proposed Site Plan - Compared

Drawing No.	Sheet No.	Version	Revision
2018 / 02	/AP4		

Scale	Date	Drawn on A1 sheet by
1 / 500	18th April 2018	R. Arwel Davies

Appendix B

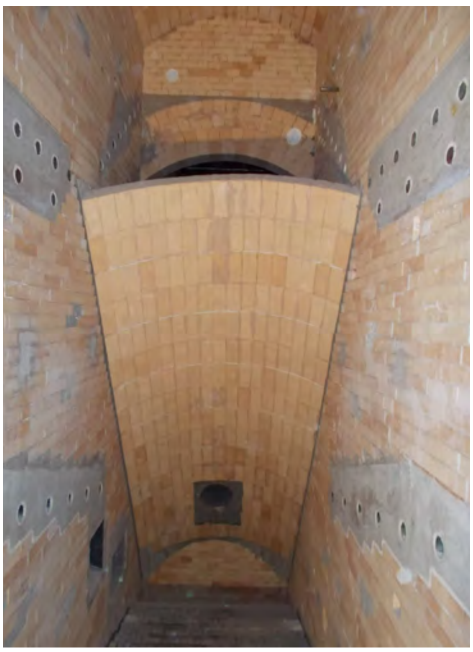
Technical Specifications

uniconfort®
BIOMASS BOILERS AND CHP PLANTS

COMBUSTOR

STANDARD | E 1

Manual for
INSTALLATION, MAINTENANCE, STORAGE



Carefully read these instructions before first use.

GB

Ed. 03/2017 - Rev.00

Translation of original Italian instructions

MANUFACTURER'S NOTE:

Revision Index

Rev.	Date	Revision Description
00	03/2017	Basic manual. First edition.

Table of Contents

Section 1 - Machine description and technical data

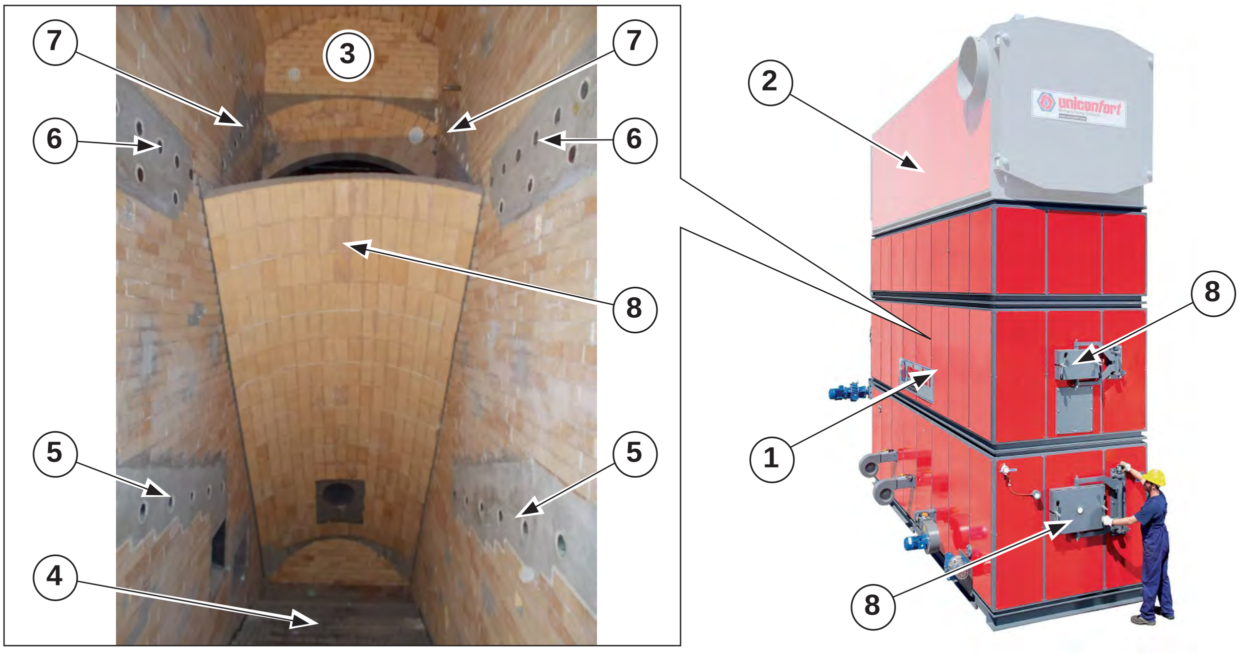
1.1 General description of the combustor

NOTE: The photos and images used in this publication are all for example purposes and may show a different "Combustor" from the one actually installed in your system. However, all the information concerning the main units, safety devices and maintenance operations described in this documentation remain valid.

The **Combustor** (or combustion chamber) is the central body of the boiler (Det. 1) within which combustion of the solid fuel occurs and the thermal energy required to feed the heat exchanger is produced (Det. 2). The combustor is designed and sized according to the thermal power required by the boiler it is to be the main part and consists of a combustion chamber lined with refractory material that withstands high temperatures (Det. 3), a mobile grate system (Det. 4) operated by hydraulic cylinders for feeding the fuel into the chamber (including an ash extraction device) and three separate air supply systems (primary, secondary and tertiary air) whose purpose is to promote the fuel drying and ignition stage and subsequently to optimise the combustion process in the various chamber areas (Det. 5, 6 and 7) blowing in a controlled manner the oxidizing agent (air) into the chamber. Each combustor is with one or more inspection hatches (e.g. Det. 8) to visually check the inside of the combustion chamber and to perform cleaning operations (with machine stopped and completely cooled).

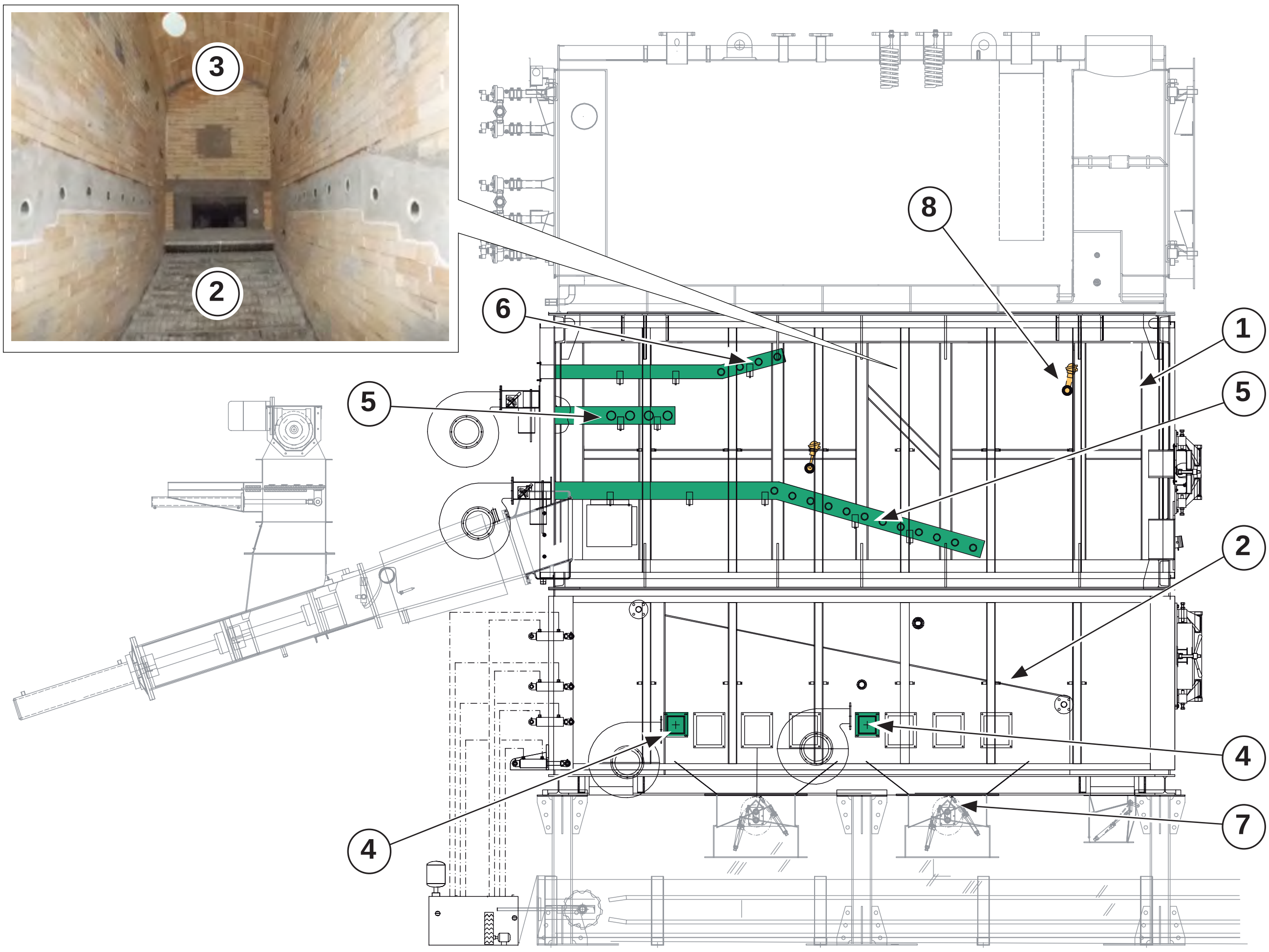
Optimisation of the combustion process is assured by the machine control system (PLC or SUPERVISOR) which, analysing the data collected by the various cycle monitoring electrical devices (temperature probes, thermostats, vacuum meters etc.) adjusts the amount of oxidising air blown into the various areas of the chamber and increases/decreases the solid fuel fed in.

NOTE: As mentioned above, the dimensions, shape of the combustion chamber and any vaults (e.g. Det. 8) is variable according to the dimensions and power required of the boiler.



1.2 Identification of main combustor parts

With reference to the example picture below, the Combustor (regardless of the size) generally consists of the following main parts:



Part	Description
1	Combustor metal frame
2	Grate
3	Refractory lining
4	Primary air ventilation
5	Secondary air ventilation
6	Tertiary air ventilation
7	Ash extraction
8	Instrumentation (Temperature probes, vacuum meter...).

1.3 Description of main combustor parts

1.3.1 Combustor metal frame

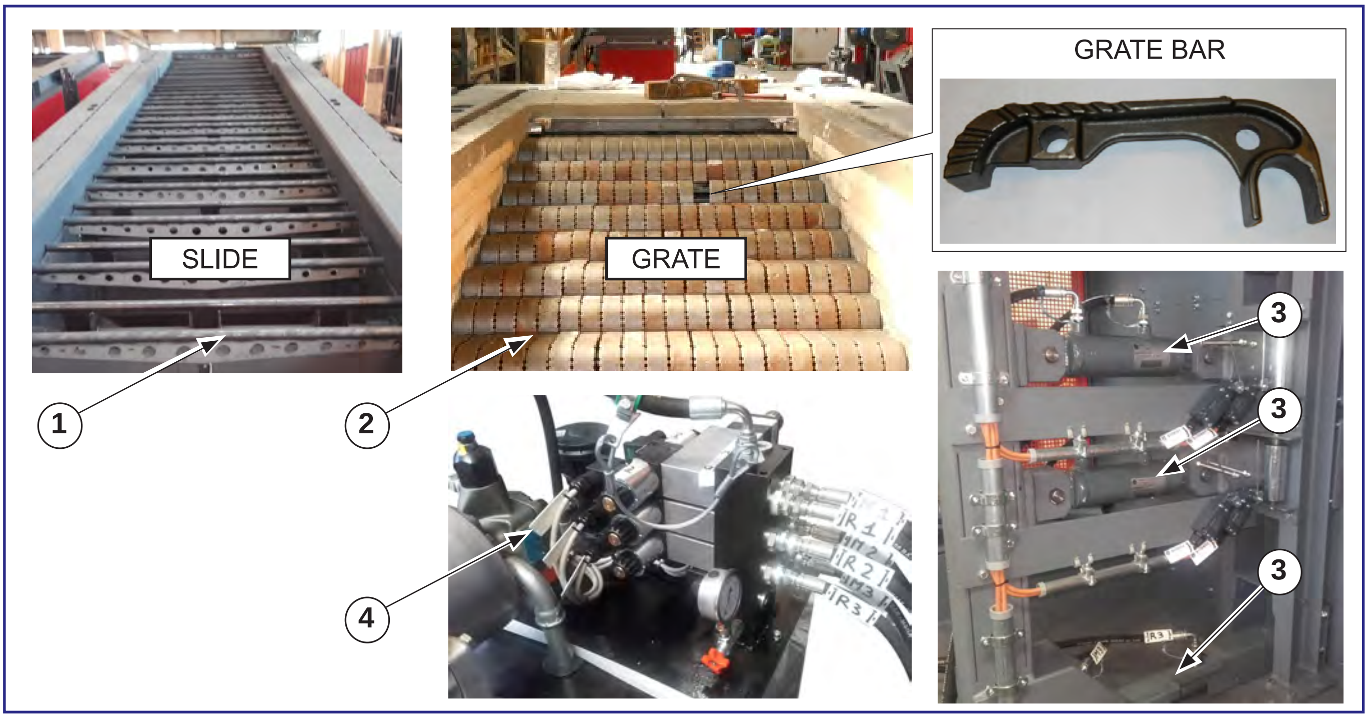
The combustor main frame is constructed in solid metal and has the purpose of supporting all the components of the combustion chamber 's core.
Design takes into account the thermal dilation the main structure is subject to upon start-up to prevent said deformations from undermining the integrity of the structure and refractory lining installed inside.

1.3.2 Grate

The grate is the mechanical device installed on the lower part of the combustion chamber that has the purpose of feeding the solid fuel into the chamber while promoting combustion by distributing the primary air blow evenly (or under grate) through appropriate ventilation holes.
This device essentially consists of a mobile slide (Det. 1) completely covered with grate bars* (Det. 2) and

The alternated translation movement of the grate bars installed on the mobile slide, achieved through a designated hydraulic system consisting of hydraulic cylinders (Det. 3) and power unit (Det. 4), makes it possible to move the mass of fuel from the loading area to ash unloading at the end of the grate.
The number of grates (rows of bars alternated to rows of mobile bars) depends on the dimensions of the combustion chamber and the thermal power to be generated by the boiler

*) The grate bars are cast in chrome steel for high temperature, they are supported on the back by a thick pipe and at the front they are supported on the next grate row. An iron bar of 18 mm diameter goes through the front hole thus joining half of the rods in each row of the grate.



The grate is with its own water cooling circuit that prevents the heat developed by combustion in the chamber from overheating its structure and warping it due to thermal dilation, with the risk of undermining system operation and boiler safety.

WARNING ! The water used in the cooling circuit of the grate must meet specifications and requirements set out by the manufacturer in folder "N - Auxiliary".

1.3.3 Refractory lining

The internal walls of the combustion chamber are fully lined with refractory material in order to insulate the chamber, make it easier to reach the operating temperatures (variable from 700°C to 1000°C) and maintain the operating temperature reached preventing heat dispersal that may cause, in addition to worse performance, severe deformation of the boiler's main frame due to overheating from high temperature.

The thickness of the refractory lining is variable according to the size of the boiler and thermal power produced.

The chamber lining is executed with refractory bricks with high alumina content (Det. 1), appropriately with suitable refractory adhesives and refractory casting with high insulating density.

WARNING ! After system installation (and before making the boiler fully operational) it is important to perform the refractory drying procedure to remove excess water contained in the refractory materials to prevent any severe damage to the refractory materials due to quick and violent evaporation of the water they contain.

The drying operation consists of slow heating of the refractory walls remaining for a long time at various temperatures to allow the water to evaporate slowly, so as not to damage the masonry.

The start-up and refractory drying operation must be performed by UNICONFORT srl technicians or by authorised personnel according to the methods set out in the "REFRACTORY DRYING" procedure they hold exclusively.

The formation of small cracks due to wear on the refractory lining is to be considered wholly normal in view of the heavy duty conditions the material is constantly subject to. However, it is recommended to constantly monitor the wear condition of the lining following the indications in chapter "4 - Machine maintenance".

1.3.4 Primary air ventilation

The primary air ventilation system consists of appropriate fans (in variable number according to the boiler size) controlled by inverter the purpose of which is to blow under the mobile grate the air required for ignition and combustion of the solid fuel being fed on the grate. All fans are with an electric damper (directly controlled by the unit's control system) and a manual damper that are appropriately set according to the quantity of oxidising agent one wishes to blow into the chamber.
The manual damper is set directly by the system tester and generally does not require further adjustments,

- **Open position** when the fan is in operation (to allow air to be fed into the combustion chamber;
- **Closed position**, when the fan is stationary to prevent the gas to go back from the boiler to the outside environment.

1.3.5 Secondary air ventilation

The secondary air ventilation system generally consists of two fans controlled by an individual inverter the purpose of which is to blow into the top part of the combustion chamber the air required for complete combustion of the fuel residues dispersed in the fumes produced in the combustion stage. The air is blown into the chamber through the two external ducts installed on the two sides of the boiler. The ventilation units

All fans are with an electric damper (directly controlled by the unit's control system) and a manual damper that are appropriately set according to the quantity of oxidising agent one wishes to blow into the chamber.
The manual damper is set directly by the system tester and generally does not require further adjustments,
:

- **Open position** when the fan is in operation (to allow air to be fed into the combustion chamber;
- **Closed position**, when the fan is stationary to prevent the gas to go back from the boiler to the outside environment.

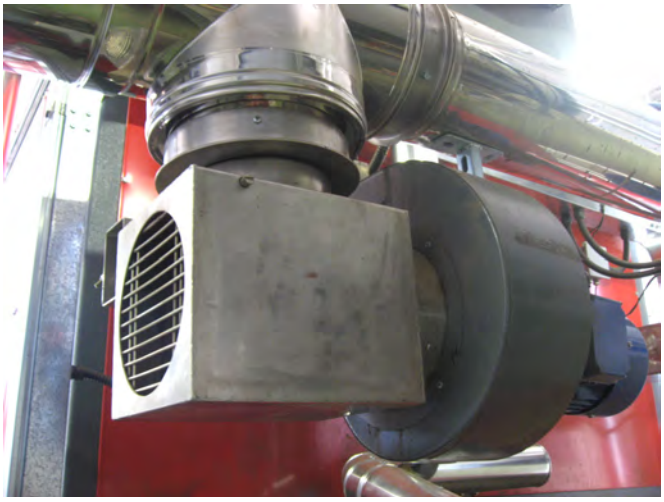
The secondary air ventilation unit is also with appropriate directional dampers to aim the air to the top or bottom of the combustion chamber (top secondary air or bottom secondary air).
The fans of the secondary air supply unit can feed into the combustion chamber either cold air (at ambient temperature) or hot gas if the boiler's gas extraction system is used to heat the air of the secondary ventilation circuit before being fed into the combustion chamber.

1.3.6 Tertiary air ventilation

The tertiary air ventilation system also consists of two fans controlled by inverter, the purpose of which is to blow air into the top part of the combustion chamber (on outlet towards the heat exchanger) creating a high speed for complete combustion of the residual unburnt parts and conveyance of the hot gas in turbulence from the combustion chamber to the heat exchanger.
All fans are with an electric damper (directly controlled by the unit's control system) and a manual damper that are appropriately set according to the quantity of oxidising agent one wishes to blow into the chamber.
The manual damper is set directly by the system tester and generally does not require further adjustments,

- **Open position** when the fan is in operation (to allow air to be fed into the combustion chamber;
- **Closed position**, when the fan is stationary to prevent the gas to go back from the boiler to the outside environment.

The picture shows, by way of example, an air ventilation unit applied to the GLOBAL series boilers.

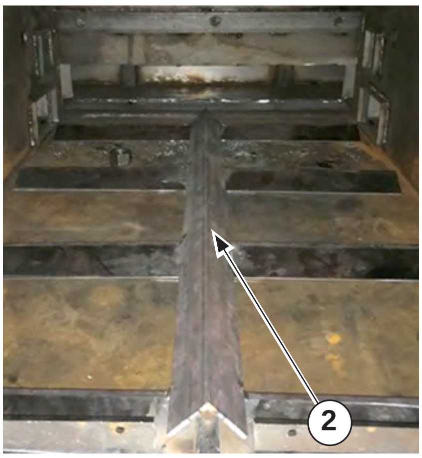


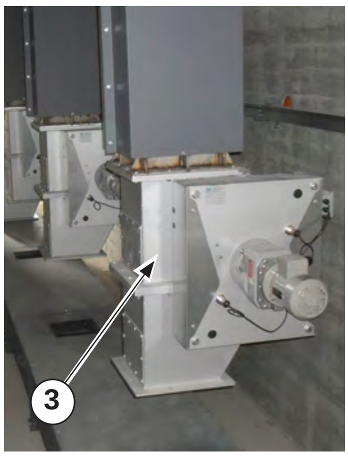
1.3.7 Ash extraction

The collection and extraction system of the ash produced during combustion is on the base of the combustion chamber.

The ash extraction and collection systems provided may be:

- **Screw** (Det. 1): The ash produced is unloaded into a hopper at the bottom of the chamber and conveyed outside the boiler by a screw placed across the chamber and operated by a designated gear motor.
- **Rake** (Det. 2): The ashes produced are collected on the bottom of the chamber (underneath the grate) and pushed into an ash collecting and extraction channel by an appropriate rake actuated in alternated motion (forward/backwards) by an appropriate hydraulic cylinder.
- **Swing check valve** (Det. 3): The ash produced is conveyed into appropriate hoppers installed underneath the grate. A swing check valve applied underneath each conveyor unloads the ash into collecting drums or additional extraction devices.





1.4 Applications and intended uses

The **Combustor** is solely designed and constructed to become an integral part of the boilers of the GLOBAL series produced by UNICONFORT srl and produce the heat required to heat the transfer inside

The Combustor (or combustion chamber) must always be installed and used according to the manufacturer's "INTENDED USES" (see paragraph 1.5).

1.5 Intended use

The use of the **Combustor** produced by UNICONFORT srl shall be deemed proper only if the following provisions are complied with:

- The **Combustor** must have been correctly installed on the boiler and be started up (Commissioning) by the test technicians of UNICONFORT srl.
- The **Combustor** must be used within the operating limits established by the manufacturer and set out in the construction and assembly design issued by UNICONFORT srl prior to system supply (see paragraph "1.7 Technical of the combustor"); The data concerning the maximum operating conditions the combustor may be subject to are set out in paragraph "1.5.1 - Maximum operating conditions".
- The **Combustor** may only be used if all the control and safety devices indicated by the manufacturer are correctly installed and perfectly operable;
- The **Combustor** must undergo the routine maintenance and inspection operations as scheduled and instructed in this manual.
- The **Combustor** and the system it is an integral part of must be managed by adequately trained personnel, instructed on correctly operating it and made aware of the potential residual risks on the machine.
- The **Combustor** must solely be fed with the solid fuel (biomass) established in the contract.

1.5.1 Maximum operating conditions

The table below sums up the main operating conditions (limit values) beyond which it is not allowed to use the combustor.

Description	U.M.	Value
Admissible fuel type	/	Virgin wood chips
Temperature inside the combustion chamber	°C	max 1200
Negative pressure inside the combustion chamber	mm H2O	max -350
Firebox power		See CE plate
Maximum temperature of the grate cooling water circuit	°C	109
Maximum pressure on the grate cooling water circuit	bar	6

For all technical specifications of the Combustor, refer to document "DESIGN DATA" prepared by UNICONFORT srl specifically for your system and attached herewith.

1.5.2 Combustor performance data

The table below sums up the main performance data of a general character concerning the combustor.

For all technical specifications, specific for the Combustor installed in your boiler, refer to document "DESIGN DATA" prepared by UNICONFORT srl specifically for your system and attached herewith.

Emissions	The contractual level of emissions is only guaranteed with a fuel having a Lower Calo- alue between 8.6 MJ/kg and 13.6 MJ/kg.
Test inspection	The test inspection will be carried out with a fuel having a Lower Value betwe- en 9.0 MJ/kg and 10.0 MJ/kg.
Chemical composition	Maximum content of nitrogen (N): in the fuel less than 0.3% by mass
	Content of sulphur: in the fuel less than 0.02% by mass
Minimum load	the minimum load of the combustor is 50% of the nominal load. Below the technical minimum the combustor may remain on in stand-by but compliance with the emissions in the atmosphere is not assured
Technical minimum	the technical minimum is 35% of the nominal load. Below this the combustor must be turned off to prevent damage

Notes:

- All the characteristics of the fuel described above must be met at the same time.
- In the absence of a pilot (ignition) burner it is obligatory to use wood chips with maximum humidity of 30%, pellets or briquette wafers to switch on the boiler.
- In the presence of a pilot (ignition) burner, it is obligatory to use wood chips with maximum humidity of 45%, pellets or briquette wafers to switch on the boiler.
- In order to ensure the stable adjustment of the boiler, a gradual change of the biomass (PCI, density and size) is acceptable, provided it does not exceed 10% of each single value in less than 30 minutes.
- The required thermal load to the heat generator must vary by a maximum of 10% in one hour, to ensure that the combustion process in the boiler takes place in a proper and stable manner.
- The minimum technical heat output of the boiler is 50% of the nameplate rated power.
- Guaranteed smoke emissions (with the exclusion of any regional limits) are those prescribed by Decree Law 152/06.
- Any combination of the above-mentioned fuels is subject to the prior authorisation of Uniconfort.

1.5.2 Fuel Data Table

The table below sums up the main data of the solid fuel to be used, including maximum size allowed according to the type of loading device used to feed the combustor (Duplo, screw or pusher).

Type of machine: GLOBAL/G	
Specifications for virgin wood	
Origin of the Fuel	Bio fuel (ref. Table 1, par.6.1 – UNI EN 17225-1) type 1.1; 1.2.1; 1.3.1; 1.4 provided the origin is as above.
Permitted moisture conditions (W)	Up to M55 (<55% wet base, <122% dry base).

Specifications for virgin wood	
Lower Calorific value allowed	> 7.5 MJ/kg and < 16.7 MJ/kg
Maximum ash content	up to 3 % (A3.0)
Minimum ash melting temperature	minimum 1100°C
Fuel density (bulk state)	wood chips: 250-400 kg/m3
	pellet (with 100% load): up to 650 kg/m3

Fuel Size	
Feeding with Duplo	Fine Sawdust (diameter <3.15mm): max 2% of the load volume
	Sawdust (5 mm ≤ diameter ≥ 3.15 mm)
	Wood chips: P100, in any case the length of all pieces must not exceed 125 mm.
	Hog fuel: P63 with max. 30x30 mm sect. and in any case the length of all pieces must not exceed 125 mm
	Bark: dimensions max 125x10x20mm max 25% in volume per load unit
Screw Feeding	Wood pellets: D 12, DU95.0
	Fine sawdust (diameter <3.15mm): max 2% of the load volume
	Sawdust (5 mm ≤ diameter ≥ 3.15 mm)
For machines ≤ 600,000 Kcal/h	Wood chips: P16 in any case the length of all pieces must not exceed 30 mm
	Hog fuel: P16 and in any case the length of all pieces must not exceed 30 mm
For machines > 600,000 Kcal/h	Wood chips: P45 in any case the length of all pieces must not exceed 50 mm
	Hog fuel: P45 and in any case the length of all pieces must not exceed 50 mm
Pusher Feeding	Fine sawdust (diameter <3.15mm): max 2% of the load volume
	Sawdust (5 mm ≤ diameter ≥ 3.15 mm)
	max 30% of the volume of the biomass mixture,
	Wood chips: P100 in any case the length of all pieces must not exceed 200 mm
	Hog fuel: P200 with max sect. 50x50 mm
	Bark: dimensions max 200x10x20mm max 25% in volume per load unit
Power yield	Although the permitted range includes the fuels set out above, The nominal power is only assured with fuel having LCV between 8.6 MJ/kg and 13.6 MJ/kg.
	For fuels outside of this range, but still within the allowed fuels, there is a decrease of the nominal output.

1.6 Misuse - Exclusion of liability

The “Combustor” must be used according to the manufacturer’s intended uses set out in paragraph 1.5. Any other type of use is considered misuse and forbidden and relieves UNICONFORT srl from any civil and criminal liability.

In particular, it is forbidden to use the **combustor**, even partially:

- With the safety and/or protection devices disabled, faulty and/or removed;
- With solid fuel having physical properties or dimensions other than indicated in the technical data sheets;
- By entrusting plant operat el;
- In case of serious lack of maintenance;
- operations on the machine without the authorisation of the manufacturer;
- In total or partial non-compliance with the instructions;
- Using non-original spare parts.
-

ATTENTION: it is also strictly forbidden to use the combustor as solid waste incinerator or for any other type of material other than the biomass established by contract.

ATTENTION: Any type of modification requires a special written authorisation by UNICONFORT srl, which shall be issued only after ensuring the modification requested by the User is compatible with the uses intended by the manufacturer and that the machine’s safety and operational set-up is in any case complied with.

ATTENTION: The manufacturer shall not be liable for any modification to the machine which has not been authorized by the same, and which increases the risks and/or generates new ones. Any modification carried out without the manufacturer’s authorisation shall render any form of warranty void and shall invalidate the declaration of conformity issued by UNICONFORT srl, pursuant to the Machinery Directive 2006/42/EC.

1.7 Combustor technical specifications

1.7.1 Environmental characteristics of the installation site

Before installing the boiler, make sure that the environmental characteristics of the installation site fall within the parameters indicated in annex **"GLB - General information"**.

1.7.2 "Combustor" technical specifications

All **Combustors** produced by UNICONFORT srl are designed and constructed to obtain the thermal power needed to optimise operation of the exchanger according to the power required by the customer.

All technical are therefore variable according to the system and are set out in the construction and assembly design issued by UNICONFORT srl prior to supplying the system.
The project of UNICONFORT srl will include, by way of example and not limited to, the following data:

- Boiler dimensions (Length, width and height);
- Fuel loading capacity (maximum volume);
- Admissible fuel type;
- Boiler power;
- Size of the pistons actuating the mobile grate;
- Type and power of the hydraulic unit coupled to the mobile grate.

NOTE: All the technical specifications of the combustor and boiler it is an integral part of are set out in the document "DESIGN DATA" prepared by UNICONFORT srl specifically for your system and attached herewith.

1.7 Noise

The "Combustor" (or combustion chamber) is an integral part of the Global boiler it is incorporated in and as a consequence it is an integral part of the complete system in which the boiler is installed.
The sound pressure level in the operator's work station must therefore be assessed only after assembling and installing all the parts making up the system.
However, since all the moving components (e.g. mobile grate, swing check valves, ash extraction screws...) are completely enclosed by the refractory material and insulated panels, the noise level perceived by the personnel working around the Global boiler is rather low, also considering the fact that the hydraulic drive

For information concerning the noise level emitted by the hydraulic unit and by the fans installed in your system, refer to the relevant use and maintenance manuals issued by the individual manufacturers and attached herewith.

The real noise level in the installation site must however be measured by the User directly with a sound meter test on the fully assembled and operating system, in order to define whether it is required to adopt specific protection measures (PPE) for the operators.

Section 2 - Signs and safety measures

2.1 Safety signs

Appropriate signs and safety plates are generally applied by the technicians of UNICONFORT srl on the outer walls of the combustion chamber, at the time of installation or commissioning of the system, in order to provide useful information on potentially hazardous areas and on the obligations/prohibitions to be complied with during machine use/maintenance.

The table below shows, by way of example, the position that UNICONFORT srl technicians have deemed more suitable to apply the safety plates.Please note that the position of the signs applied on your system may differ from the one pictured; the type of decals and the approximate area of application, however, remain valid.

Note: All the safety signs applied to the machine must be kept clean and in good conditions. The Customer is responsible for their replacement if, for any reason, they should be damaged, detached and/or become unreadable.

MANDATORY SIGNS		
Ref.	**Pictogram**	**Description**
O1		Protect your hands with appropriate safety gloves for the operation to be carried out
DANGER SIGNS		
Ref.	**Pictogram**	**Description**
P1		MOVING PARTS hazard sign
P2		BURN hazard sign due to contact with very hot surfaces
PROHIBITION SIGNS		
Ref.	**Pictogram**	**Description**
D1		Access forbidden to all unauthorised personnel.
D2		Do not operate on moving parts
D3		Do not remove guards and safety devices,

2.2 Work areas, residual risk areas and measures to be taken

2.2.1 Work areas

The “Combustor”, after assembly and incorporating in the boiler it is going to be an integral part of, operates automatically and continuously, therefore no operator presence is required except working as supervisor.
Operator presence is only required for routine maintenance and cleaning operations solely to be performed with machine stopped and cold.
For maintenance and cleaning operations the operator in charge may access the inside of the combustor only by opening the inspection hatches located on the front of the boiler (to access the combustion chamber and grate bars) or disassembling the outer side panels to access the lower part of the mobile grate and swing check valves.

2.2.2 Area identification

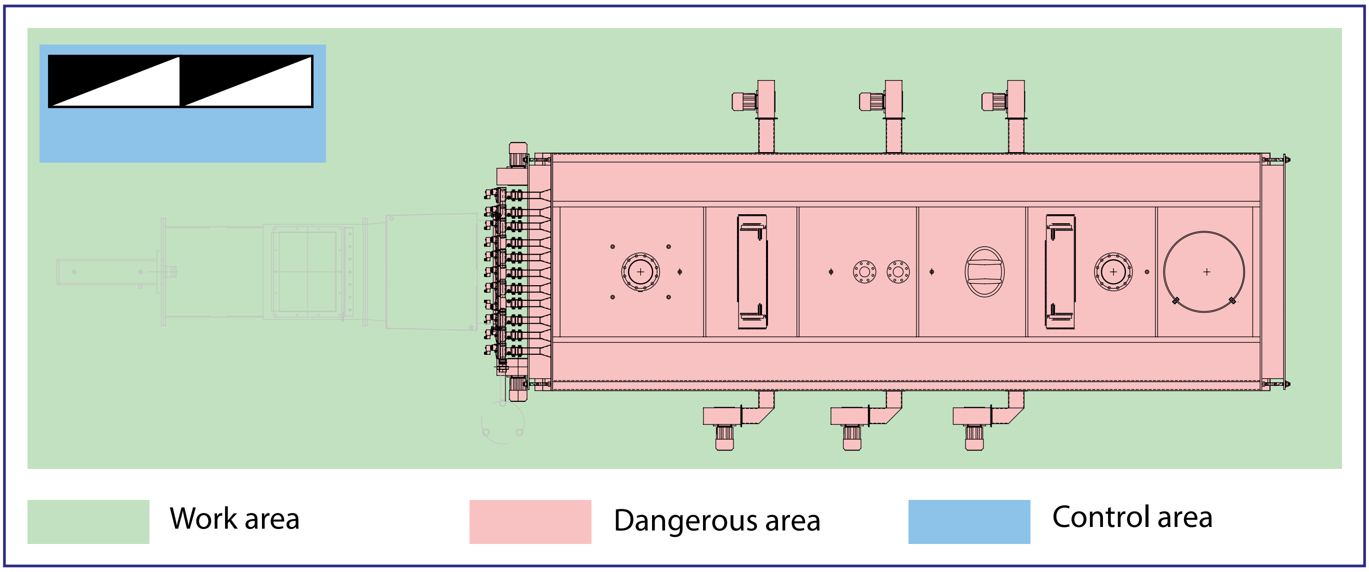
With reference to the example picture below, the system areas are:

- **Work area:** the areas that the user and other operators can freely access during normal system operation. Normal machine operation can be monitored from this area. In this case the work area corresponds to the outer boilerperimeter, with minimum clearances for access of people or equipment.

- **Dangerous area:** Area restricted to skilled maintenance technicians and represents the internal areas of the boiler and various drive units (hydraulic unit, external fans etc.). In these areas it is forbidden to operate (introduce limbs or tools) when the machine is in operation.

Attention: All inspection, cleaning and any maintenance operations inside the combustion chamber or on the mobile grate are only permitted to the authorised personnel only with boiler off and completely cooled..

“Dangerous area” refers to all those areas where there are parts in motion, or very hot, strictly reserved to skilled maintenance technicians authorised to perform inspection and maintenance operations, solely with boiler off and cooled.



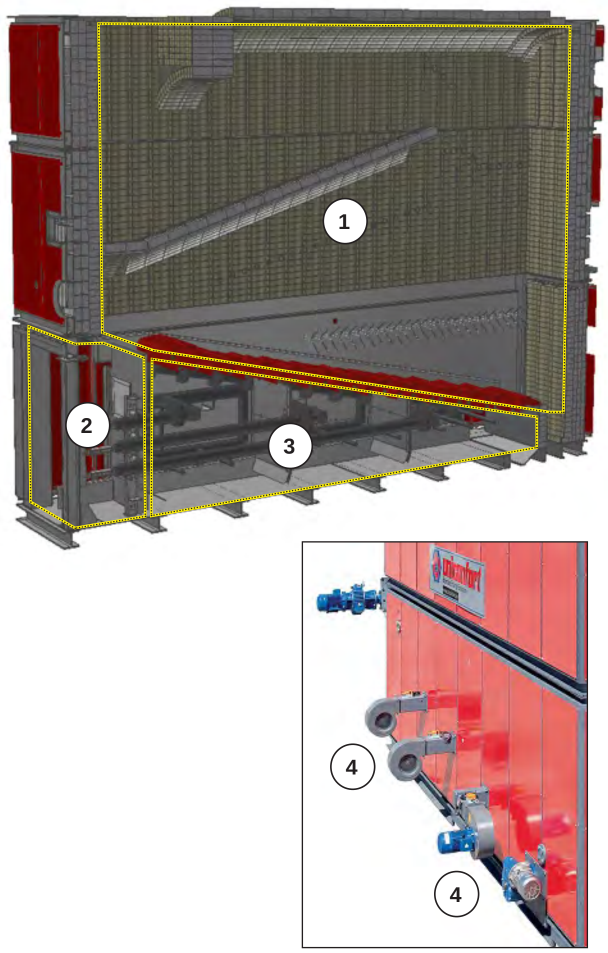
2.2.3 Residual risk areas

During operation of the boiler, all moving parts, surfaces or parts at high temperature are completely enclosed by inspection hatches, refractory lining and insulating panels and hence cannot be accidentally accessed by the operator.

However, during operation or while performing inspection, cleaning and maintenance of the combustor, certain operations may be as **“POTENTIALLY HAZARDOUS”** for the operator carrying out their tasks in a negligent and/or careless way.

The residual risk areas on the “Combustor” are those as “Dangerous area” in paragraph 2.2.2 (areas inside the boiler).

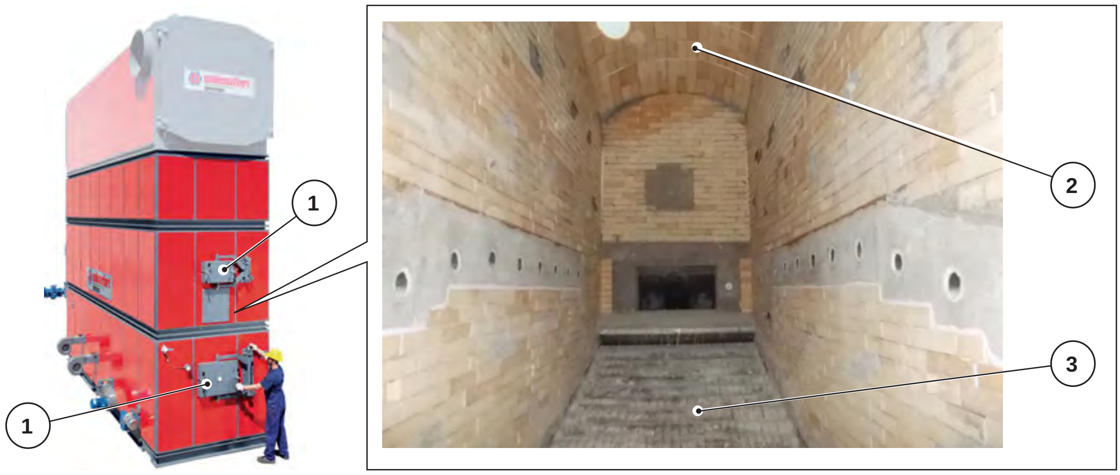
The section view in the table shows the residual risk areas that can be on the Combustor during its operation and during maintenance operations.

Area	Description of residual risk area	Identification of residual risk area
1	**Combustion chamber and mobile grate**	
2	**Hydraulic unit and hydraulic cylinders actuating the mobile grate.**	
3	**Mobile slides supporting and moving the grates.**	
4	**Motors driving the primary, secondary and tertiary air fans and ash extraction unit motor (if any).**	

2.2.4 Residual risks and measures to be taken

The following tables describe the residual risks, related to MACHINE OPERATION and MAINTENANCE operations. The useful measures to be implemented to perform the various work tasks safely are indicated

Area: Combustion chamber and mobile grate



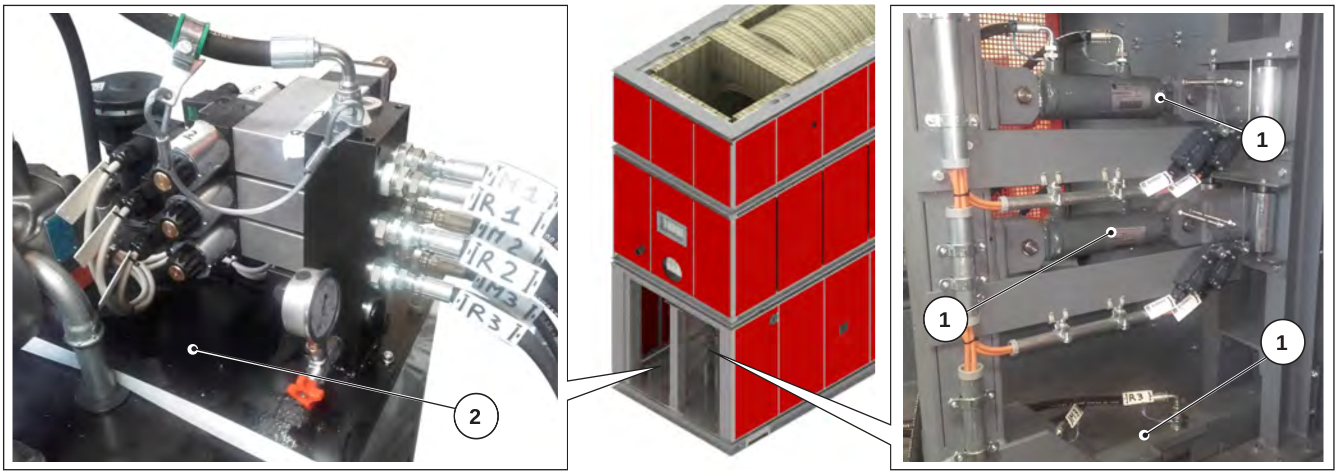
OPERATING MACHINE

	Residual risk		Measures to be taken
	- Burn hazard due to contact with very hot surfaces or with scalding air if an inspection hatch is opened (e.g. Det. 1) when the boiler is in operation. - Risk of combustion smoke intoxication if an inspection hatch is opened (Det. 1) when the boiler is in operation or if one or more hatches have not been closed properly.		- Follow the instructions indicated on the safety signs applied on the boiler and near the inspection hatches. - Ensure all the inspection hatches are correctly closed before the boiler is fully operational. - NEVER open the combustion chamber door when the machine is operating or when the internal temperature is high.

MACHINE UNDER MAINTENANCE

	Residual risk		Measures to be taken
	- Risk of impact/bruising against the refractory lining (Det. 2) and against the and mobile parts of the mobile grate (Det. 3) during inspection, cleaning and maintenance operations. - Risk of entrainment, crushing and shearing of the lower and upper limbs against the grate bars and the mobile grate bars during inspection, cleaning and replacement operations if the mobile grate is manually operated during maintenance operations - Burn hazard due to contact with high temperature surfaces if accessing the combustor when its internal parts have not yet completely cooled. - Risk of inhaling burnt and unburnt gases during maintenance/cleaning operations.		- Forbid opening of the inspection hatches and access to the "Combustor" to all unauthorised personnel; - Follow the instructions indicated on the safety signs applied near the machine. - Wear suitable PPE before carrying out maintenance/cleaning operations. - Entrust the maintenance operations to a qua- - Disconnect the hydraulic unit from the power source by turning in position "O" the local power supply switch and padlocking it safely in order to prevent any accidental operation of the mobile grate. - Ensure the internal parts of the combustor have completely cooled before performing any kind of inspection or maintenance (**less than 40°C**).

Area: Hydraulic unit and hydraulic cylinders actuating the mobile grate.



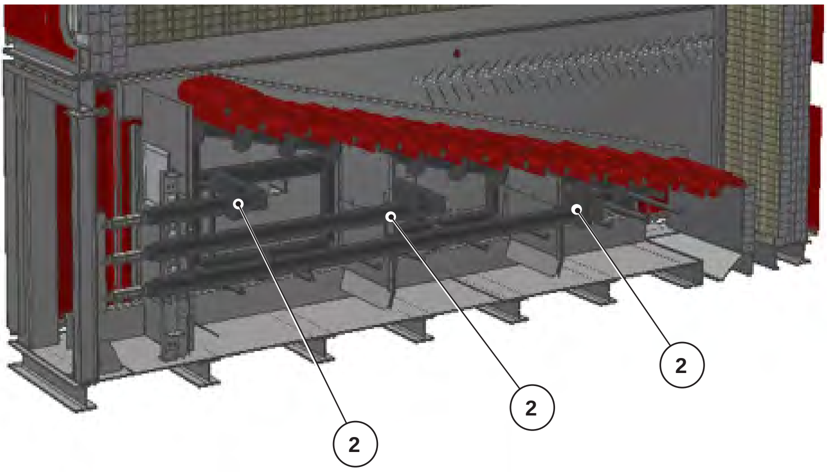
OPERATING MACHINE

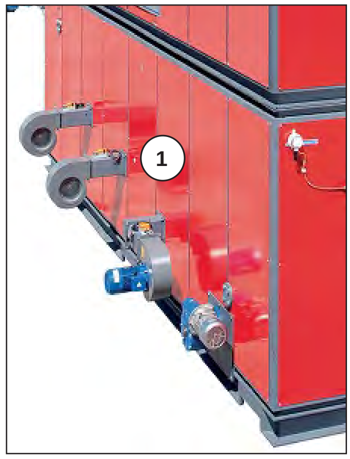
Residual risk	Measures to be taken
- Risk of Impact/bruising against the cylinders moving the mobile grate (Det. 1) and against the relevant driving hydraulic power unit (Det. 2) if the enclosing panels are not correctly installed on the boiler. - Risk of crushing the upper limbs between the cylinders moving the mobile grate (Det. 1) if the enclosing panels are not correctly installed on the boiler. - Risk of burning/scalding by contact with very hot surfaces on valves and pipes of the oil hydraulic circuit. - Risk of due to the presence of any liquid seepage from the oil hydraulic circuit.	- During normal boiler operation, forbid all personnel to access the hydraulic unit and hydraulic cylinders driving the mobile grate; - Ensure the enclosing panels are always installed on the boiler during its operation. - Adhere to the instructions provided on the safety signs applied on the machine. - Keep the area clean removing any liquid residues. - Do not smoke near the hydraulic unit.

MACHINE UNDER MAINTENANCE

Residual risk	Measures to be taken
- Impact, crushing, shearing and cutting on the components manually moved during maintenance operations. - Risk of burning/scalding by contact with very hot surfaces on valves and pipes of the hydraulic circuit. - Risk of being hit by pressurised jets in case of hydraulic system maintenance if pressure has not been discharged beforehand. - Risk of contact with hydraulic oil during inspection/maintenance operations. - Risk of due to the presence of any liquid seepage or residues.	- Forbid all unauthorised personnel to access the hydraulic unit and hydraulic cylinders driving the mobile grate; - Entrust the maintenance operations to a qua- - Adhere to the instructions indicated on the safety signs applied on the machine. - Wear suitable PPE before carrying out maintenance operations. - Discharge the hydraulic system's pressure before performing any maintenance operation on the unit. - Keep the work area clean removing any - mable liquid residues. - Do not smoke near the hydraulic unit.

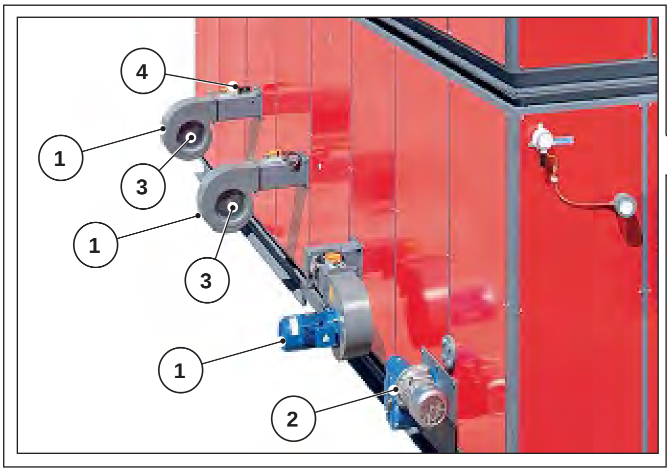
Area: Mobile slides supporting and moving the grates.





OPERATING MACHINE			
Residual risk		Measures to be taken	
	- Burn/scalding hazard due to contact with very hot surfaces if the insulated enclosing panels (Det. 1) are not applied to the operating boiler.		- Ensure all the insulated enclosing panels are correctly applied to the machine.
MACHINE UNDER MAINTENANCE			
Residual risk		Measures to be taken	
	- Risk of impact/bruising against the and mobile parts of the mobile slides (Det. 2) during inspection, cleaning and maintenance operations. - Risk of entrainment, crushing and shearing of the upper limbs between the mobile slides and the machine's frame during inspection, cleaning and replacement operations if the mobile grate is manually operated during maintenance operations. - Burn hazard due to contact with high temperature surfaces if performing inspection and maintenance operations when the internal parts have not yet completely cooled.		- Forbid removal of the insulated enclosing panels to all unauthorised personnel; - Follow the instructions indicated on the safety signs applied near the machine. - Entrust the maintenance operations to a qua- - Disconnect the hydraulic unit from the power source by turning in position "O" the local power supply switch and padlocking it safely in order to prevent any accidental operation of the mobile grate. - Ensure the internal parts of the combustor have completely cooled before performing any kind of inspection or maintenance.

Installation area of the motors driving the primary, secondary and tertiary air fans and ash extraction unit motor



OPERATING MACHINE

Residual risk	Measures to be taken
- Risk of Impact/bruising against the motors and fans of the primary, secondary and tertiary air supply units (e.g. Det. 1) and the screw drive gear motor of the ash extraction unit (if any - e.g. Det. 2) - Risk of cutting/shearing the upper limbs if the fans have been started up without the safety nets (e.g. Det. 3) - Electrocution hazard due to contact with electrically powered components (motors and fans).	- Forbid access to the area where the motors/ fans are installed to all unauthorised personnel. - Ensure all fans are with the appropriate safety nets before starting up the machine. - Adhere to the instructions provided on the safety signs applied on the machine.

MACHINE UNDER MAINTENANCE

Residual risk	Measures to be taken
- Risk of impact/bruising, entanglement and shearing on mobile parts (fans and screws) if moved manually during maintenance operations. - Risk of electrocution by contact with live parts during maintenance of the electrically powered motors and dampers (e.g. Det. 4).	- Forbid access to the area where the motors/ fans are installed to all unauthorised personnel. - Follow the instructions indicated on the safety signs applied near the machine. - Entrust the maintenance operations to a quali- “Mechanical and or Electrical maintenance technician”. - Ensure the machine is powered off (power cut-out switch in position “O” and with safety padlock on) before performing any type of maintenance (mechanical or electric) on the motors or fans.

2.3 Safety measures taken

2.3.1 Operator safety devices

In order to safeguard the health and safety of the operators in charge of running the system, UNICONFORT srl has implemented a series of safety measures and devices.
, all the mobile grate components (slides, grate with bars, hydraulic unit and hydraulic drive cylinders) are inaccessible to the operator and are protected by insulated panelling and enclosing metal plates to prevent any type of contact, even accidental.

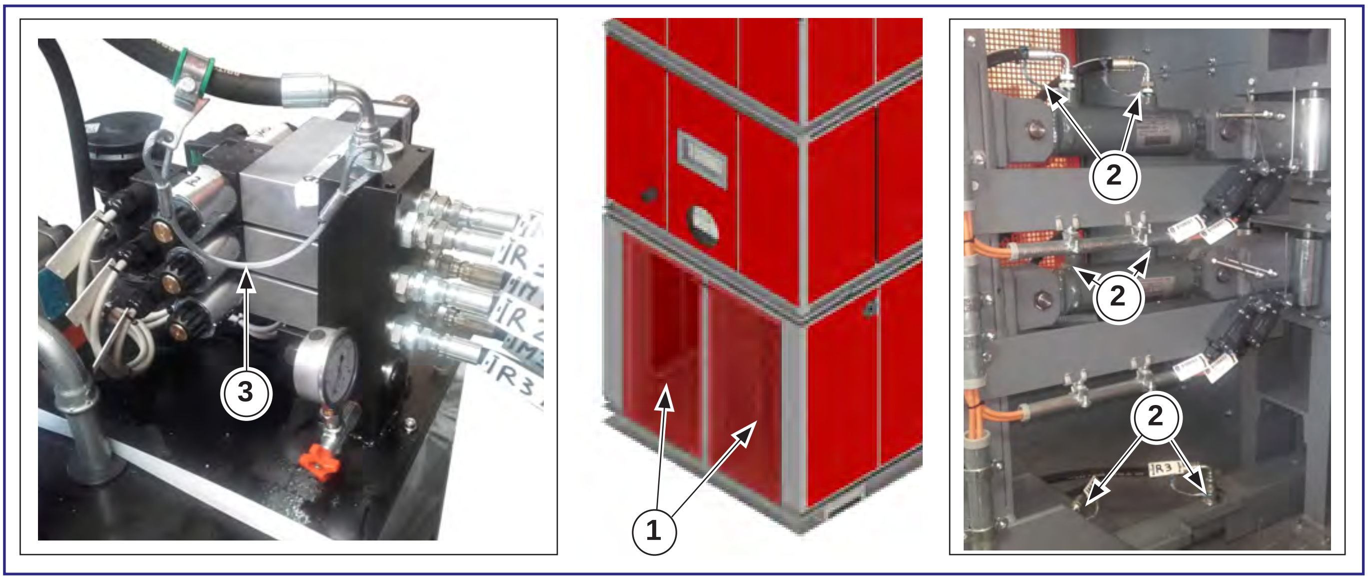
ATTENTION: If for reasons of maintenance, inspection or various operations the fixed guards closing the hydraulic unit and cylinders driving the mobile grate are opened or removed, they must be fitted back on before starting up the system again.

ATTENTION: Access to the hydraulic unit and hydraulic cylinders is only permitted to the authorised personnel (Mechanical maintenance technician) and only after the system has been disconnected from the power supply source (local power switch in pos. "O" and padlocked).

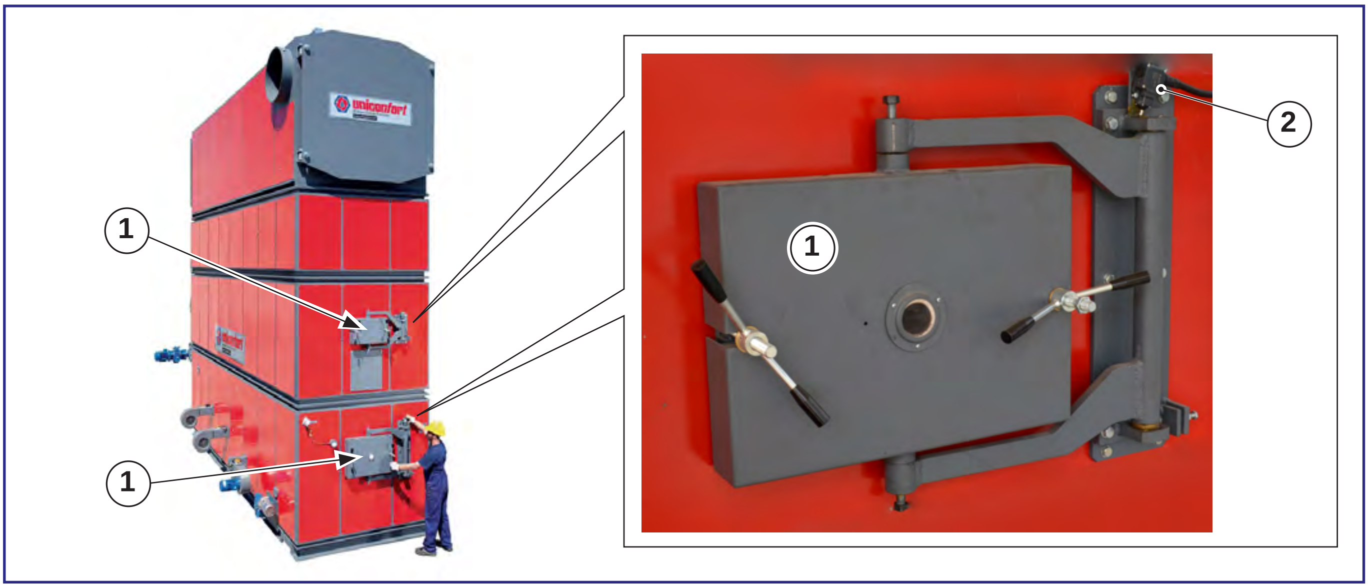
Furthermore, the personnel in charge must be perfectly aware of the extant residual risks in the various areas of the system and of the measures to be taken set out in paragraph 2.2.4.

<u>**The system is equipped with the following operator safety devices:**</u>

- **Access doors with lock and key** to completely close the installation area of the hydraulic unit and hydraulic cylinders actuating the mobile grate (Det. 1).
- **Steel cables to tie the high pressure pipes feeding the hydraulic cylinders**. The steel cables tie all the hydraulic pipes actuating the cylinders to the cylinder sleeve (e.g. Det. 2) and those of the unit to the relevant tank (e.g. Det. 3) to prevent, in the event of rupture of the relevant the pressure of the oil contained to cause whiplash hazardous for the operator working for any maintenance

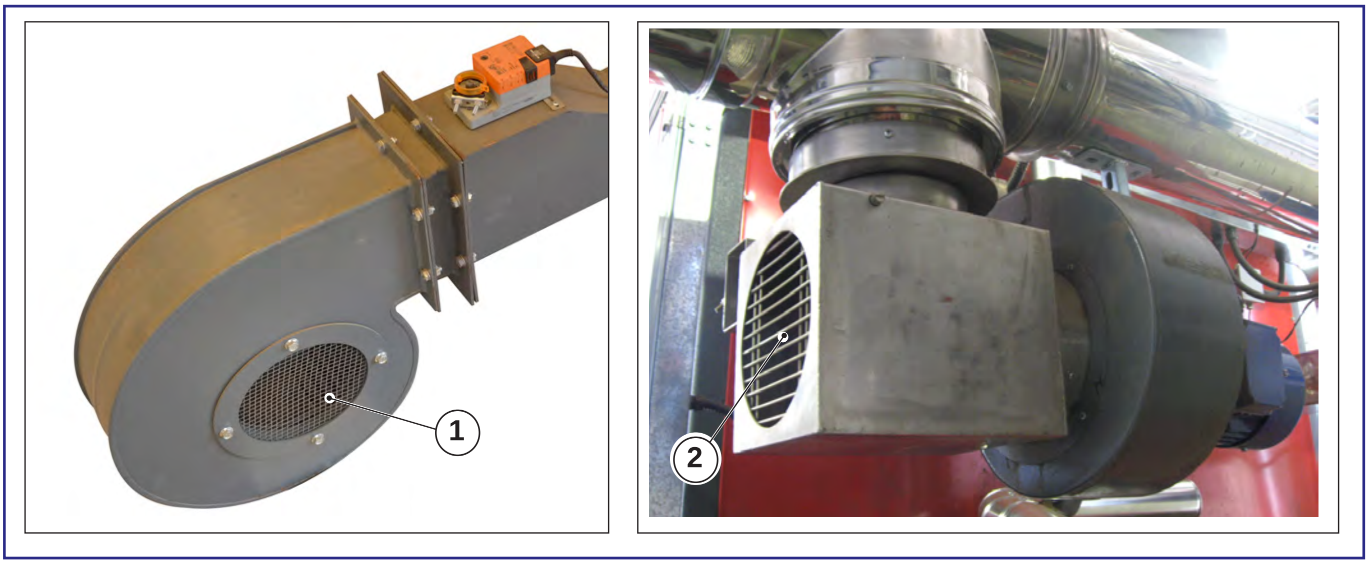


- **Combustion chamber inspection doors (Det. 1)**. Used to clean the combustion chamber from the ashes produced during operation and to perform any manual fuel loading. If opened with machine in operation, the associated safety micro switch (Det. 2) generates a primary alarm, totally shutting down the boiler and the feeding system, stopping the primary and secondary air fans and stopping the ash collection and extraction device, while leaving only the gas extraction and system on (for a set time.



- **Anti-intrusion mesh fixed guards** to protect the fans that supply combustion air to the boiler (e.g. Det. 1).

- **Anti-intrusion mesh fixed guards** on the distribution boxes on the ventilation systems (e.g. Det. 2).

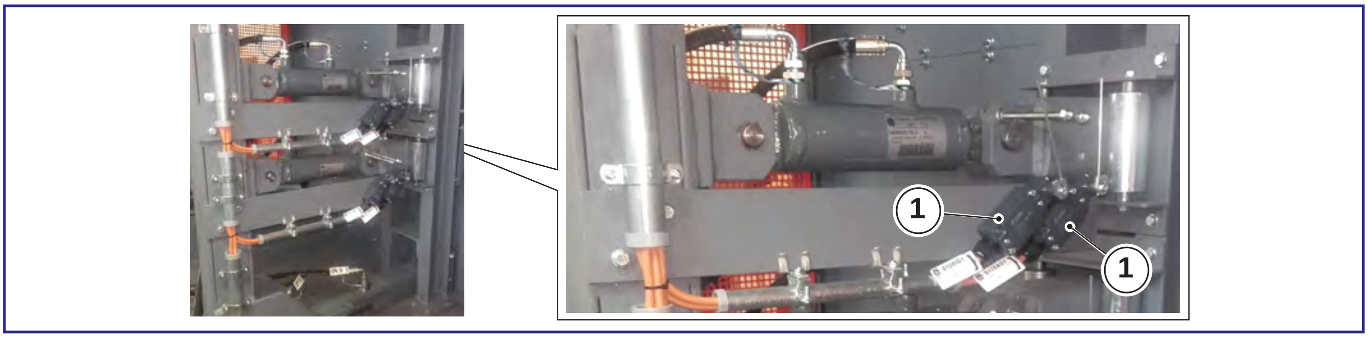


2.3.2 Electrical and electromechanical control and monitoring devices

The system has a series of electrical and electro-mechanical devices that control and monitor the combustor's cycle work settings and act if the readings exceed the maximum settings

Control devices

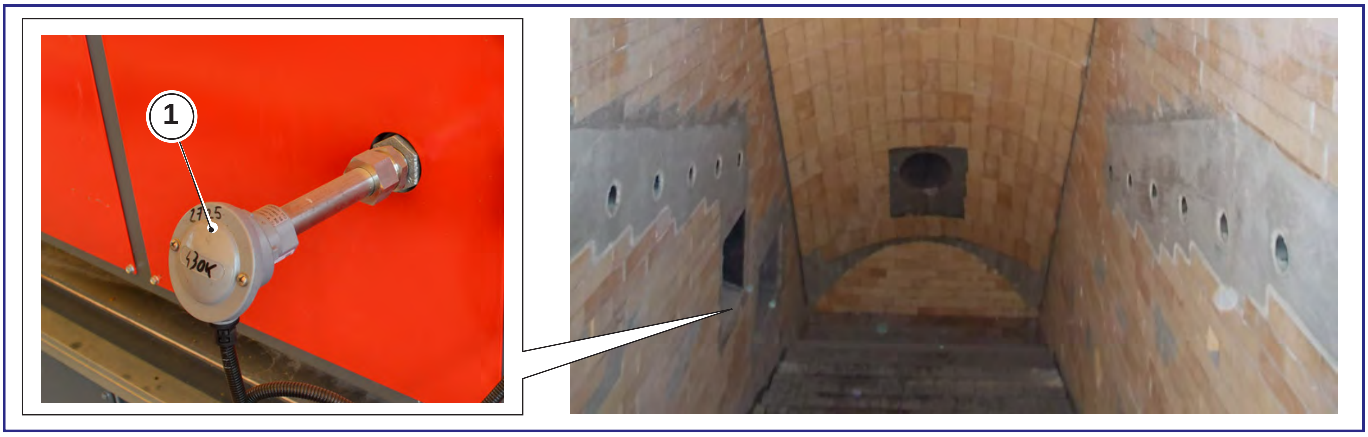
- **Limit micro switches on the hydraulic cylinders actuating the mobile grate (Det. 1):** They detect the stroke end position of the associated cylinder and control stroke inversion.



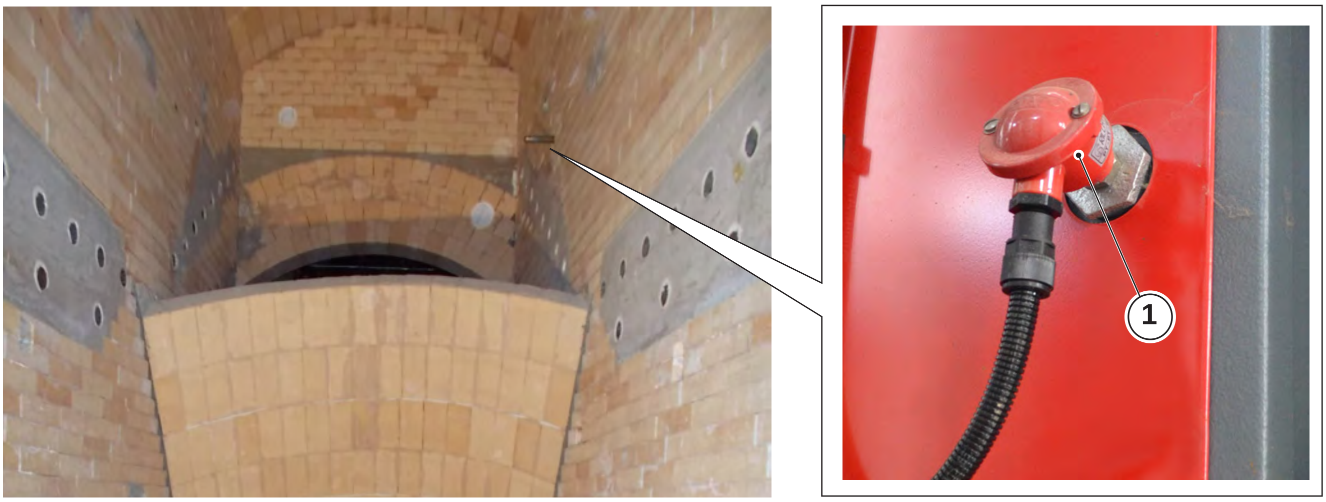
Monitoring devices

To assure and control optimal combustion process inside the chamber, it is with appropriate control

- **Temperature probe on the combustion chamber refractory lining (Det. 1):** This probe detects the temperature reached by the refractory lining within the combustion chamber. The probe, calibrated with two different warning thresholds, can manage the system differently based on the temperature detected. In particular:
  - If the probe detects a higher temperature than the "First threshold" set limit, it sends a signal to the boiler's control system, which reduces the combustion power until the temperature of the combustion chamber falls back within the safety parameters;
  - If the probe detects a higher temperature than the "Second threshold" set limit, it sends a signal to the unit's control system, which generates a primary alarm and stops the boiler until the internal combustion chamber temperature decreases below the set temperature.



- **Fume temperature probe at the heat exchanger inlet (Det. 1 in the picture on the following page)**. This probe e as it is red) is as “POST FIREBOX” and has the purpose of reading the temperature of the gas ducted from the combustion chamber to the heat exchanger. The probe protrudes by 10÷15 cm from the refractory lining, in order to detect the fume temperature correctly. This probe too is calibrated with two different thresholds, to control the system based on the temperature reading. In particular:
  - If the probe detects a higher temperature than the “First threshold” set limit, it sends a signal to the boiler’s control system, which reduces the combustion power until the temperature of the combustion chamber falls back within the safety parameters;
  - If the probe detects a higher temperature than the “Second threshold” set limit, it sends a signal to the unit’s control system, which generates a primary alarm and stops the boiler until the internal combustion chamber temperature decreases below the set temperature.

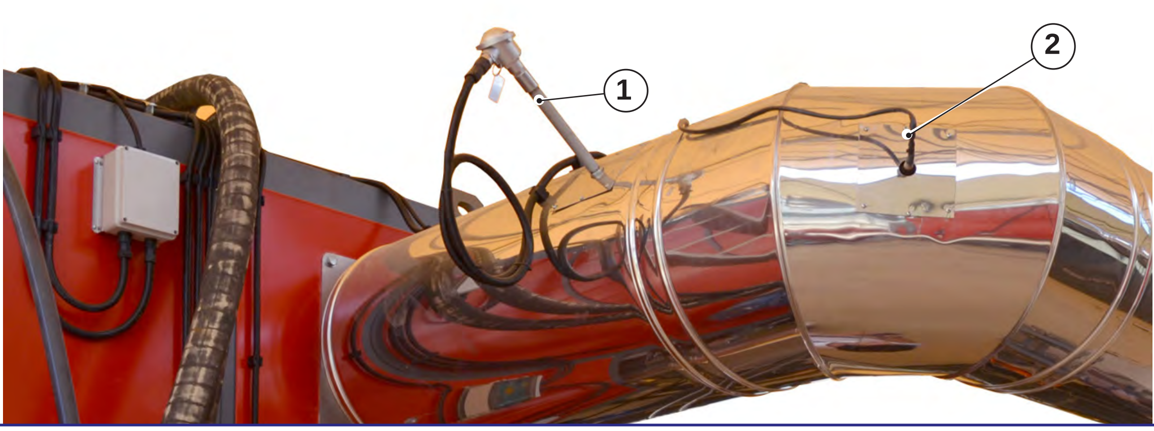


- **Vacuum meter (Det. 1).** It monitors in real time the negative pressure value created within the combustion chamber, allowing it to be automatically adjusted based on the reading. The vacuum meter is calibrated by UNICONFORT srl technicians and allows the fume extraction fan motor power to be increased or decreased (e.g. Det. 2) based on the negative pressure reading.
  Example: by setting the negative pressure at 6 (6 mm of water column, corresponding to 60 Pa), if the instrument reads a negative pressure within the combustion chamber lower than 6, it increases the speed of the fume extraction motor; vice versa, if the reading is higher than 6, it decreases the extraction power (by decreasing the extraction motor speed).

ATTENTION: In order to guarantee correct operation of the vacuum meter, the copper pipe must be cleaned daily (Det. 3) from any ash residues. Cleaning must be performed by disconnecting the rubber hose (Det. 4) and blowing compressed air into the hose.

- **Temperature probe in the flue (e.g. Det. 1)**. The that discharges the fumes produced within the combustion chamber is with a temperature probe. The probe, calibrated with two different warning thresholds, can manage the system differently based on the temperature detected. In particular:
  - **First temperature threshold = 60 °C:** If, within 15 minutes from system start, the probe does not detect a minimum temperature of 60°C in the it triggers alarm "106: Fire is out. Check chamber" to signal that ignition of the fuel within the combustion chamber has failed. Solve the cause that prevented correct fuel ignition and restart the system.
  - **Second temperature threshold (settable) [e.g. 220°C - 250°C]:** If the probe detects a temperature that falls within the "Second temperature threshold" range, it sends a signal to the boiler control system, which reduces the combustion power until the temperature of the combustion chamber falls back within the safety parameters;
    If the probe detects a higher temperature than the "Second threshold" limit (e.g.: >250°C) it sends a signal to the unit's control system, which triggers a primary alarm and shuts down the boiler until the internal combustion chamber temperature decreases below the set temperature.

- **Lambda probe** (e.g. Det. 2). The lambda probe measures the percentage (%) of oxygen in the fumes conveyed towards the in order to assess whether the combustion within the chamber is optimal (the presence of oxygen in the gas is an indication of poor combustion). If oxygen is detected in the gas, the control unit which the probe is connected to adjusts the secondary fans speed (if with inverter) and/or controls opening and closing of the dampers on the air feeding ducts, in case the fan motors are not controlled by inverter, so as to adjust the of combustion air fed into the combustion chamber, to optimise fuel combustion.

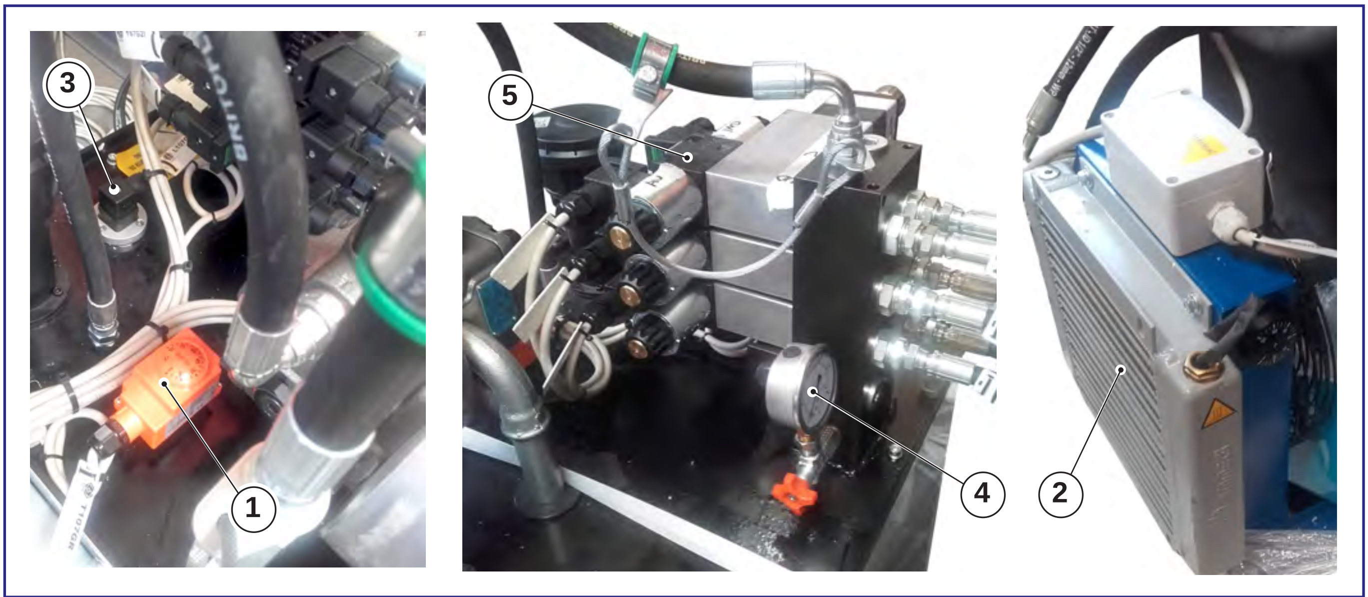


- **Oil temperature monitoring probe (Part. 1).** Its purpose is to monitor the temperature reached by the oil in the hydraulic circuit actuating the cylinders. If the probe reads oil temperature exceeding 45°C it automatically starts the cooling fan installed on the heat exchanger (Det. 2) and keeps it running until the temperature drops below the calibration setting.

- **Oil pressure gauge (Det. 4).** The pressure gauge is with a cock, normally closed, that isolates it from the pressurised circuit. Opening the cock lets you read the actual oil pressure inside the hydraulic circuit.

Attention: After each reading it is recommended to close the cock to disconnect the pressure gauge from the pressurised circuit and preserve its integrity in the long term.

- **Hydraulic circuit pressure adjustment valve** (Det. 5). It lets you adjust the oil pressure for forward and back stroke of the hydraulic cylinder moving the movable rake.



Section 3 - Machine installation

3.1 Foreword

UNICONFORT srl shall supply, before delivering the machine, all the documents relating to the preparation of the installation site and information required for arranging the connections to the various power sources. In particular, the installation layouts and construction designs of the boilerare provided, which include the overall dimensions, indications for laying the foundations and pits to house the various plant components (supply units, pits for installing the Redler or ash extraction screw etc.).

<u>The preparation of the installation site is the customer's responsibility.</u>

For all general information concerning preparation of the installation area and operations for acceptance and handling of the type machine:

-
- Lighting of the installation site;
- Transport and handling of the boiler parts;
- n of lifting equipment;
- Machine acceptance and preservation
- Connections to the power supply systems.

refer to the lay-out drawings and construction design provided by UNICONFORT srl prior to machine delivery.

3.2 Machine installation

All boiler installation operations in the system it is to be an integral part of are performed by t***echnicians of UNICONFORT srl and/or by personnel expressly authorised by UNICONFORT srl*** with the aid of the equipment and personnel provided by the Customer following the indications in the **"ASSEMBLY PLAN"** they are the sole holders of.

ATTENTION: While handling the loads, make sure that access to the area of operations is for-bidden to all unauthorised personnel.

3.3 Checks and Inspections - First Start-Up

All the preliminary checks of correct boiler installation and inspections on the safety devices and all the mechanical adjustments are carried out, after the installation has been completed, by ***UNICONFORT srl technicians or personnel expressly authorised by UNICONFORT srl***, who is also authorised by the

Section 4 - Machine maintenance

4.1 Foreword

As for any other type of mechanical system, the combustor must undergo adequate scheduled maintenance in order to prevent wear and cause damage to the machine.

All the materials or components used in operations for replacement or maintenance shall comply with the original or be approved by UNICONFORT srl.

ATTENTION: All inspection and maintenance operations on the combustor (combustion chamber) and on the mobile grate must be performed on machine off, disconnected from the power supply and only after the temperature of the internal parts has dropped below 40 °C.

The maintenance and checks to be performed must include:
- CHECK
- REPLACEMENT / REPAIR / LUBRICATION

according to the table in paragraph "4.3 Maintenance plan Scheduled operations".

4.2 Warnings and safety provisions during maintenance

WARNINGS:
- Inspection and maintenance operations must only be performed by adequately trained personnel, according to the directives and safety regulations in force in the country of installation, exclusively using appropriate tools, instruments and any products to perform the required operations safely.
- For all maintenance or cleaning operations, the operators in charge must be with appropriate
- Ensure to correctly restore any parts and guards blocked with screws that have been removed to perform the maintenance operations.
- Do not start up the machine if any damaged or worn parts have been found that could not be replaced with spare parts authorised by UNICONFORT srl.

Safety regulations:

Before performing any maintenance operation on the **Movable plane** ensure the machine has been fully secured following the indications below:
- Stop operation of the boiler. Stop all machine drives (in particular stop movement of the **Movable plane**).
- Disconnect the machine's power supply circuit and ensure it cannot be accidentally powered by third parties (set the main cut-out switch "MS" in position "O" and padlock it for safety.
- Wait for the temperature of the parts subject to heating (e.g. hydraulic units, mobile rake moving cylinders etc.) to have dropped so they can be touched safely.

4.3 Scheduled maintenance operations

The tables below list the inspection and maintenance operations considered necessary to maintain the combustor and its main units in perfect operating conditions. Where applicable, reference to the individual

Refractory lining		
No.	**Operation**	**Any Specification**
1	Visual inspection of the refractory lining of the combustion chamber	**Specification No. 01**

Mobile grate		
No.	**Operation**	**Any Specification**
1	Visual inspection of the mobile grate and replacement of any broken or very worn bars as required.	**Specification No. 02**
2	Inspection of grate cooling circuit	**Specification No. 03**

Primary, secondary and tertiary air fans and motors		
No.	**Operation**	**Any Specification**
1	Cleaning of the fans, distribution box and primary, secondary and tertiary air ducts	**Specification No. 04**
2	Replacement of broken fan motors, electric dampers or distribution boxes	**Specification No. 05**
3	Maintenance of fan motors, electric dampers	**See suppliers' manuals [*]**
4	Greasing fan bearings	**Specification No. 06**

Swing check valves, rake and ash extraction screw		
No.	**Operation**	**Any Specification**
1	Check operation of swing check valves (if any)	**Specification No. 07**
2	Check operation of ash extraction screw (if any)	**Specification No. 08**
3	Check and cleaning of rake (if any) and under grate area	**Specification No. 09**

Hydraulic power unit and hydraulic circuit		
No.	**Operation**	**Any Specification**
1	Fluid level check on unit	**Specification No. 10**
2	Fluid top-up on unit	
3	Fluid temperature check on unit	
4		**Specification No. 11**

Hydraulic power unit and hydraulic circuit		
No.	**Operation**	**Any Specification**
5		See supplier's manual [*]
6		
7		
8		Specification No. 12
9	External unit cleaning	Specification No. 13
10	Fluid replacement and internal tank cleaning	Specification No. 14
11	Accumulator pre-load check	See supplier's manual [*]
12	Replacement of elastic plugs of the transmission joint	
13	Cleaning of heat exchanger and zinc replacement	

Electrical and electromechanical instrumentation (Probes, micro switches...)		
No.	**Operation**	**Any Specification**
1	Periodic inspection of electrical and electromechanical instrumentation.	Specification No. 15

Metal frame		
No.	**Operation**	**Any Specification**
1	Inspection of metal frame condition	Specification No. 16
2	Inspection of insulation panels condition	

Expansion joint (if any)		
No.	**Operation**	**Any Specification**
1	Inspection of external fabric condition	17

Emergency flue and ventilation ducts		
No.	**Operation**	**Any Specification**
1		18

[*] - For more information on maintenance operations such as methods and frequency of the operation to be performed on trade components (e.g. fan, motor etc.) refer to the relevant use and maintenance manual issued by the manufacturer and attached herewith.

ATTENTION! For the operating frequencies of individual maintenance operations refer to table "Maintenance plan" provided in annex "M - Maintenance" specifically designed by UNICONFORT srl for your system.

SPC_01 Refractory lining inspection

Frequency	Operator in charge	Time required	PPE Intended	Required tools/instruments
See annex **"M - Maintenance"**	[Mechanical maintenance technician]	2 hours		Standard tools

With combustor off and empty, perform a visual inspection of the condition of the refractory lining according to the indications below.

MAIN RESIDUAL RISKS CONNECTED TO THE OPERATION	
	Risk of impact/bruising against the fixed parts of the machine and against the refractory material walls.
	Risk of entrainment, crushing and shearing of the lower and upper limbs between the fixed grate bars and the mobile grate bars if the mobile grate is manually operated during inspection.
	Burn/scalding hazard due to contact with high temperature surfaces if performing inspection when the internal parts of the combustor have not yet completely cooled.

Checking machine - operator safety conditions

Before opening the inspection hatches and accessing the inside of the combustor, ensure that:
- The combustion chamber has completely cooled;
- The oil hydraulic power unit actuating the mobile grate is stationary and disconnected from the power mains (local power unit switch turned to position "O", safely padlocked and key removed);
- The person in charge of inspection is adequately trained and equipped with the required PPE.

Description of the operations: Checking the state of repair of the refractory lining

- Open the inspection hatches and access the inside of the combustor with a halogen lamp to light the refractory surfaces.
- Visually inspect the state of repair of the lining to identify any

Note: In view of the high temperature and heavy duty operating conditions the lining is subject to, the formation of cracks and few millimetres wide (less than 4 mm) should be considered wholly normal and no cause .

- No maintenance operations are required if cracks less than 4 millimetres wide are found. However, it is recommended to document with photos the worn/damaged part found to compare them with the condition of the lining at the next inspection.

- If cracks wider than 5 millimetres are found, or a shift in the refractory lining is observed (movement of individual bricks or parts of the walls), document the damaged area with photos and contact the support service of **UNICONFORT srl**.

ATTENTION: Significant cracks and shifts of the refractory material may quickly undermine the boiler's functionality and affect its safety. Any flames escaping the combustion chamber may cause a fire of the boiler or of the system it is installed in. NEVER restart the boiler in the event of significant cracks or refractory lining shift before alerting and consulting with the support technicians of Uniconfort srl.

SPC_02 Mobile grate inspection

Frequency	Operator in charge	Time required	PPE Intended	Required tools/instruments
See annex **"M - Maintenance"**	[Mechanical maintenance technician]	4 hours		Standard tools

With combustor off and empty, perform a visual inspection of the state of repair of the mobile grate bars, and replace any bro-
.

	MAIN RESIDUAL RISKS CONNECTED TO THE OPERATION
⚠	*Risk of impact/bruising against the fixed parts of the machine and against the refractory material walls.*
⚠	*Risk of entrainment, crushing and shearing of the lower and upper limbs between the fixed grate bars and the mobile grate bars if the mobile grate is manually operated during inspection.*
⚠	*Risk of crushing one's fingers between the half rows of bars and on the "Big Bar" during replacement operations.*
⚠	*Burn/scalding hazard due to contact with high temperature surfaces if performing inspection when the internal parts of the combustor have not yet completely cooled.*

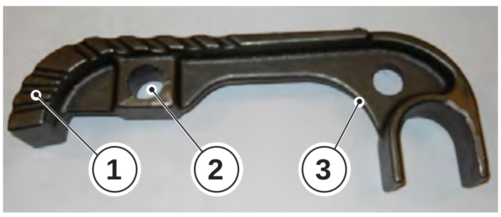
Checking machine - operator safety conditions

Before opening the inspection hatches and accessing the inside of the combustor, ensure that:
- The combustion chamber has completely cooled;
- The oil hydraulic power unit actuating the mobile grate is stationary and disconnected from the power mains (local power unit switch turned to position "O", safely padlocked and key removed);
- The person in charge of inspection is adequately trained and equipped with the required PPE.

Description of the operations: Grate bar replacement

- Open the inspection hatches and remove any residues of ash and unburnt material from the surface of the mobile grate using an industrial vacuum cleaner or broomstick.
- Access the inside of the combustor with a halogen lamp to appropriately light the surface of the mobile grate.
- Visually inspect the state of repair of the grate bars and ensure they are all properly aligned. Should one or more broken or particularly worn rate bars be found, it is required to replace them, following the instructions below.

Grate bar description	
1	Ventilation holes for air distribution underneath the grate
2	Hole to introduce Ø 18 round bar (for alignment)
3	Part resting onto support pipe



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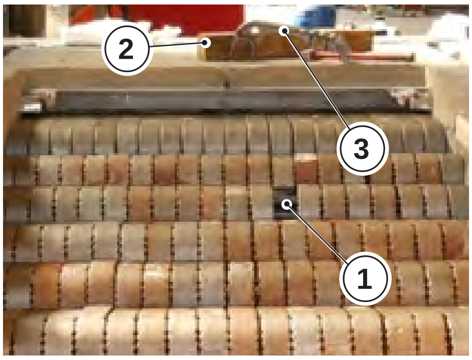
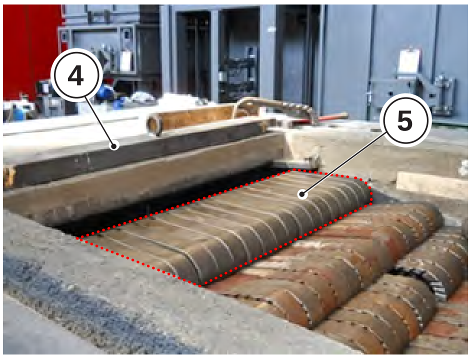
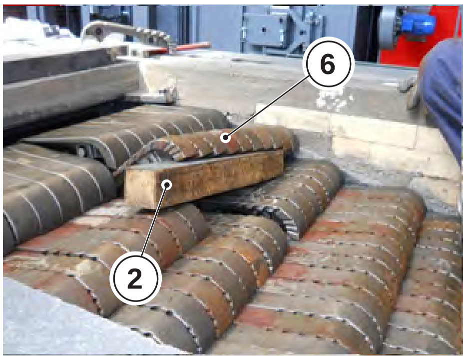
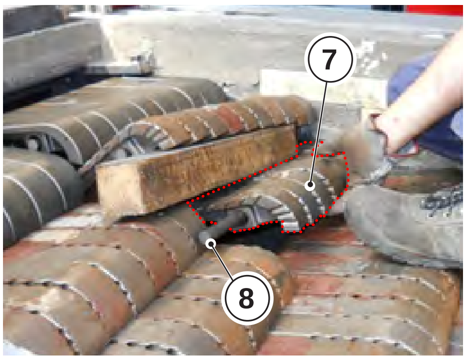
Grate bar assembly sequence		
No.	**Description**	
1	After identifying the element to be replaced (e.g. Det. 1), you need a hammer, a wood beam just a bit shorter than half the grate's width (e.g. Det. 2) and a new grate bar of the same shape and size as the one to be replaced (e.g. Det. 3).	
2	Lift the compensation element at the start of the grate called "Big Bar" (Det. 4). This element allows the row of grate bars (Det. 5) to be conveniently lifted.	
3	Use a lever and lift the row of grate bars above the one where the grate bar to be replaced is (Det. 6) and keep it lifted by placing the wood beam (Det. 2) under the lifted grate bars (obtaining a set-up as pictured).	
4	Lift the entire half row of grate bars where the one to be replaced is (Det. 7) in order to be able to extract the Ø 18 mm round bar (Det. 8) that joins all the grate bars of the half row.	

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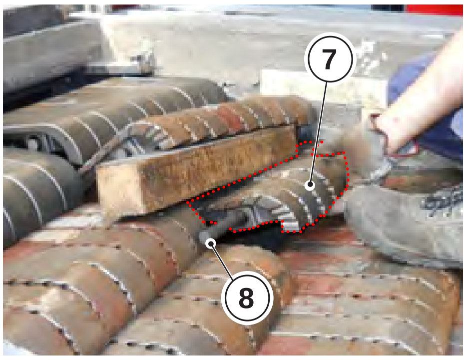
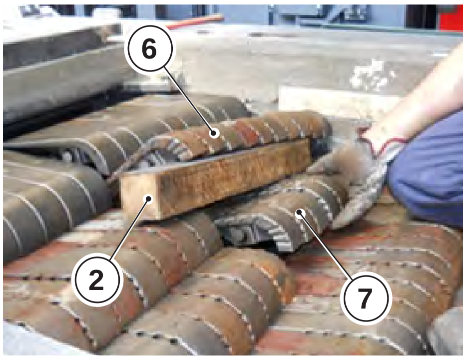
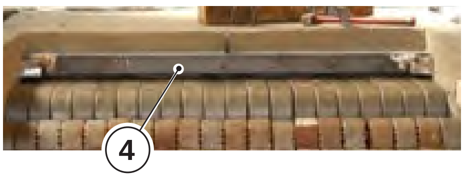
Grate bar assembly sequence		
No.	**Description**	
5	Completely extract the alignment round bar (Det. 8) from the lifted half row of grate bars (Det. 7).	
6	Remove the part that is broken or needs to be replaced and insert the new one (Det. 9) and align it with all the grate bars of the half row.	
7	Insert the Ø 18 mm round bar (Det. 8) in the alignment holes in the grate bars in order to align and join the entire half row.	
8	After aligning the half row bars, remove the wood beam (Det. 2) so the upper half row of grate bars (Det. 6) is supported by the one you have just aligned (Det. 7). ***ATTENTION: Finger crushing hazard between the two half rows of grate bars during removal of the wood beam.***	
9	Replace in its seat at the head of the grate the “Big Bar” previously lifted (Det. 4). ***ATTENTION: Finger crushing hazard between the “Big Bar” and its seat.***	

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SPC_03 Inspection of grate cooling circuit

Frequency	Operator in charge	Time required	PPE Intended	Required tools/instruments
See annex **"M - Maintenance"**	[Mechanical maintenance technician]	2 hours		Standard tools

Every time the system is down, with combustor off and empty, perform inspection of the operating status of the grate cooling circuit following the indications below.

MAIN RESIDUAL RISKS CONNECTED TO THE OPERATION	
⚠	*Risk of impact/bruising against the fixed parts of the machine during inspection.*
⚠	*Burn/scalding hazard due to contact with high temperature surfaces if performing inspection when the mobile grate has not yet completely cooled.*

Checking machine - operator safety conditions

Before checking the state of repair of the grate cooling circuit ensure that:

- LThe combustion chamber has completely cooled;
- The oil hydraulic power unit actuating the mobile grate is stationary and disconnected from the power mains (local power unit switch turned to position "O", safely padlocked and key removed);
- The person in charge of inspection is adequately trained and equipped with the required PPE.

Description of the operations

- Access the internal part of the combustor (under grate) and visually inspect the state of repair of the cooling circuit ensuring there are no leaks of liquid or areas that show conspicuous signs of deformation from overheating (indication of

Should any damage from overheating or breakdowns on the cooling circuit be found, document with photos and contact the support service of Uniconfort srl.

- Before each time the combustor is ignited, check functionality of the cooling circuit and ensure any shut-off valves are in "OPEN" position and blocked in said position with a padlock.
- is circulating in the cooling circuit.

ATTENTION: In the event of failed water circulation inside the cooling circuit, the combustor MUST NOT be ignited.

SPC_04 Cleaning of fans, distribution boxes and primary, secondary and tertiary air ducts

Frequency	Operator in charge	Time required	PPE Intended	Required tools/instruments
See annex **"M - Maintenance"**	[Mechanical maintenance technician]	8 hours		Standard tools

Every time the system is down, with combustor off, perform cleaning of the fans, boxes and ventilation ducts (primary, secondary and tertiary air) following the indications below.

MAIN RESIDUAL RISKS CONNECTED TO THE OPERATION	
	Risk of impact/bruising against the fixed parts of the machine during inspection.
	Burn/scalding hazard due to contact with high temperature surfaces if performing cleaning of parts when they have not yet completely cooled.

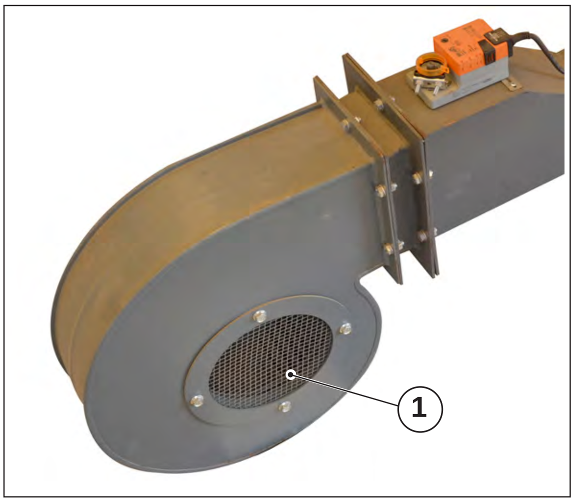
Checking machine - operator safety conditions

Before performing cleaning, ensure that:

- LThe boiler is off and disconnected from the power source (main switch MS in position "O" and padlocked);
- The local cut-off switches applied to the individual fans (if any) are turned to the "O" position and safely padlocked
- The person in charge of inspection is adequately trained and equipped with the required PPE.

Description of the operations

- Remove the protection grates from the fans (e.g. Det. 1) and clean the fans and internal parts using compressed air or dry cloths.
- Remove the protection grates from the distribution boxes (e.g. Det. 2) and clean the internal parts using compressed air or dry cloths.



In the event of considerable accumulated dust, have specialised chimney sweeping personnel clean the ventilation ducts.

SPC_05 Replacement of broken fan motors, electric dampers or distribution boxes

Frequency	Operator in charge	Time required	PPE Intended	Required tools/instruments
When required	[Mechanical maintenance technician]	/		Standard tools

In the event of a broken fan, electric damper or distribution box, replace them following the indications below.

MAIN RESIDUAL RISKS CONNECTED TO THE OPERATION	
⚠	*Risk of impact/bruising against the fixed parts of the machine during inspection.*
⚠	*Risk of being hit (or of hitting other persons) due to tools or replaced component falling from a height if the component is installed in the top part of the boiler.*
⚠	*Burn/scalding hazard due to contact with high temperature surfaces if performing replacement of parts when they have not yet completely cooled.*
⚠	*Electrocution hazard if performing replacement of electrically actuated components without having disconnected them from the power mains beforehand.*

Checking machine - operator safety conditions

Before performing replacement of faulty parts ensure that:

- lThe local cut-off switches applied to the individual fans (if any) are turned to the “O” position and safely padlocked. Otherwise, disconnect the power supply upstream of the boiler turning to position “O” the main power cut-off switch located on the power supply panel.
- The person in charge of replacement is adequately trained and equipped with the required PPE.

Description of the operations

- If the component to be replaced is at a considerable height, arrange a scaffold or use a standard-compliant platform for safe access.
- Harness the component to be replaced to appropriate lifting equipment to prevent it from falling to the ground during replacement operations.
- Open the electrical shunting box of the component to be replaced and disconnect all power cables.
- that hold the component to be replaced in work position.
- Place the broken component onto the ground and replace it w
- Use appropriate lifting equipment and install the new component in the correct work position, and lock it in position with
- Restore the electrical wiring on the new component’s shunting box.
- Ensure not to forget tools or equipment used during the replacement in the area of operations.
- t were removed to make replacement operations easier.
- Power on the component and set the local power switch (or the master one) in position “ I “.
- Ensure the new component works correctly.
- If the component to be replaced is a distribution box (due to breakdown, fault or because it is burnt), remove the relevant

.

SPC_06 Greasing fan bearings

Frequency	Operator in charge	Time required	PPE Intended	Required tools/instruments
Every 1000 hours of operation	[Mechanical maintenance technician]	/		Pump for manual greasing

Every 1000 hours of operation, grease the bearings of the fans following the indications below.

MAIN RESIDUAL RISKS CONNECTED TO THE OPERATION	
	Risk of impact/bruising against the fixed parts of the machine during lubrication.
	Risk of being hit (or of hitting other persons) due to tools falling from a height if the component to be greased is installed in the top part of the boiler.
	Risk of shearing the upper limbs if greasing bearings on fans in operation

Checking machine - operator safety conditions

Before performing greasing of the fan bearings ensure that:

- The local cut-off switches applied to the individual fans (if any) are turned to the “O” position and safely padlocked. Otherwise, disconnect the power supply upstream of the boiler turning to position “O” the main power cut-off switch located on the power supply panel.
- The maintenance technician is adequately trained and equipped with the required PPE.

Description of the operations

- If the component to be greased is at a considerable height, arrange a scaffold or use a standard-compliant platform for safe access.
- Remove, if required, the protection grates to be able to reach the bearings to be greased.
- Use a manual greasing pump and grease the bearings using the quantity and type of grease recommended by the supplier of the fan installed on the boiler (see use and maintenance manuals of the individual fans, issued by the manufacturers and attached herewith).

SPC_07 **Check operation of swing check valves (if any)**

Frequency	Operator in charge	Time required	PPE Intended	Required tools/instruments
See annex "M - Maintenance"	[Mechanical maintenance technician]	/		Standard tools

According to the frequencies set out in annex **"M - Maintenance"**, perform a functional inspection of the swing check valves installed in the system following the indications below.

MAIN RESIDUAL RISKS CONNECTED TO THE OPERATION	
⚠	*Risk of impact/bruising against the fixed parts of the machine during inspection operations.*
⚠	*Risk of inhaling pulverised ash during inspection/maintenance operations.*

Checking machine - operator safety conditions

Adhere to the provisions set out in the use and maintenance manual of the swing check valves issued by the manufacturer and attached herewith.

Description of the operations

- Perform the functional checks and any routine maintenance operations following the indications set out in the relevant use and maintenance manual issued by the manufacturer and attached herewith.

Should clogging occur inside the swing check valves, a block/clogging signal is automatically sent to the unit's control system.
Stop the unit and wait for the parts to cool down completely before performing cleaning and releasing the valve.

SPC_08 Check operation of ash extraction screw

Frequency	Operator in charge	Time required	PPE Intended	Required tools/instruments
See annex “M - Maintenance”	[Mechanical maintenance technician]	/		Standard tools

According to the frequencies set out in annex **“M - Maintenance”**, perform a functional inspection of the ash extraction screw (if installed in your system) following the indications below.

MAIN RESIDUAL RISKS CONNECTED TO THE OPERATION	
⚠	*Risk of impact/bruising against the fixed parts of the machine during inspection operations.*
⚠	*Risk of inhaling pulverised ash during inspection/maintenance operations.*
⚠	*Burn/scalding hazard due to contact with high temperature surfaces if performing maintenance operations on parts that have not completely cooled.*

Checking machine - operator safety conditions

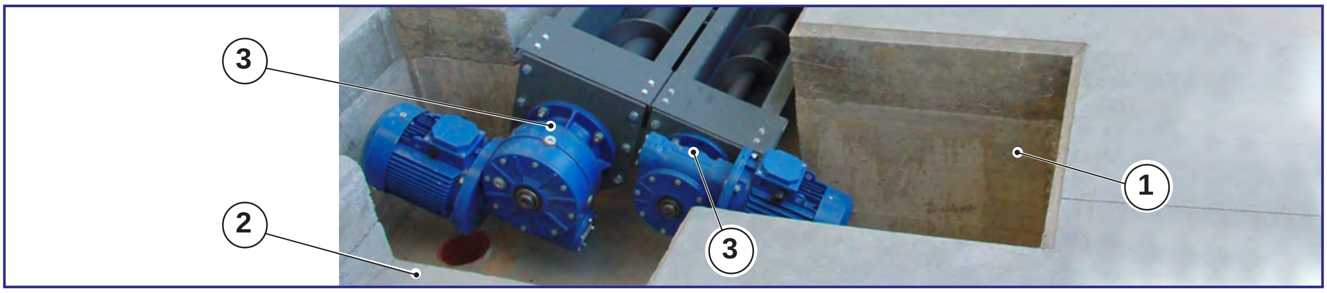
Before performing any kind of inspection or maintenance on the ash extraction screw ensure that:

- The boiler is off and completely cooled.
- The local power cut-out switch (if any) is turned to position “O” and safely padlocked. Otherwise, disconnect the power supply upstream of the boiler turning to position “O” the main power cut-off switch located on the power supply panel.
- The maintenance technician is adequately trained and equipped with the required PPE.

Description of the operations

- Grease the bearings of the supports at the two ends.
- Check the condition of the joi .
- Ensure the screw is intact and not worn, by measuring the spiral height. If wear greater than 10 mm is found, perform replacement using a screw that has the same physical features and size as the one to be replaced.

NOTE: When the ash extraction screw is installed in the pit (e.g. Det. 1), it must be replaced by extracting it from the side of the pit that has an access opening (Det. 2) after removing covers, supports or drive gear motor (e.g. Det. 3).



Should clogging occur inside the ash extraction screw, a block/clogging signal is automatically sent to the unit’s control system.
Stop the unit and wait for the parts to cool down completely before performing cleaning and releasing the screw.

SPC_09 Check and cleaning of rake (if any) and under grate area

Frequency	Operator in charge	Time required	PPE Intended	Required tools/instruments
See annex **"M - Maintenance"**	[Mechanical maintenance technician]	/		Standard tools

According to the frequencies set out in annex **"M - Maintenance"**, perform a functional inspection of the rake (if installed in your system) and under grate area following the indications below.

MAIN RESIDUAL RISKS CONNECTED TO THE OPERATION	
⚠	*Risk of impact/bruising against the fixed parts of the machine during inspection operations.*
⚠	*Risk of inhaling pulverised ash during inspection/maintenance operations.*
⚠	*Burn/scalding hazard due to contact with high temperature surfaces if performing maintenance operations on parts that have not completely cooled.*

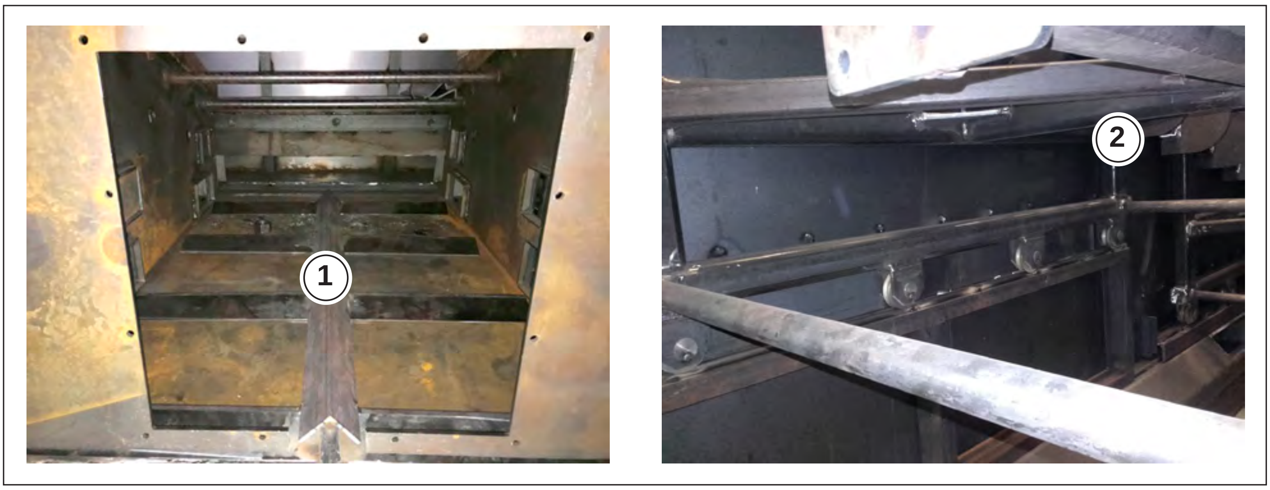
Checking machine - operator safety conditions

Before performing any kind of inspection or maintenance on the ash extraction screw ensure that:

- The boiler is off and completely cooled.
- The local power cut-out switch (if any) of the hydraulic unit actuating the rake is turned to position "O" and safely padlocked.
- The maintenance technician is adequately trained and equipped with the required PPE.

Description of the operations

- Check the pipes and on the hydraulic cylinder actuating the rake (if installed in your system) and ensure there
- Perform general rake cleaning (Det. 1and the area under the grate (Det. 2).
- Ensure the structures of the parts are intact and without any warping due to overheating.
- Ensure there are no mechanical impediments (warped structures) that may restrict or hinder free rake movement.



SPC_10 Oil level and temperature check on hydraulic unit

Frequency	Operator in charge	Time required	PPE Intended	Required tools/instruments
See annex **"M - Maintenance"**	[Mechanical maintenance technician]	5 min		Standard tools

According to the frequency set out in annex **"M - Maintenance"**, perform visual check of the level and temperature of the oil in the tank of the hydraulic unit. Should an abnormality be found (low oil level or oil temperature too high) perform the corrective actions set out below.

MAIN RESIDUAL RISKS CONNECTED TO THE OPERATION	
⚠	*Risk of impact/bruising against the fixed walls of the unit.*
⚠	*Risk of tripping into the hydraulic system's pipes.*
⚠	*Risk of contact with very hot surfaces.*
⚠	*Risk of fire due to the presence of flammable liquids.*
⚠	*Risk of being hit by pressurised fluid jets.*

Checking machine - operator safety conditions

Before performing any corrective actions on the hydraulic power unit, ensure that:

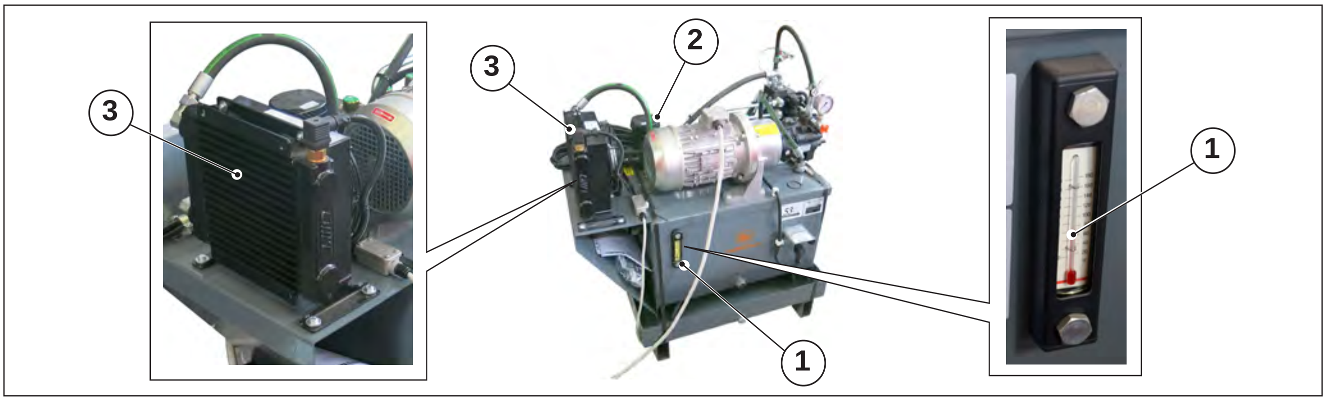
- The hydraulic power unit is stationary and powered off (Local power cut-out switch turned to position "O", safely padlocked and key removed);
- The person in charge of inspection and any maintenance is adequately trained and equipped with the required PPE.

Description of the operations: Oil level and temperature check

- Check the level and temperature of the oil contained in the tank by means of the appropriate sight glass (Det. 1).
  - Should the oil level be found to be low, open the cap (Det. 2) and restore the correct level by adding oil of the same type as that in the tank.

    ATTENTION: Never mix different types of oil. For the recommended types of oil refer to the use and maintenance manual of the unit issued by the manufacturer and attached herewith.

  - Should an abnormal raise in oil temperature be observed, ensure the heat exchanger (Det. 3) works properly. If required, perform maintenance/cleaning of the exchanger (see use and maintenance manual of the unit issued by the manufacturer and attached herewith).



SPC_11 Mesh filter cleaning on oil filling cap in the tank

Frequenza	Addetto	Tempo richiesto	D.P.I. Previsti	Attrezzi/utensili necessari
See annex **“M - Maintenance”**	[Mechanical maintenance technician]	15 min		Compressed air Paintbrush Naphtha for cleaning

Follow the frequencies set out in annex **“M - Maintenance”**, and perform accurate cleaning of the mesh inside the oil s tank, adhere to the indications below.

MAIN RESIDUAL RISKS CONNECTED TO THE OPERATION	
⚠	*Risk of impact/bruising against the fixed walls of the unit.*
⚠	*Risk of tripping into the hydraulic system’s pipes.*
⚠	*Risk of contact with very hot surfaces.*
⚠	*Risk of fire due to the presence of flammable liquids.*
⚠	*Risk of being hit by fluid jets.*

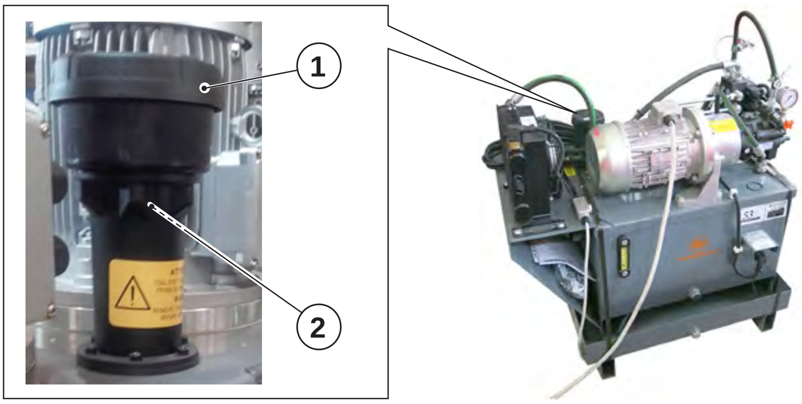
Checking machine - operator safety conditions

Before performing any corrective actions on the hydraulic power unit, ensure that:

- The hydraulic power unit is stationary and powered off (Local power cut-out switch turned to position “O”, safely padlocked and key removed);
- The person in charge of inspection and any maintenance is adequately trained and equipped with the required PPE.

Description of the operations: Mesh filter cleaning

- inside it (Det. 2).
- Clean the mesh using a compressed air blow, paying attention not to aim the air blow (and any oil splashes) towards oneself or other persons.
- If required, use a soft paintbrush and naphtha to clean the mesh more thoroughly. If even cleaning with naphtha does not have good results, replace the using the original or manufacturer’s recommended spare parts (see operating manual of the unit issued by the manufacturer and attached herewith).
- e cap on tightly.



SPC_12 Check tightening of fittings and condition of pipes

Frequency	Operator in charge	Time required	PPE Intended	Required tools/instruments
See annex **“M - Maintenance”**	[Mechanical maintenance technician]	15 min		Standard tools

Adhere to the frequencies set out in annex **“M - Maintenance”**, and perform an accurate inspection of the degree of tightening of the hydraulic pipe on the hydraulic unit, on valves and on the mobile grate’s moving cylinders and any rake. To do so follow the instructions below.

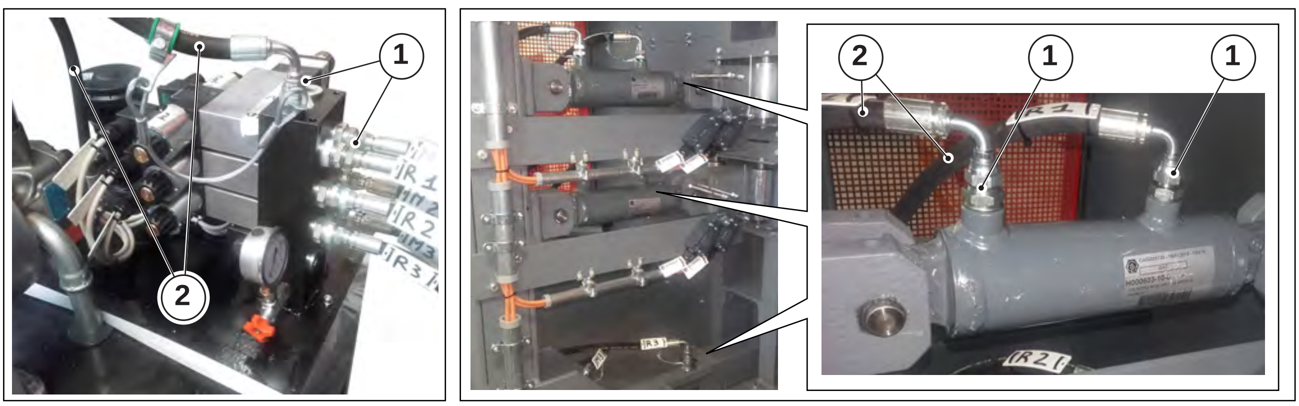
MAIN RESIDUAL RISKS CONNECTED TO THE OPERATION	
⚠	*Risk of impact/bruising against the fixed walls of the unit.*
⚠	*Risk of tripping into the hydraulic system’s pipes.*
⚠	*Risk of contact with very hot surfaces.*
⚠	*Risk of fire due to the presence of flammable liquids.*
⚠	*Risk of being hit by pressurised fluid jets.*

Checking machine - operator safety conditions

- The hydraulic power unit is stationary and powered off (Local power cut-out switch turned to position “O”, safely padlocked and key removed);
- The person in charge of inspection and any maintenance is adequately trained and equipped with the required PPE.

Description of the operations: Check tightening of fittings and condition of pipes

- Ensure all connecting of the hydraulic pipes in the system are properly tightened, and ensure there are no oil leaks or seepage near the joints (e.g. Det. 1).
  -
  ATTENTION: In the event of leaks, remove the oil residues from the hydraulic circuit and accurately clean the areas concerned. After that, check the oil level in the tank and if required top up following the instructions in specification no. 10.
- Check the integrity of the hydraulic system pipes (e.g. Det. 2) and ensure they are in good conditions. Should conspicuous cracks be observed, replace as soon as possible.



SPC_13 External unit cleaning

Frequency	Operator in charge	Time required	PPE Intended	Required tools/instruments
See annex **"M - Maintenance"**	[Mechanical maintenance technician]	15 min		Standard tools

Follow the frequencies set out in annex **"M - Maintenance"**, and perform accurate external cleaning of the hydraulic unit. To do so follow the instructions below.

PRINCIPALI RISCHI RESIDUI CONNESSI ALL'OPERAZIONE	
⚠	*Risk of impact/bruising against the fixed walls of the unit.*
⚠	*Risk of tripping into the hydraulic system's pipes.*
⚠	*Risk of contact with very hot surfaces.*
⚠	*Risk of fire due to the presence of flammable liquids.*
⚠	*Risk of being hit by pressurised fluid jets.*

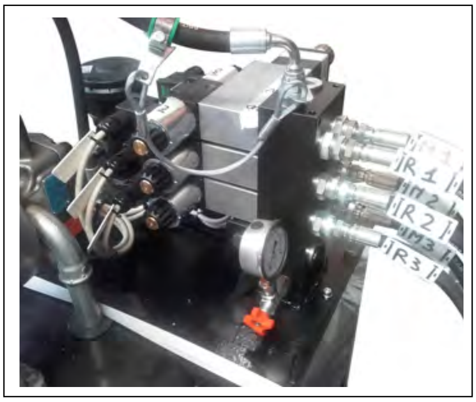
Checking machine - operator safety conditions

Before performing external cleaning of the hydraulic unit, ensure that:

- The hydraulic power unit is stationary and powered off (Local power cut-out switch turned to position "O", safely padlocked and key removed).
- The person in charge of inspection and any maintenance is adequately trained and equipped with the required PPE.

Description of the operations: External unit cleaning

- Perform external cleaning of the tank, motor and all components of the hydraulic system (e.g. valves, pressure gauge, pipes etc.) using moist rags and absorbent paper. Avoid using aggressive detergents that might spoil the paint and undermine the components' integrity. Also avoid using abrasive brushes or metal tools to remove any dirt residues or scaling from the surfaces of the unit.
- During cleaning it is recommended to inspect the state of repair of the pipes and the tightening of the following the



SPC_14 Fluid replacement and internal tank cleaning

Frequency	Operator in charge	Time required	PPE Intended	Required tools/instruments
See annex **"M - Maintenance"**	[Mechanical maintenance technician]	1 hour		Standard tools

Follow the frequencies set out in annex **"M - Maintenance"** and replace the contained in the hydraulic unit after accurately cleaning the tank to prevent waste oil deposits and accumulated sludge from undermining the of the pump and whole system. To do so follow the instructions below.

MAIN RESIDUAL RISKS CONNECTED TO THE OPERATION	
⚠	*Risk of impact/bruising against the fixed walls of the unit.*
⚠	*Risk of tripping into the hydraulic system's pipes.*
⚠	*Risk of contact with very hot surfaces.*
⚠	*Risk of fire due to the presence of flammable liquids.*
⚠	*Risk from contact with oil.*

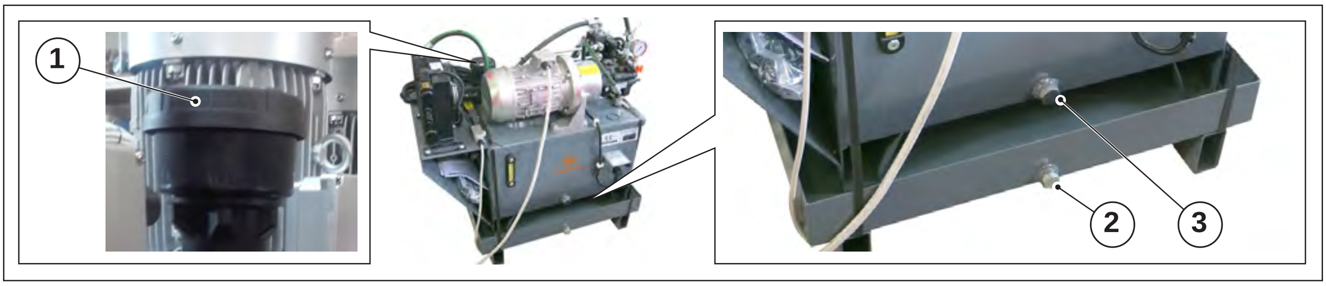
Checking machine - operator safety conditions

s tank, ensure that:

- LThe hydraulic power unit is stationary and powered off (Local power cut-out switch turned to position "O", safely padlocked and key removed).
- The person in charge of inspection and any maintenance is adequately trained and equipped with the required PPE.

Description of the operations: Fluid replacement and internal tank cleaning

- Screw of ng cap (Det. 1);
- Loosen and remove the closi d under the unit (Det. 2);
- tainer under the drain of the collecting tank to collect the oil extracted from the tank.
- Loosen and remove the closing cap placed on the lower part of the tank (Det. 3) and drain all the waste oil in the collecting tank and then in the container arranged for draining.
  Attention: If the container used is not capacious enough, close the caps of the tank (Det. 3) and collecting tank (Det.2) and replace the container or empty the extracted oil into appropriate collecting drums. **Collect and dispose of waste oil according to the laws in force in the country where the machine is installed**.
- After draining all the oil, perform accurate cleaning of the inside of the tank using products/solvents compatible with the type of used to feed the system (see use and maintenance manual of the unit issued by the manufacturer and attached herewith).
- When washing is completed close the drain caps and add the



SPC_15 Periodic inspection of electrical and electromechanical instrumentation.

Frequency	Operator in charge	Time required	PPE Intended	Required tools/instruments
See annex **"M - Maintenance"**	[Mechanical maintenance technician] [Electric maintenance technician]	2 hours		Standard tools

Following the frequencies set out in annex "M - Maintenance", perform inspection of all the electrical and electromechanical instrumentation applied to the boiler (limit switch, probes etc..) and perform cleaning, checking functionality and, where required, replace using original spare parts.

MAIN RESIDUAL RISKS CONNECTED TO THE OPERATION	
⚠	*Risk of impact/bruising against the fixed parts of the boiler.*
⚠	*Risk of tripping into the hydraulic system's pipes.*
⚠	*Risk of contact with very hot surfaces.*

Checking machine - operator safety conditions

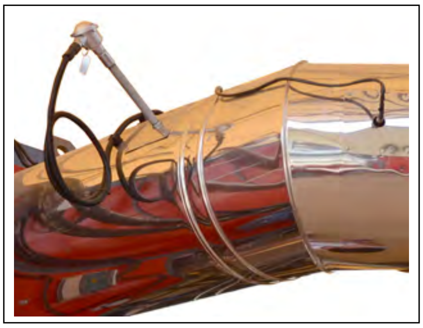
Before performing any kind of inspection on the electrical and electromechanical instrumentation, ensure that:

- The boiler is off and completely cooled.
- The local power cut-out switch (if any) is turned to position "O" and safely padlocked. Otherwise, disconnect the power supply upstream of the boiler turning to position "O" the main power cut-off switch located on the power supply panel.
- The maintenance technician is adequately trained and equipped with the required PPE.

Description of the operations: External unit cleaning

- With the set frequency, clean all electromechanical limit switches applied to the boiler (e.g. Det. 1) to prevent accumulated dirt, ash or dust from causing malfunctions and check functionality.
- With the set frequency, check functionality of the temperature monitoring probes applied to the boiler (e.g. Det. 2).
- With the set frequency, clean and check functionality of the vacuum meter applied to the boiler (e.g. Det. 2).
- Any replacement of broken or malfunctioning components must be performed using original parts.

ATTENTION: Do not modify the installation position of probes or micro switches. Moving their position even by just a few centimetres may distort the reading of the values or anticipate or delay their tripping thus undermining correct performance of the boiler's work cycle (synchronism, automatic start and shutdowns).



SPC_16 **Inspection of metal frames and insulation panels.**

Frequency	Operator in charge	Time required	PPE Intended	Required tools/instruments
See annex **"M - Maintenance"**	[Mechanical maintenance technician]	2 hours		Standard tools

Follow the frequencies set out in annex **"M - Maintenance"**, and perform a visual inspection of the general condition of the boiler's metal frame and insulation panels.

MAIN RESIDUAL RISKS CONNECTED TO THE OPERATION	
	Risk of impact/bruising against the fixed parts of the boiler.
	Risk of contact with very hot surfaces.

Checking machine - operator safety conditions

Before performing any inspection of the metal frame and insulation panels, ensure that:

- The boiler is off and completely cooled.
- The local power cut-out switch (if any) is turned to position "O" and safely padlocked. Otherwise, disconnect the power supply upstream of the boiler turning to position "O" the main power cut-off switch located on the power supply panel.
- The maintenance technician is adequately trained and equipped with the required PPE.

Description of the operations: External unit cleaning

- With the established frequency, perform accurate visual inspection of the state of repair of the boiler's outer metal frame.
  - Should any onset of rust, corrosion, scaling or decay of the outer paint be observed, clean the area concerned and restore the initial conditions using appropriate products.
- Check verticality of the posts.
- Perform accurate visual inspection of the state of repair of the insulation panels applied to the boiler.
  - If any damage, breakdowns or conspicuous wear is observed, restore the insulating layer with material having the same chemical and physical features.
- Access the area under the grate and ensure the support structure of the mobile grate (slides) and the relevant cooling circuit have no warping due to overheating.

Note: Should any warping due to overheating or corrosion be observed on the metal frame or internal structure of the boiler (e.g. area under the grate) and should you have any doubts on how to act, document the area concerned with photos and contact the support service of Uniconfort srl. The personnel in charge will be able to indicate any corrective actions required to restore the original condition of the machine.

SPC_17 Expansion joint inspection

Frequency	Operator in charge	Time required	PPE Intended	Required tools/instruments
See annex **"M - Maintenance"**	[Mechanical maintenance technician]	2 hours		Standard tools

If the system is with an expansion joint (between the combustor and heat exchanger) perform a visual inspection of its state of repair following the frequencies set out in annex **"M - Maintenance"**

MAIN RESIDUAL RISKS CONNECTED TO THE OPERATION	
	Risk of impact/bruising against the fixed parts of the boiler.
	Risk of contact with very hot surfaces.

Checking machine - operator safety conditions

Before performing the inspection of the expansion joint, ensure that:

- The boiler is off and completely cooled.
- The maintenance technician is adequately trained and equipped with the required PPE.

Description of the operations: External unit cleaning

- Visually check the state of repair of the expansion joint placed between the gas outlet area from the combustor and their entry into the heat exchanger and ensure the outer cloth is not damaged and has no clear signs of wear.
  - In the event of damage to the outer cloth, repair it using appropriate material and following the operating issued by the manufacturer (see supplier's manual attached herewith).

- Check internally the insulating material and should any conspicuous damage or wear be observed, restore it following the indications provided in the supplier's manual (see supplier's manual attached herewith).

SPC_18 Inspection of emergency flue and ventilation ducts

Frequency	Operator in charge	Time required	PPE Intended	Required tools/instruments
See annex **“M - Maintenance”**	[Mechanical maintenance technician]	2 hours		Standard tools

Follow the frequencies set out in annex **“M - Maintenance”** and check the condition and of the system’s emergency

MAIN RESIDUAL RISKS CONNECTED TO THE OPERATION	
	Risk of impact/bruising against the fixed parts of the boiler.
	Risk of contact with very hot surfaces.
	Danger of falling from any ladders or scaffolds used for inspections at height.

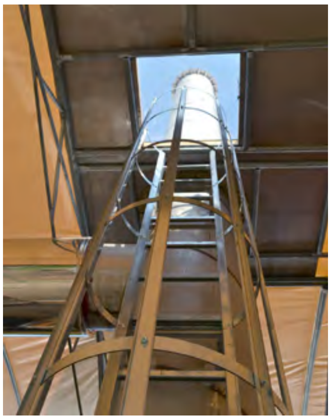
Checking machine - operator safety conditions

- The boiler is off and completely cooled.
- The maintenance technician is adequately trained and equipped with the required PPE.

Description of the operations: External unit cleaning

- At each system downtime check the condition and functionality o
  - In the event of damage to the supporting metal work (supports, beams, supporting tie rods etc.) restore it performing the appropriate maintenance or replace any damaged supporting parts.
-
  - ient, hire specialised personnel f .

ATTENTION: In the event of poor efficiency of the emergency flue, stop the system (if in operation) or do not start it (in the event of downtime). Perform all the checks and corrective actions required to restore correct operation of the flue, and if required contact specialised chimney sweeping and maintenance firms.


4.4 Troubleshooting - Causes - Solutions

This paragraph sums up the main reasonably foreseeable problems that may occur during operation of the **Combustor**. The main causes and possible solutions are provided for each problem, in order to restore correct boiler operation.

ATTENTION: Troubleshooting, any inspections and all repairs must be performed by adequately trained personnel who have been made aware of all the residual risks and safety indications provided in this folder and in the general system operating manual.

PROBLEM	CAUSE	SOLUTION
The boiler doesn't start	Power outage	Power on the boiler setting the master switch to the "I" position.
	Motor overload protection device has tripped.	Reset the circuit breaker.
	Thermostats intervened.	Reset the operating and/or safety thermo-stat.
	Pressure switches intervened.	Reset the pressure switches.
	Doors open	Close the doors
Defective combustion	Combustion chamber or mobile grate clogged by ash and combustion products.	Clean the entire combustion chamber, even under the burner and mobile grate.
	No primary and/or secondary combu-stion air.	Adjust the quantity of primary and seconda-ry air through the appropriate dampers
	Excessive fuel feeding	Reduce the amount of fuel fed into the combustor..
	Fuel is too humid.	
High fume temperature	Over-temperature in the	Spegnere la macchina e pulire il combusto-re e la griglia mobile dai depositi di cenere che ostacolano la corretta combustione.
No negative pressure in the combustion chamber	Check the fume extractor motorised damper	Replace the damper's servomotor
	Check the operation of the negative pressure measuring device	Clean the copper pipe that connects the vacuum meter to the combustion chamber
		Replace digital vacuum meter
Abnormal noise from friction between metal parts is he-ard during operation.	Possible breakdown of a mobile grate bar.	Stop combustor operation and wait for the combustion chamber to cool completely. Remove the deposited ash and clean the mobile grate looking for any grate bar that needs replacing.
	Possible breakdown of the ash ex-traction rake.	Stop combustor operation and wait for the combustion chamber to cool completely. Clean the area under the grate to clear up the bottom and identify the point and extent of the breakage.

PROBLEM	CAUSE	SOLUTION
The boiler is powered electrically, the hydraulic unit is in operation but the mobile grate remains still.	The hydraulic unit is blocked due to the oil level low probe triggered.	Check the amount of oil in the tank and top up to the correct level as required.
		Ensure there are no oil leaks from the
		Check correct operation of the oil level probe and replace if required.
	The hydraulic unit is blocked due to excessive oil temperature.	Check correct operation of the cooling fan unit. Then wait for the oil temperature to drop to operating level.

The Support service of UNICONFORT srl is available to provide useful indications to solve any issues not mentioned here or to act directly if deemed necessary.

4.5 Alarms and warnings

The combustor has its own safety circuit connected to the system's electrical board, that signals any alarms that may be triggered during system operation.

Any functional fault is therefore indicated by an alarm message displayed on the board and by appropriate sound and light signals to attract the attention of the system operator.

4.7 System storage in case of prolonged stoppage

Should it be required to stop the system for an extended time (longer than 15 days), some simple measures must be taken to preserve the integrity and functionality of all units making up the combustor. , it is required to:

- Switch off the boiler and disconnect the power supply of all the motors and all the electrically operated devices, setting to position "O" the relevant local power switches (if any) or the master switch in the line electric panel.

ATTENTION: Wait for any combustion still going on in the combustor to be fully extinguished, and ensure the internal temperature of the combustion chamber has dropped below 40°C before accessing the internal parts.

IMPORTANT! Before accessing the internal parts of the combustor, obtain the PPE required for the individual operations (Gloves, helmet, appropriate clothing, safety shoes etc.)

- Close all the manual damp , secondary and tertiary air ventilation circuits.
- Close the top of the emergency chimney with a rain cowl (only if the chimney does not have its own rain cowl).
- Shut off the grate cooling water circuit (turn the shut-off valves in "CLOSED" position and padlock them).
- Adequately add the cooling water contained in the circuit with antifreeze liquid and deoxygenating agent so as to prevent any breakdowns due to freezing or corrosion. For the operating methods and amounts of product to be used, follow the indications issued by the supplier of the products used.
- Remove from the mobile grate all ash residues and clean it using an industrial vacuum cleaner in order to be able to check the state of repair of the grate bars.

IMPORTANT: Refer to the use and maintenance manual of the hydraulic unit installed in your system (issued by the manufacturer and attached herewith) and ensure any requirements concerning the minimum and maximum storage of the power unit have been complied with (e.g. minimum and maximum temperature, maximum humidity in the unit's installation site and site of prolonged storage when left inactive) and if required, implement all the requirements set forth by the manufacturer.

ATTENTION: Before restarting the combustor following a prolonged stoppage, perform a visual check of the state of preservation of all its components and remedy any damage or faults observed. Subsequently restore the electrical connections to the motors, fill to the correct level the hydraulic unit actuating the mobile grate and supply the grate cooling water circuit by moving in position "OPEN" the relevant shut-off valves.

Section 5 - Decommissioning and disposal

5.1 Decommissioning, disassembly and disposal of materials

Every country has regulations on waste disposal, therefore comply with the provisions of the speci- laws and relevant authorities of the country where the system is dismantled and disposed of. In general, it is required to appoint specialised centres for demolition and disposal of the components and parts making up the combustor.

For decommissioning, disassembly and disposal of the materials/components adhere to the following provisions:

Disconnect the machine from the power mains and ensure that, with machine powered off, the hydraulic circuit of the various units is not pressurised.

- Drain the grate cooling water circuit.
- Contact the relevant authorities to notify and certify demolition of the machine, in compliance with the laws in force in the country where the machine is installed.
- Drain the oil in the power unit and hydraulic circuit actuating the mobile grate, and collect the oil in appropriate containers for subsequent storage and disposal according to the law.
- Disassemble the machine carefully dividing its materials based on their chemical nature (iron, refractory , etc.).
- Make sure that the where the machine or its parts are stored is made of washable, non-absorbent material and having suitable drain ducts, to prevent accidental oil or rust leakages. These drains must convey any leakages to waterproof collection tanks.
- Should the machine or its components be stored outdoors pending disposal, cover with insulating sheets, in order to prevent damages to the structures due to rain and humidity, with consequent oxidation and rust build-up.
- In compliance with the provisions in force in the country where the machine is installed and used, scrap all the materials and substances resulting from disassembly..

Instructions for disposal

The waste generated by machine demolition (oil, iron, refractory material, ceramic copper, mechanical and electrical components etc.) must be disposed of according to the laws in force in the country where the machine is installed and used.

For information on disposal, contact the relevant authorities, or appoint specialised and authorised waste disposal companies.

Appendix C

Emissions Monitoring Results

Exova Catalyst, Unit C6, Emery Court, The Embankment Business Park, Heaton Mersey, Stockport, SK4 3GL
E: toby.campbell@exova.com
Your Exova Catalyst Contact: Toby Campbell (07825 130 074)

Stack Emissions Testing Report Commissioned by
Newbridge Energy Ltd

Installation Name & Address
Blazers Fuels Ltd
Brickfield Lane
Ruthin
Denbeighshire
North Wales
LL15 2TN

Stack Reference
Biomass CHP Plant Exhaust

Dates of the Monitoring Campaign
5th October 2017

Job Reference Number
CAT-3701

Report Written by
Danny Pryke Team Leader MCERTS Level 2 MM 03 163 TE1 TE2 TE3 TE4

Report Approved by
Matthew Pendlebury Team Leader MCERTS Level 2 MM 04 535 TE1 TE2 TE3 TE4

Report Date
18th October 2017

Version
Version 1

Signature of Report Approver

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Opinions and interpretations expressed herein are outside the scope of Exova Catalyst's ISO 17025 accreditation.

Executive Summary

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MONITORING OBJECTIVES

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust
5th October 2017

Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by Newbridge Energy Ltd to carry out stack emissions testing for Blazers Fuels Ltd on the Biomass CHP Plant Exhaust at Ruthin.

The aim of the monitoring campaign was to perform testing, as requested by the customer, for a number of prescribed pollutants. There are no emission limits set for any of the pollutants at this time.

Special Requirements

There were no special requirements.

Target Parameters

Total Particulate Matter, PM_{10}, $PM_{2.5}$, Oxides of Nitrogen (as NO_2), Carbon Monoxide

MONITORING RESULTS

Blazers Fuels Ltd, Ruthin

Biomass CHP Plant Exhaust

5th October 2017

where MU = Measurement Uncertainty associated with the Result

Parameter			Concentration				Mass Emission			
			Units	**Result**	**MU +/-**	**Limit**	**Units**	**Result**	**MU +/-**	**Limit**
Total Particulate Matter [1]			mg/m³	6.4	0.40	-	g/hr	56.9	4.6	-
PM_{10} [1]			mg/m³	0.29	0.46	-	g/hr	2.6	4.1	-
$PM_{2.5}$ [1]			mg/m³	0.21	0.35	-	g/hr	1.9	3.1	-
Oxides of Nitrogen (as NO_2) [1]			mg/m³	82.1	2.5	-	g/hr	725	43.8	-
Carbon Monoxide [1]			mg/m³	10.5	1.1	-	g/hr	92.6	10.9	-
Carbon Dioxide	% v/v	**Wet** 7.92	% v/v	**Dry** 8.95	0.28					
Oxygen	% v/v	**Wet** 10.2	% v/v	**Dry** 11.6	0.35					
Water Vapour			% v/v	11.6	0.58					
Stack Gas Temperature			°C	160						
Stack Gas Velocity			m/s	6.1	0.16					
Volumetric Flow Rate (ACTUAL)			m³/hr	14061	729					
Volumetric Flow Rate (REF) [1]			m³/hr	8827	458					

NOTE: VOLUMETRIC FLOW RATE & VELOCITY DATA TAKEN FROM AN AVERAGE OF ALL OF THE ISOKINETIC RUNS.

[1] Reference Conditions (REF) are: 273K, 101.3kPa, without correction for water vapour content.

MONITORING DATE(S) & TIMES

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust
5th October 2017

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m³	6.4	g/hr	56.9	05/10/2017	10:50 - 11:20, 11:22 - 11:52	60
PM_{10}	R1	mg/m³	0.29	g/hr	2.6	05/10/2017	13:45 - 14:45	60
$PM_{2.5}$	R1	mg/m³	0.21	g/hr	1.9	05/10/2017	13:45 - 14:45	60
Oxides of Nitrogen (as NO_2)	R1	mg/m³	82.1	g/hr	725	05/10/2017	10:50 - 11:50	60
Carbon Monoxide	R1	mg/m³	10.5	g/hr	92.6	05/10/2017	10:50 - 11:50	60
Carbon Dioxide	R1	% v/v	8.95			05/10/2017	10:50 - 11:50	60
Oxygen	R1	% v/v	10.2			05/10/2017	10:50 - 11:50	60
Velocity & Volumetric Flow Rate	R1					05/10/2017	09:43 - 10:03	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust
5th October 2017

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operation
Capacity (of 100%) and Tonnes / Hour	Full Capacity
Continuous or Batch Process	Continuous Batch
Feedstock (if applicable)	Wood Chip Pallets
Abatement System	Bag Filter and Cyclone
Abatement System Running Status	On
Fuel	Natural Gas
Plume Appearance	None Visible

MONITORING & ANALYTICAL METHODS

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust
5th October 2017

	Monitoring				Analysis					
Parameter	**Standard**	**Technical Procedure**	**ISO 17025 Testing**	**Testing Lab**	**Analytical Procedure**	**Analytical Technique**	**ISO 17025 Analysis**	**Analysis Lab**	**MCERTS Testing**	**LOD (Average)**
Total Particulate Matter	EN 13284-1	CAT-TP-01	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.12 mg/m³
PM_{10}	BS EN ISO 23210	CAT-TP-26	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.23 mg/m³
$PM_{2.5}$	BS EN ISO 23210	CAT-TP-26	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.18 mg/m³
Water Vapour	EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.10 % v/v
Oxides of Nitrogen (as NO_2)	EN 14792	CAT-TP-21	Yes	CAT	Chemiluminescence by Horiba PG-250				Yes	0.41 mg/m³
Carbon Monoxide	EN 15058	CAT-TP-21	Yes	CAT	NDIR by Horiba PG-250				Yes	0.42 mg/m³
Carbon Dioxide	ISO 12039	CAT-TP-21	Yes	CAT	NDIR by Horiba PG-250				Yes	0.10 % v/v
Oxygen	EN 14789	CAT-TP-21	Yes	CAT	Dry Zirconia Cell by Horiba PG-250				Yes	0.06 %
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41	Yes	CAT	Pitot Tube and Thermocouple				Yes	1.2 m/s

ANALYSIS LABORATORIES

(with short name reference as appears in the table above)

Exova Catalyst (CAT)	ISO 17025 Accreditation Number: 4279

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
All Parameters	All Runs	There are no deviations associated with the sampling employed.

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.90
Width	m	-
Area	m²	0.64
Port Depth	cm	24
Orientation of Duct	-	Vertical
Number of Ports	-	2
Sample Port Size	-	5" Flange

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	Permanent
Inside / Outside	Inside

Platform Details

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	Yes
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	Yes
Platform has vertical base boards (approx. 0.25m high)	Yes
Platform has chains / self closing gates at top of ladders	Yes
There are no obstructions present which hamper insertion of sampling equipment	Yes
Safe Access Available	Yes
Easy Access Available	Yes

Sampling Location / Platform Improvement Recommendations

Although this platform does not meet the requirements in the Environment Agency's Technical Guidance Note M1 and EN 15259, it is adequate for the testing carried out on this stack.

EN 15259 Homogeneity Test Requirements

There is no requirement to perform a EN 15259 Homogeneity Test on this Stack.

Sampling Plane Validation Criteria (from EN 15259)

Criteria in EN 15259	Units	Traverse 1		Required	Compliant
Lowest Differential Pressure	Pa	22.0		> 5 Pa	Yes
Mean Velocity	m/s	6.48		-	-
Lowest Gas Velocity	m/s	6.24		-	-
Highest Gas Velocity	m/s	6.65		-	-
Ratio of Above	: 1	1.07		< 3 : 1	Yes
Maximum Angle of Swirl	°	5		< 15°	Yes
No Local Negative Flow	-	Yes		-	Yes

PLANT PHOTOS

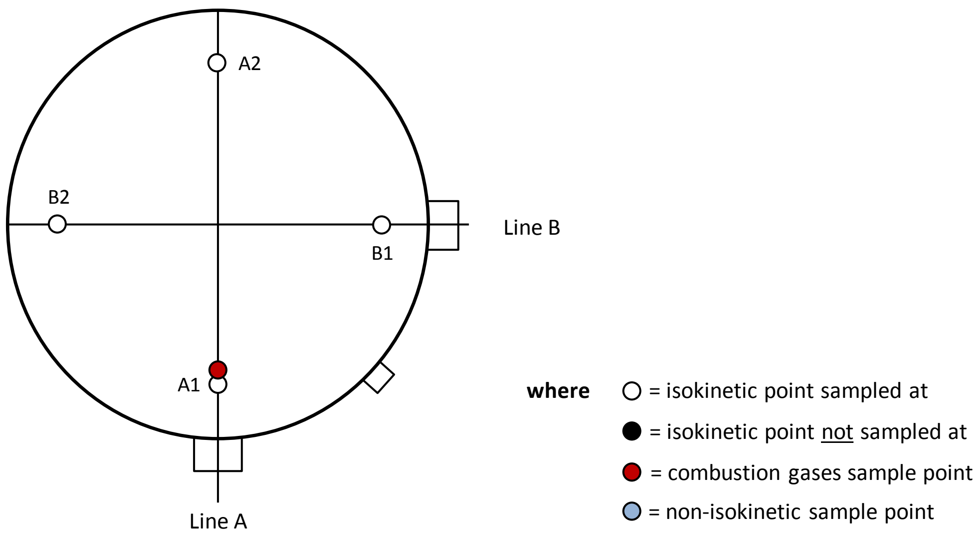
Photo 1

Photo 2

Photo 3

Photo 4

SAMPLE POINTS



APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Danny Pryke	MCERTS Level 2	MM 03 163	TE1 TE2 TE3 TE4
Trainee	Lee Heaton	MCERTS Trainee	MM 17 1433	None

LIST OF EQUIPMENT

Extractive Sampling

Equipment Type	Equipment I.D.
Control Box DGM (1)	CAT 7.62
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.132
Box Thermocouples (2)	-
Umbilical (1)	-
Umbilical (2)	-
Oven Box (1)	-
Oven Box (2)	-
Heated Probe (1)	CAT 5.108
Heated Probe (2)	CAT 5.013
Heated Probe (3)	CAT 5.017
S-Pitot (1)	CAT 21S.51
S-Pitot (2)	-
L-Pitot	-
Site Balance	CAT 17.26
500g / 1Kg Check Weights	CAT 17.26
Last Impinger Arm	-
Callipers	CAT 23.27
Tubes Kit Thermocouple	-

Instrumental Analysers

Equipment Type	Equipment I.D.
Horiba PG-250	CAT 39.11
Horiba PG-350E	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Servomex 5200MP	-
Ankersmid APS 313	CAT 4.753
Gasmet DX4000	-
Gasmet Sampling System	-
Bernath 3006 FID	-
M&C PSS	CAT 12.87
Mass Flow Controller (1)	CAT 25.1
Mass Flow Controller (2)	CAT 25.2
Mass View (1)	-
Mass View (2)	-
Easylogger EN-EL-12 Bit	-
Hioki 5043 (V)	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items

Equipment Type	Equipment I.D.
Digital Manometer (1)	CAT 3.25
Digital Manometer (2)	-
Digital Temperature Meter	CAT 3.25
Stopwatch	CAT 14.72
Barometer	CAT 13.38
Stack Thermocouple (1)	-
Stack Thermocouple (2)	-
Stack Thermocouple (3)	-
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	CAT 20.92
20m Heated Line (1)	-
20m Heated Line (2)	-
Dual Channel Heater Controller	-
Single Channel Heater Controller	-
Laboratory Balance	CAT 1.18 / 1.18a
Tape Measure	CAT 16.31

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	EN 13284-1	CAT-TP-01
PM_{10}	BS EN ISO 23210	CAT-TP-26
$PM_{2.5}$	BS EN ISO 23210	CAT-TP-26
Water Vapour	EN 14790	CAT-TP-05
Oxides of Nitrogen (as NO_2)	EN 14792	CAT-TP-21
Carbon Monoxide	EN 15058	CAT-TP-21
Carbon Dioxide	ISO 12039	CAT-TP-21
Oxygen	EN 14789	CAT-TP-21
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41

PRELIMINARY STACK SURVEY: CALCULATIONS

General Stack Details

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	0.90
Stack Width, W	m	-
Stack Area, A	m²	0.64
Average Stack Gas Temperature, T_a	°C	160
Average Stack Gas Pressure	Pa	23.8
Average Stack Static Pressure, P_{static}	kPa	0.02
Average Barometric Pressure, P_b	kPa	100.2
Average Pitot Tube Calibration Coefficient, C_p	-	0.84

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m³ p	Conc kg/m³ p_i
CO_2	-	8.95	7.92	0.0895	44.01	1.9635	0.1757
O_2	-	11.56	10.23	0.1156	32.00	1.4277	0.1651
N_2	-	79.48	70.30	0.7948	28.01	1.2498	0.9934
Moisture (H_2O)	-	-	11.56	0.1156	18.02	0.8037	0.0929

Where: p = M / 22.41

p_i = r x p

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m³	1.334
Wet Density (STP), P_{STW}	kg/m³	1.273
Dry Density (Actual), P_{Actual}	kg/m³	0.833
Average Wet Density (Actual), $P_{ActualW}$	kg/m³	0.794

Where: P_{STD} = sum of component concentrations, kg/m³ (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m³ (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (at each sampling point) = $P_{STW} \times (T_s / P_s) \times (P_a / T_a)$

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF [1]
Temperature	°C	160	0.00
Total Pressure	kPa	100.2	101.3
Moisture	%	11.6	11.6

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m³/hr	14843
Gas Volumetric Flowrate (STP, Wet)	m³/hr	9264
Gas Volumetric Flowrate (STP, Dry)	m³/hr	8193
Gas Volumetric Flowrate REF [1]	m³/hr	9264

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID)

(1 of 1)

Parameter	Units	Value
Date of Survey	-	05/10/2017
Time of Survey	-	09:43 - 10:03
Atmospheric Pressure	kPa	100.2
Average Stack Static Pressure	Pa	20
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 200 (500Pa)	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C_p	-	0.84
Number of Lines Available	-	2
Number of Lines Used	-	2

		Sampling Line A					Sampling Line B				
Traverse Point	**Depth m**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**
STATIC (Units: Pa)		*18.0*					*22.0*				
Mean		**24.5**	**160.1**	**0.794**	**6.59**		**23.0**	**159.5**	**0.795**	**6.38**	
1	0.13	24.0	160.1	0.794	6.52	3.0	22.0	159.5	0.795	6.24	3.0
2	0.77	25.0	160.0	0.794	6.65	2.0	24.0	159.4	0.795	6.51	5.0

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID) - MEASUREMENT UNCERTAINTY

(1 of 1)

Performance characteristics (Uncertainty Components)	Uncertainty	Value	Units
Standard Uncertainty on the coefficient of the Pitot Tube	u(k)	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	u(Δpi)	1.072	Pa
- Resolution	u(res)	0.00087	
- Calibration	u(cal)	0.059	
- Drift	u(drift)	0.083	
- Lack of Fit	u(fit)	0.007	
- Overall corrections to dynamic measurements	u(Cf)	0.150	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00007	-
- φO_2,w	-	10.228	
- φCO_2,w	-	7.916	
- Oxygen, dry	u(ϕO_2,d)	0.354	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.274	
- Water Vapour	u(ϕH_2O)	0.590	
- Oxygen, wet	u(ϕO_2,w)	0.320	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.248	
Standard uncertainty associated with the stack temperature	u(Tc)	2.208	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.694	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	0.758	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00429	-
Standard uncertainty associated with the local velocities	u(vi)	0.152	Pa
Standard uncertainty associated with the mean velocity	u(v)	0.084	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	0.164	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	2.53	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	770.0	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00070	
- $u^2(qV,w)$	-	154341	
- u(qV,w)	-	392.9	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	5.19	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	6.4		6.4
Uncertainty	±mg/m³	0.40		0.40
Mass Emission	g/hr	56.9		56.9
Uncertainty	±g/hr	4.6		4.6

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	12.2		12.2
Uncertainty	±% v/v	0.62		0.62

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.12		0.12

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	EN 13284-1	
Technical Procedure	CAT-TP-01	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Positioning of Filter	Out Stack	
Filter Size and Material	47mm Glass Fibre	
Number of Sampling Lines Used	2 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	4 / 4	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1, A2, B1 & B2	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	751.5	
Stack static pressure, P_{static}	mmH_2O	1.5	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	751.6	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	113.0	
Total mass collected in impingers (silica trap)	g	6.2	
Total mass of liquid collected, V_{lc}	g	119.2	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.1485	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	1.1450	
Gas meter correction factor, Y_d	-	1.0140	
Average dry gas meter temperature, T_m	°C	21.4	
Average pressure drop across orifice, ΔH	mmH_2O	36.2	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	1.0683	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.1221	
B_{wo} as a percentage	% v/v	12.21	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	12.21	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	1.2168	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2	% v/v	9.00	
O_2	% v/v	11.00	
Total	% v/v	20.00	
N_2	% v/v	80.00	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	29.88	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.43	
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	-	34.97	
Velocity pressure coefficient, C_p	-	0.84	
Average of velocity heads, ΔP_{avg}	mmH_2O	2.13	
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	1.46	
Average stack gas temperature, T_s	°C	159.9	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s + 273})) / (\sqrt{(M_s)(P_s)})$	m/s	6.09	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	0.64	
$Q_a = (60)(A_s)(V_s)$	m^3/min	232.7	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	145.1	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	127.4	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	9.97	
Nozzle area, A_n	mm^2	78.13	
Total sampling time, q	min	60	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	113.8	

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	10:50 - 11:20, 11:22 - 11:52	
Sampling Dates	-	05/10/2017	
Sampling Device	-	ISO	
Volume Sampled (REF)	m³	1.2168	
Filter I.D. Number	-	47-46158	
Start Filter Mass	g	0.15270	
End Filter Mass	g	0.15407	
Total Mass on Filter	g	0.00137	
Probe Rinse I.D. Number	-	PR-47-46158	
Start Probe Rinse Mass	g	2.64765	
End Probe Rinse Mass	g	2.65412	
Total Mass in Probe Rinse	g	0.00647	
Total Mass Collected	mg	7.84	
Calculated Concentration	mg/m³	6.44	
Balance Uncertainty / LOD	mg/m³	0.12	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	05/10/2017	
Average Volume Sampled (REF)	m³	1.2168	
Filter I.D. Number	-	47-46157	
Start Filter Mass	g	0.15484	
End Filter Mass	g	0.15485	
Total Mass on Filter	g	0.00001	
Probe Rinse I.D. Number	-	PR-47-46157	
Start Probe Rinse Mass	g	2.69527	
End Probe Rinse Mass	g	2.69532	
Total Mass in Probe Rinse	g	0.00005	
Total Mass Collected	mg	0.06	
Calculated Concentration	mg/m³	0.05	
Balance Uncertainty / LOD	mg/m³	0.12	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

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Sample Runs

Leak Test Results	Units	Run 1	
Mean Sampling Rate	l/min	19.4	
Pre-Sampling Leak Rate	l/min	0.13	
Post-Sampling Leak Rate	l/min	0.13	
Allowable Leak Rate	l/min	0.39	
Leak Test Acceptable	-	Yes	

Water Droplets	Units	Run 1	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	Units	Run 1	
Measurement Uncertainty (MU)	%	5.1	
Allowable MU	%	20	
MU Acceptable	%	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	
Less than 50% Faded	%	Yes	

Isokinetic Criterion Compliance	Units	Run 1	
Isokinetic Variation	%	113.8	
Allowable Isokinetic Range	%	95 - 115	
Isokineticity Acceptable	-	Yes	

Weighing Uncertainty Criteria	Units	Run 1	
Overall Weighing Uncertainty	± mg	0.25	
Overall Weighing Uncertainty	± mg/m³	0.21	
ELV [Daily ELV for IED]	mg/m³	N/A	
Allowable Weighing Uncertainty	mg/m³	N/A	
Weighing Uncertainty Acceptable	-	N/A	

Filter Temperatures	Units	Run 1	
Pre-Conditioning Temperature	°C	180	
Post-Conditioning Temperature	°C	160	
Maximum Filter Temperature	°C	160	

Test Conditions	Units	Run 1	
Ambient Temperature Recorded?	-	Yes	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	20.0	
Pre-Sampling Leak Rate	l/min	0.11	
Post-Sampling Leak Rate	l/min	0.12	
Allowable Leak Rate	l/min	0.40	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m³	N/A	
Blank Acceptable	-	N/A	

Acetone / Water Rinse Blank	Units	Blank
Acetone / Water Rinse Value	mg/l	2.7
Allowable Blank	mg/l	10
Blank Acceptable	-	Yes

Method Deviations

Nature of Deviation	Run Number	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	1	
There are no deviations associated with the sampling employed.	wx	

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value				Standard uncertainty			
Measured Quantities	**Symbol**	**Run 1**			**Symbol**	**Units**	**Run 1**	
Sampled Volume (Actual)	V_m	1.15			uV_m	m³	0.02	
Sampled Gas Temperature	T_m	294.4			uT_m	K	2.00	
Sampled Gas Pressure	ρ_m	100.2			$u\rho_m$	kPa	0.50	
Sampled Gas Humidity	H_m	0.00			uH_m	% v/v	1.00	
Leak	L	0.67			uL	%	-	
Mass of Particulate	m	7.84			um	mg	0.14	
Uncollected Mass	UCM	0.06			uUCM	mg	-	

	Uncertainty as a Percentage			
Measured Quantities	**Units**	**Run 1**		**Requirement of Standard**
Sampled Volume (Actual)	%	2.00		≤2%
Sampled Gas Temperature	%	0.68		≤1%
Sampled Gas Pressure	%	0.50		≤1%
Sampled Gas Humidity	%	1.00		≤1%
Leak	%	0.67		≤2%
Mass of Particulate	%	-		<5% of ELV
Uncollected Mass	%	-		-

	Uncertainty in Measurement Units					Sensitivity Coefficient	
Measured Quantities	**Symbol**	**Units**	**Run 1**			**Run 1**	
Sampled Volume (STP)	V_m	m³	1.07			6.03	
Leak	L	mg/m³	0.02			1.00	
Mass of Particulate	L_r	mg	7.84			0.82	
Uncollected Mass	UCM	mg	0.04			0.82	

	Uncertainty in Result		
Measured Quantities	**Units**	**Run 1**	
Sampled Volume (STP)	mg/m³	0.16	
Leak	mg/m³	0.02	
Mass of Particulate	mg/m³	0.12	
Uncollected Mass	mg/m³	0.03	

	Oxygen Correction Part of MU Budget		
Measured Quantities	**Units**	**Run 1**	
O_2 Correction Factor	-	N/A	
Stack Gas O_2 Content	% v/v	N/A	
MU for O_2 Correction	-	N/A	
Overall MU For O_2 Measurement	%	N/A	

Parameter	**Units**	**Run 1**	
Combined uncertainty	mg/m³	0.20	
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m³	0.40	
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m³	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m³	0.40	
Reported Uncertainty	mg/m³	0.40	
Expanded uncertainty (95% confidence), without Oxygen Correction	%	6.2	
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	6.2	
Reported Uncertainty	%	6.2	

PM_{10}: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.29		0.29
Uncertainty	±mg/m³	0.46		0.46
Mass Emission	g/hr	2.6		2.6
Uncertainty	±g/hr	4.1		4.1

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	11.2		11.2
Uncertainty	±% v/v	0.56		0.56

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.23		0.23

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	BS EN ISO 23210	
Technical Procedure	CAT-TP-26	
Sizing Device	TCR Tecora MSSI 3-Stage Cascade Impactor	
Sizing Device Material	Stainless Steel	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

PM_{10}: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	759.0	
Stack static pressure, P_{static}	mmH_2O	1.8	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	759.1	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	125.3	
Total mass collected in impingers (silica trap)	g	28.4	
Total mass of liquid collected, V_{lc}	g	153.7	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.1915	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	1.5950	
Gas meter correction factor, Y_d	-	1.0140	
Average dry gas meter temperature, T_m	°C	21.8	
Average pressure drop across orifice, ΔH	mmH_2O	124.9	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	1.5136	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.1123	
B_{wo} as a percentage	% v/v	11.23	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	11.23	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	1.7051	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet (O_{2REFw}) = $(21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	
O_2 Reference Factor dry (O_{2REFd}) = $(21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2	% v/v	9.00	
O_2	% v/v	11.00	
Total	% v/v	20.00	
N_2	% v/v	80.00	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	29.88	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.55	
Velocity of stack gas, V_{spt}			
Velocity pressure coefficient, C_p	-	0.83	
Average stack gas temperature, T_s	°C	159.9	
Velocity of stack gas (pre-test from traverse), V_{spt}	m/s	6.16	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	0.64	
$Q_a = (60)(A_s)(V_s)$	m^3/min	235.2	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	148.1	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	131.5	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	13.00	
Nozzle area, A_n	mm^2	132.75	
Total sampling time, q	min	60	
Velocity at nozzle, V_n	m/s	5.66	
$\%I = V_n / V_{spt} \times 100$	%	91.9	

PM_{10}: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	13:45 - 14:45	
Sampling Dates	-	05/10/2017	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	1.7051	
2nd Stage of Cascade Impactor (PM_{10} to $PM_{2.5}$)			
Filter I.D. Number (2nd Stage)	-	PM2-01519	
Start Filter Mass (2nd Stage)	g	0.12710	
End Filter Mass (2nd Stage)	g	0.12724	
Total Mass	g	0.00014	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3-01519	
Start Filter Mass (3rd Stage)	g	0.14576	
End Filter Mass (3rd Stage)	g	0.14612	
Total Mass	g	0.00036	
Total Mass Collected	mg	0.50	
Calculated Concentration	mg/m^3	0.29	
Balance Uncertainty / LOD	mg/m^3	0.23	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	05/10/2017	
Average Volume Sampled (REF)	m^3	1.7051	
2nd Stage of Cascade Impactor (PM_{10} to $PM_{2.5}$)			
Filter I.D. Number (2nd Stage)	-	PM2-01543	
Start Filter Mass (2nd Stage)	g	0.12894	
End Filter Mass (2nd Stage)	g	0.12895	
Total Mass	g	0.00001	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3-01543	
Start Filter Mass (3rd Stage)	g	0.15180	
End Filter Mass (3rd Stage)	g	0.15186	
Total Mass	g	0.00006	
Total Mass Collected	mg	0.07	
Calculated Concentration	mg/m^3	0.04	
Balance Uncertainty / LOD	mg/m^3	0.23	

PM_{10}: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1
Expected Sampling Rate	l/min	25.0
Pre-Sampling Leak Rate	l/min	0.16
Allowable Leak Rate	l/min	0.50
Leak Test Acceptable	-	Yes

Water Droplets	Units	Run 1
Are Water Droplets Present	-	No

MU (Concurrent Water Vapour)	Units	Run 1
Measurement Uncertainty (MU)	%	5.0
Allowable MU	%	20
MU Acceptable	%	Yes

Silica Gel (Concurrent Water Vapour)	Units	Run 1
Less than 50% Faded	%	Yes

Isokinetic Criterion Compliance	Units	Run 1
Isokinetic Variation	%	91.9
Allowable Isokinetic Range	%	90 - 130
Isokineticity Acceptable	-	Yes

Filter Temperatures	Units	Run 1
Pre-Conditioning Temperature	°C	180
Post-Conditioning Temperature	°C	160
Maximum Filter Temperature	°C	160

Test Conditions	Units	Run 1
Ambient Temperature Recorded?	-	Yes

Cut Size	Units	Run 1
D_{50} Cut Size	µm	10.05
Allowable D_{50} Cut Size	µm	9 - 11
D_{50} Cut Size Acceptable	-	Yes

PM_{10}: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	25.0	
Pre-Sampling Leak Rate	l/min	0.22	
Allowable Leak Rate	l/min	0.50	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m³	N/A	
Blank Acceptable	-	N/A	

Method Deviations

Nature of Deviation	Run Number	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	1	
There are no deviations associated with the sampling employed.	wx	

PM_{10}: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value				Standard uncertainty			
Measured Quantities	**Symbol**	**Run 1**			**Symbol**	**Units**	**Run 1**	
Sampled Volume (Actual)	V_m	1.60			uV_m	m^3	0.03	
Sampled Gas Temperature	T_m	294.8			uT_m	K	2.00	
Sampled Gas Pressure	ρ_m	101.2			$u\rho_m$	kPa	0.50	
Sampled Gas Humidity	H_m	0.00			uH_m	% v/v	1.00	
Leak	L	0.64			uL	%	-	
Mass of Particulate	m	0.50			um	mg	0.40	
Uncollected Mass	UCM	0.07			uUCM	mg	-	
Particulate Sizing	PS	10.0			uPS	%	-	

	Uncertainty as a Percentage			
Measured Quantities	**Units**	**Run 1**		**Requirement of Standard**
Sampled Volume (Actual)	%	2.00		≤2%
Sampled Gas Temperature	%	0.68		≤1%
Sampled Gas Pressure	%	0.49		≤1%
Sampled Gas Humidity	%	1.00		≤1%
Leak	%	0.64		≤2%
Mass of Particulate	%	-		<5% of ELV
Uncollected Mass	%	-		-
Particulate Sizing	%	10.0		-

	Uncertainty in Measurement Units					Sensitivity Coefficient	
Measured Quantities	**Symbol**	**Units**	**Run 1**			**Run 1**	
Sampled Volume (STP)	V_m	m^3	1.51			0.19	
Leak	L	mg/m^3	0.00			1.00	
Mass of Particulate	L_r	mg	0.50			0.59	
Uncollected Mass	UCM	mg	0.04			0.59	
Particulate Sizing	PS	mg	0.02			1.00	

	Uncertainty in Result		
Measured Quantities	**Units**	**Run 1**	
Sampled Volume (STP)	mg/m^3	0.01	
Leak	mg/m^3	0.00	
Mass of Particulate	mg/m^3	0.23	
Uncollected Mass	mg/m^3	0.02	
Particulate Sizing	mg/m^3	0.02	

	Oxygen Correction Part of MU Budget		
Measured Quantities	**Units**	**Run 1**	
O_2 Correction Factor	-	N/A	
Stack Gas O_2 Content	% v/v	N/A	
MU for O_2 Correction	-	N/A	
Overall MU For O_2 Measurement	%	N/A	

Parameter	**Units**	**Run 1**	
Combined uncertainty	mg/m^3	0.24	
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.46	
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.46	
Reported Uncertainty	mg/m^3	0.46	
Expanded uncertainty (95% confidence), without Oxygen Correction	%	159.1	
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	159.1	
Reported Uncertainty	%	159.1	

$PM_{2.5}$: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.21		0.21
Uncertainty	±mg/m³	0.35		0.35
Mass Emission	g/hr	1.9		1.9
Uncertainty	±g/hr	3.1		3.1

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	11.2		11.2
Uncertainty	±% v/v	0.56		0.56

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.18		0.18

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	BS EN ISO 23210	
Technical Procedure	CAT-TP-26	
Sizing Device	TCR Tecora MSSI 3-Stage Cascade Impactor	
Sizing Device Material	Stainless Steel	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

$PM_{2.5}$: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	759.0	
Stack static pressure, P_{static}	mmH_2O	1.8	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	759.1	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	125.3	
Total mass collected in impingers (silica trap)	g	28.4	
Total mass of liquid collected, V_{lc}	g	153.7	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.1915	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	1.5950	
Gas meter correction factor, Y_d	-	1.0140	
Average dry gas meter temperature, T_m	°C	21.8	
Average pressure drop across orifice, ΔH	mmH_2O	124.9	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	1.5136	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.1123	
B_{wo} as a percentage	% v/v	11.23	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	11.23	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	1.7051	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2	% v/v	9.00	
O_2	% v/v	11.00	
Total	% v/v	20.00	
N_2	% v/v	80.00	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	29.88	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.55	
Velocity of stack gas, V_{spt}			
Velocity pressure coefficient, C_p	-	0.83	
Average stack gas temperature, T_s	°C	159.9	
Velocity of stack gas (pre-test from traverse), V_{spt}	m/s	6.16	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	0.64	
$Q_a = (60)(A_s)(V_s)$	m^3/min	235.2	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	148.1	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	131.5	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	13.00	
Nozzle area, A_n	mm^2	132.75	
Total sampling time, q	min	60	
Velocity at nozzle, V_n	m/s	5.66	
$\%I = V_n / V_{spt} \times 100$	%	91.9	

$PM_{2.5}$: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	13:45 - 14:45	
Sampling Dates	-	05/10/2017	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	1.7051	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3-01519	
Start Filter Mass (3rd Stage)	g	0.14576	
End Filter Mass (3rd Stage)	g	0.14612	
Total Mass	g	0.00036	
Total Mass Collected	mg	0.36	
Calculated Concentration	mg/m^3	0.21	
Balance Uncertainty / LOD	mg/m^3	0.18	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	05/10/2017	
Average Volume Sampled (REF)	m^3	1.7051	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3-01543	
Start Filter Mass (3rd Stage)	g	0.15180	
End Filter Mass (3rd Stage)	g	0.15186	
Total Mass	g	0.00006	
Total Mass Collected	mg	0.06	
Calculated Concentration	mg/m^3	0.04	
Balance Uncertainty / LOD	mg/m^3	0.18	

$PM_{2.5}$: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1	
Expected Sampling Rate	l/min	25.0	
Pre-Sampling Leak Rate	l/min	0.16	
Allowable Leak Rate	l/min	0.50	
Leak Test Acceptable	-	Yes	

Water Droplets	Units	Run 1	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	Units	Run 1	
Measurement Uncertainty (MU)	%	5.0	
Allowable MU	%	20	
MU Acceptable	%	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	
Less than 50% Faded	%	Yes	

Isokinetic Criterion Compliance	Units	Run 1	
Isokinetic Variation	%	91.9	
Allowable Isokinetic Range	%	90 - 130	
Isokineticity Acceptable	-	Yes	

Filter Temperatures	Units	Run 1	
Pre-Conditioning Temperature	°C	180	
Post-Conditioning Temperature	°C	160	
Maximum Filter Temperature	°C	160	

Test Conditions	Units	Run 1	
Ambient Temperature Recorded?	-	Yes	

Cut Size	Units	Run 1	
D_{50} Cut Size	µm	2.50	
Allowable D_{50} Cut Size	µm	2.25 - 2.75	
D_{50} Cut Size Acceptable	-	Yes	

$PM_{2.5}$: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	25.0	
Pre-Sampling Leak Rate	l/min	0.22	
Allowable Leak Rate	l/min	0.50	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m³	N/A	
Blank Acceptable	-	N/A	

Method Deviations

Nature of Deviation	Run Number	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	1	
There are no deviations associated with the sampling employed.	wx	

$PM_{2.5}$: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value: Symbol	Value: Run 1	Standard uncertainty: Symbol	Standard uncertainty: Units	Standard uncertainty: Run 1
Sampled Volume (Actual)	V_m	1.60	uV_m	m^3	0.03
Sampled Gas Temperature	T_m	294.8	uT_m	K	2.00
Sampled Gas Pressure	ρ_m	101.2	$u\rho_m$	kPa	0.50
Sampled Gas Humidity	H_m	0.00	uH_m	% v/v	1.00
Leak	L	0.64	uL	%	-
Mass of Particulate	m	0.36	um	mg	0.30
Uncollected Mass	UCM	0.06	uUCM	mg	-
Particulate Sizing	PS	10.0	uPS	%	-

Measured Quantities	Uncertainty as a Percentage: Units	Uncertainty as a Percentage: Run 1	Requirement of Standard
Sampled Volume (Actual)	%	2.00	≤2%
Sampled Gas Temperature	%	0.68	≤1%
Sampled Gas Pressure	%	0.49	≤1%
Sampled Gas Humidity	%	1.00	≤1%
Leak	%	0.64	≤2%
Mass of Particulate	%	-	<5% of ELV
Uncollected Mass	%	-	-
Particulate Sizing	%	10.0	-

Measured Quantities	Uncertainty in Measurement Units: Symbol	Uncertainty in Measurement Units: Units	Uncertainty in Measurement Units: Run 1	Sensitivity Coefficient: Run 1
Sampled Volume (STP)	V_m	m^3	1.51	0.14
Leak	L	mg/m^3	0.00	1.00
Mass of Particulate	L_r	mg	0.36	0.59
Uncollected Mass	UCM	mg	0.03	0.59
Particulate Sizing	PS	mg	0.01	1.00

Measured Quantities	Uncertainty in Result: Units	Uncertainty in Result: Run 1
Sampled Volume (STP)	mg/m^3	0.01
Leak	mg/m^3	0.00
Mass of Particulate	mg/m^3	0.18
Uncollected Mass	mg/m^3	0.02
Particulate Sizing	mg/m^3	0.01

Measured Quantities	Oxygen Correction Part of MU Budget: Units	Oxygen Correction Part of MU Budget: Run 1
O_2 Correction Factor	-	N/A
Stack Gas O_2 Content	% v/v	N/A
MU for O_2 Correction	-	N/A
Overall MU For O_2 Measurement	%	N/A

Parameter	Units	Run 1
Combined uncertainty	mg/m^3	0.18
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.35
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.35
Reported Uncertainty	mg/m^3	0.35
Expanded uncertainty (95% confidence)	%	164.9
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	164.9
Reported Uncertainty	%	164.9

OXIDES OF NITROGEN (as NO_2): RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	82.1		82.1
Uncertainty	±mg/m³	2.5		2.5
Mass Emission	g/hr	725		725
Uncertainty	±g/hr	43.8		43.8

General Sampling Information

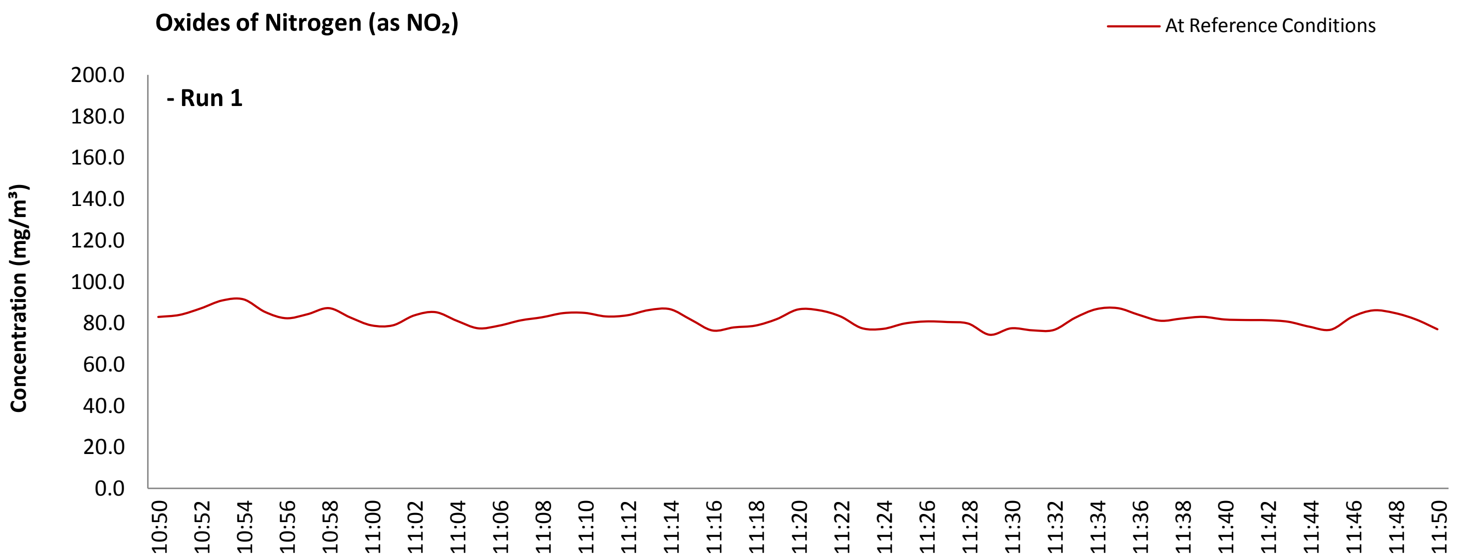
Parameter	Value	
Standard	EN 14792	
Technical Procedure	CAT-TP-21	
Probe Material	Stainless Steel	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Date & Result of Last Converter Check	17/05/2017 - 95.9%	
Span Gas Type	Nitrogen Monoxide	
Span Gas Reference Number	CYL 4.0186	
Span Gas Expiry Date	16/09/2020	
Span Gas Start Pressure (bar)	100	
Gas Cylinder Concentration (ppm)	395.7	NOTE: Dilution performed to achieve correct span value
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

OXIDES OF NITROGEN (as NO_2): DATA TREND

Graphical Trend of Data



OXIDES OF NITROGEN (as NO_2): SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	
Sampling Times	-	10:50 - 11:50	
Sampling Dates	-	05/10/2017	
Instrument Range	ppm	500	
Span Gas Value	ppm	396	

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	
Average Temperature	°C	N/A	
Allowable Temperature	< °C	N/A	
Temperature Acceptable	-	N/A	

	Zero Drift	Units	Run 1	
CAL 1	Zero Down Sampling Line (Pre)	ppm	0.10	
CAL 1	Zero Down Sampling Line (Post)	ppm	0.20	
CAL 1	Zero Drift	ppm	0.10	
	Allowable Zero Drift	± ppm	19.8	
	Zero Drift Acceptable	-	Yes	

	Span Drift	Units	Run 1	
CAL 1	Span Down Sampling Line (Pre)	ppm	395.5	
CAL 1	Span Down Sampling Line (Post)	ppm	394.9	
CAL 1	Span Drift	ppm	-0.60	
	Allowable Span Drift	± ppm	19.8	
	Span Drift Acceptable	-	Yes	

Test Conditions	Units	Run 1	
Run Ambient Temperature Range	°C	15 - 18	

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	
There are no deviations associated with the sampling employed.	x	

OXIDES OF NITROGEN (as NO_2): MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1		Units
Limit value	-		mg/m³ (REF)
TGN M2 Allowable MU	10.0		%
Measured concentration	92.81		mg/m³ (STP, dry)
Ration NO / NO_2	5		%
Range Used	500.0		ppm
Range Used [A]	1026.1		mg/m³
Cal gas conc.	395.7		ppm
Conversion	2.05		ppm to mg/m³
MCERTS Range [B]	125.0		mg/m³
Lower of [A] or [B]	125.0		mg/m³
Cal gas conc.	812.1		mg/m³

Performance characteristics	RUN 1		Units
Response time	60		seconds
Number of readings in measurement	60		-
Repeatability at zero	0.40		% full scale
Repeatability at span level	0.40		% full scale
Deviation from linearity	0.25		% of value
Zero drift	0.03		% full scale
Span drift	-0.15		% full scale
Volume or pressure flow dependence	0.40		% of full scale
Atmospheric pressure dependence	0.30		% of value/kPa
Ambient temperature dependence	0.18		% full scale/10K
Combined interference	0.60		% range
Dependence on voltage	0.40		% full scale/10V
Converter efficiency	95.9		%
Losses in the line (leak)	0.03		% of value
Uncertainty of calibration gas blending	1.40		% of value
Uncertainty of calibration gas	2.00		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		mg/m³
Standard deviation of repeatability at span level	0.05		mg/m³
Lack of fit	0.18		mg/m³
Drift	0.04		mg/m³
Volume or pressure flow dependence	0.00		mg/m³
Atmospheric pressure dependence	0.11		mg/m³
Ambient temperature dependence	0.03		mg/m³
Combined interference (from MCERTS Certificate)	0.43		mg/m³
Dependence on voltage	0.05		mg/m³
Converter efficiency	0.11		mg/m³
Losses in the line (leak)	0.01		mg/m³
Uncertainty of calibration gas blending	0.75		mg/m³
Uncertainty of calibration gas	1.07		mg/m³

			RUN 1		Units
Measurement uncertainty		**Result**	92.81		mg/m³
Combined uncertainty			1.47		mg/m³
Expanded uncertainty	k =	1.96	2.87		mg/m³
Uncertainty corrected to std conds. (O_2)			2.87		mg/m³ (REF)

	RUN 1		Units
Expanded uncertainty (no O_2) - at 95% Confidence	3.10		% of Value
Expanded uncertainty (no O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (no O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**		-

	RUN 1		Units
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% of Value
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**		-

Requirement for SRM is that Uncertainty should be <10% of the value at the ELV, on a dry gas basis, or if O_2 correction is applied less than 10% + the uncertainty associated with the O_2 correction (using sqrt of sum squares to add uncertainty components). Ref EA TGN M2.

CARBON MONOXIDE: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	10.5		10.5
Uncertainty	±mg/m³	1.1		1.1
Mass Emission	g/hr	92.6		92.6
Uncertainty	±g/hr	10.9		10.9

General Sampling Information

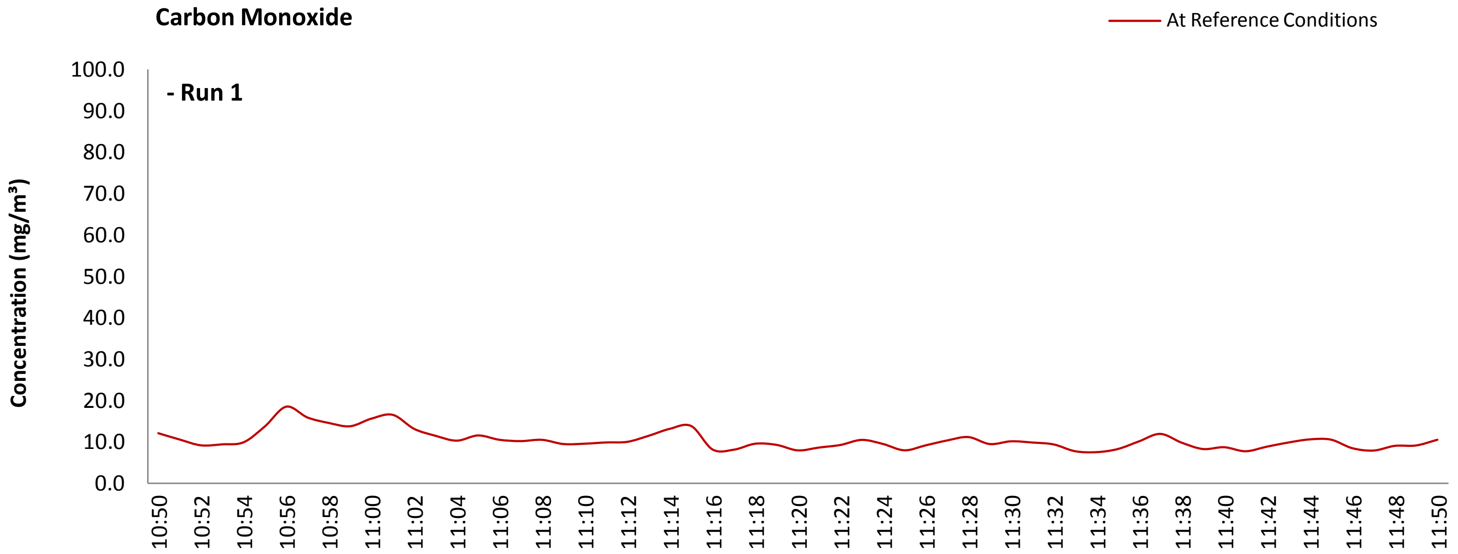
Parameter	Value	
Standard	EN 15058	
Technical Procedure	CAT-TP-21	
Probe Material	Stainless Steel	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Carbon Monoxide	
Span Gas Reference Number	CYL 2.0124	
Span Gas Expiry Date	22/07/2021	
Span Gas Start Pressure (bar)	150	
Gas Cylinder Concentration (ppm)	402.3	NOTE: Dilution performed to achieve correct span value
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

CARBON MONOXIDE: DATA TREND

Graphical Trend of Data



CARBON MONOXIDE: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	
Sampling Times	-	10:50 - 11:50	
Sampling Dates	-	05/10/2017	
Instrument Range	ppm	500	
Span Gas Value	ppm	402	

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	
Average Temperature	°C	N/A	
Allowable Temperature	< °C	N/A	
Temperature Acceptable	-	N/A	

	Zero Drift	Units	Run 1	
CAL 1	Zero Down Sampling Line (Pre)	ppm	0.00	
CAL 1	Zero Down Sampling Line (Post)	ppm	0.10	
CAL 1	Zero Drift	ppm	0.10	
	Allowable Zero Drift	± ppm	20.1	
	Zero Drift Acceptable	-	Yes	

	Span Drift	Units	Run 1	
CAL 1	Span Down Sampling Line (Pre)	ppm	402.3	
CAL 1	Span Down Sampling Line (Post)	ppm	402.0	
CAL 1	Span Drift	ppm	-0.30	
	Allowable Span Drift	± ppm	20.1	
	Span Drift Acceptable	-	Yes	

Test Conditions	Units	Run 1	
Run Ambient Temperature Range	°C	15 - 18	

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	
There are no deviations associated with the sampling employed.	x	

CARBON MONOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1		Units
Limit value	-		mg/m^3 (REF)
TGN M2 Allowable MU	6.0		%
Measured concentration	11.86		mg/m^3 (STP, dry)
Range Used	500.0		ppm
Range Used [A]	624.6		mg/m^3
Cal gas conc.	402.3		ppm
Conversion	1.25		ppm to mg/m^3
MCERTS Range [B]	95.0		mg/m^3
Lower of [A] or [B]	95.0		mg/m^3
Cal gas conc.	502.6		mg/m^3

Performance characteristics	RUN 1		Units
Response time	60		seconds
Number of readings in measurement	60		-
Repeatability at zero	0.40		% full scale
Repeatability at span level	0.40		% full scale
Deviation from linearity	0.41		% of value
Zero drift	0.02		% full scale
Span drift	-0.07		% full scale
Volume or pressure flow dependence	0.40		% of full scale
Atmospheric pressure dependence	0.30		% of value/kPa
Ambient temperature dependence	0.05		% full scale/10K
Combined interference	0.73		% range
Dependence on voltage	0.40		% full scale/10V
Losses in the line (leak)	0.00		% of value
Uncertainty of calibration gas blending	1.40		% of value
Uncertainty of calibration gas	2.00		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		mg/m^3
Standard deviation of repeatability at span level	0.05		mg/m^3
Lack of fit	0.22		mg/m^3
Drift	0.07		mg/m^3
Volume or pressure flow dependence	0.00		mg/m^3
Atmospheric pressure dependence	0.08		mg/m^3
Ambient temperature dependence	0.01		mg/m^3
Combined interference (from MCERTS Certificate)	0.40		mg/m^3
Dependence on voltage	0.05		mg/m^3
Losses in the line (leak)	0.00		mg/m^3
Uncertainty of calibration gas blending	0.10		mg/m^3
Uncertainty of calibration gas	0.14		mg/m^3

			RUN 1		Units
Measurement uncertainty		**Result**	11.86		mg/m^3
Combined uncertainty			0.64		mg/m^3
Expanded uncertainty	k =	1.96	1.26		mg/m^3
Uncertainty corrected to std conds. (O_2)			1.26		mg/m^3 (REF)

	RUN 1		Units
Expanded uncertainty (no O_2) - at 95% Confidence	10.59		% of Value
Expanded uncertainty (no O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (no O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**		-

	RUN 1		Units
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% of Value
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**		-

Requirement for SRM is that Uncertainty should be <6% of the value at the ELV, on a dry gas basis, or if O_2 correction is applied less than 6% + the uncertainty associated with the O_2 correction (using sqrt of sum squares to add uncertainty components). Ref EA TGN M2.

CARBON DIOXIDE: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

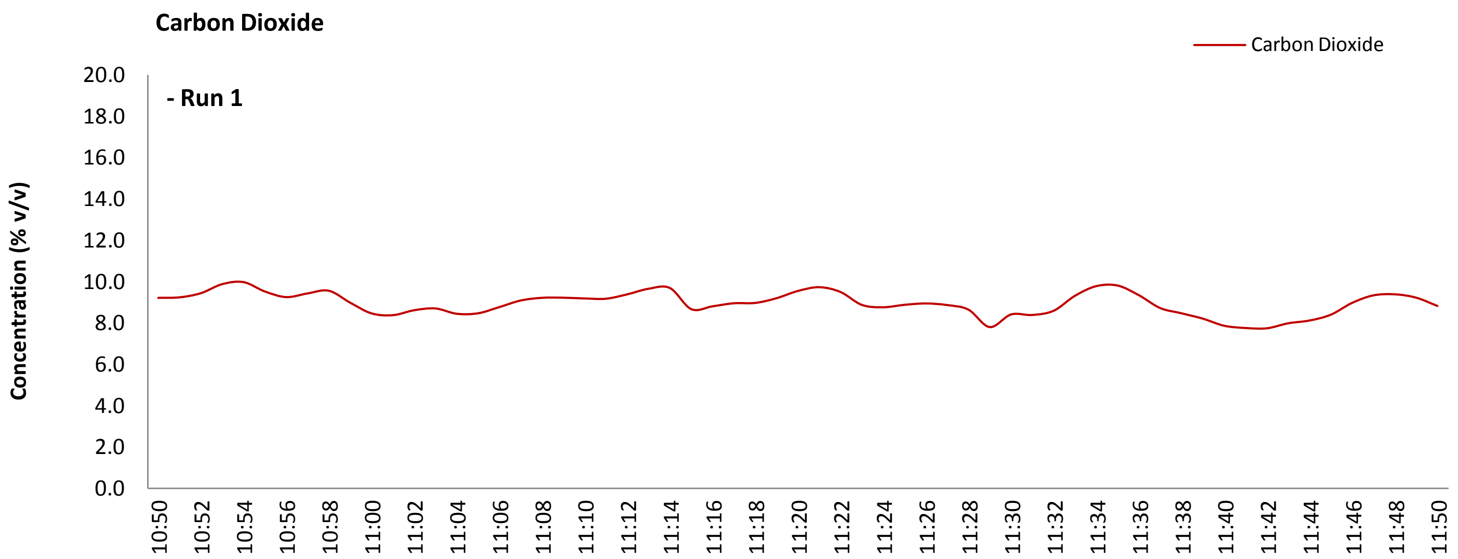
Parameter	Units	Run 1		Mean
Concentration	% v/v	8.95		8.95
Uncertainty	±% v/v	0.28		0.28

General Sampling Information

Parameter	Value	
Standard	ISO 12039	
Technical Procedure	CAT-TP-21	
Probe Material	Stainless Steel	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Carbon Dioxide	
Span Gas Reference Number	CYL 6.0035	
Span Gas Expiry Date	06/05/2022	
Span Gas Start Pressure (bar)	140	
Gas Cylinder Concentration (% v/v)	16.18	
Span Gas Uncertainty (%)	2.00	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

CARBON DIOXIDE: DATA TREND

Graphical Trend of Data



CARBON DIOXIDE: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	
Sampling Times	-	10:50 - 11:50	
Sampling Dates	-	05/10/2017	
Instrument Range	% v/v	20.0	
Span Gas Value	% v/v	16.2	

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	
Average Temperature	°C	N/A	
Allowable Temperature	< °C	N/A	
Temperature Acceptable	-	N/A	

	Zero Drift	Units	Run 1	
CAL 1	Zero Down Sampling Line (Pre)	% v/v	0.02	
CAL 1	Zero Down Sampling Line (Post)	% v/v	0.03	
CAL 1	Zero Drift	% v/v	0.01	
	Allowable Zero Drift	± % v/v	0.81	
	Zero Drift Acceptable	-	Yes	

	Span Drift	Units	Run 1	
CAL 1	Span Down Sampling Line (Pre)	% v/v	16.17	
CAL 1	Span Down Sampling Line (Post)	% v/v	16.14	
CAL 1	Span Drift	% v/v	-0.03	
	Allowable Span Drift	± % v/v	0.81	
	Span Drift Acceptable	-	Yes	

Test Conditions	Units	Run 1	
Run Ambient Temperature Range	°C	15 - 18	

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	
There are no deviations associated with the sampling employed.	x	

CARBON DIOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1		Units
Limit value	N/A		%vol
TGN M2 Allowable MU	25.0		%
Measured concentration	8.95		%vol
Range Used	20.0		%vol
Cal gas conc.	16.2		%vol

Performance characteristics	RUN 1		Units
Response time	160		seconds
Number of readings in measurement	60		-
Repeatability at zero	0.40		% full scale
Repeatability at span level	0.40		% full scale
Deviation from linearity	0.59		% of value
Zero drift	0.06		% full scale
Span drift	-0.19		% full scale
Volume or pressure flow dependence	0.40		% of full scale
Atmospheric pressure dependence	0.30		% of value/kPa
Ambient temperature dependence	0.01		% full scale/10K
Combined interference	0.00		% range
Dependence on voltage	0.40		% full scale/10V
Losses in the line (leak)	0.06		% of value
Uncertainty of calibration gas	2.00		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		%vol
Standard deviation of repeatability at span level	0.05		%vol
Lack of fit	0.07		%vol
Drift	0.00		%vol
Volume or pressure flow dependence	0.00		%vol
Atmospheric pressure dependence	0.02		%vol
Ambient temperature dependence	0.00		%vol
Combined interference (from MCERTS Certificate)	0.00		%vol
Dependence on voltage	0.05		%vol
Losses in the line (leak)	0.00		%vol
Uncertainty of calibration gas	0.10		%vol

			RUN 1		Units
Measurement uncertainty		**Result**	8.95		%vol
Combined uncertainty			0.14		%vol
Expanded uncertainty	k =	1.96	0.28		%vol

	RUN 1		Units
Expanded uncertainty (no O_2) - at 95% Confidence	3.13		% of Value

OXYGEN: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

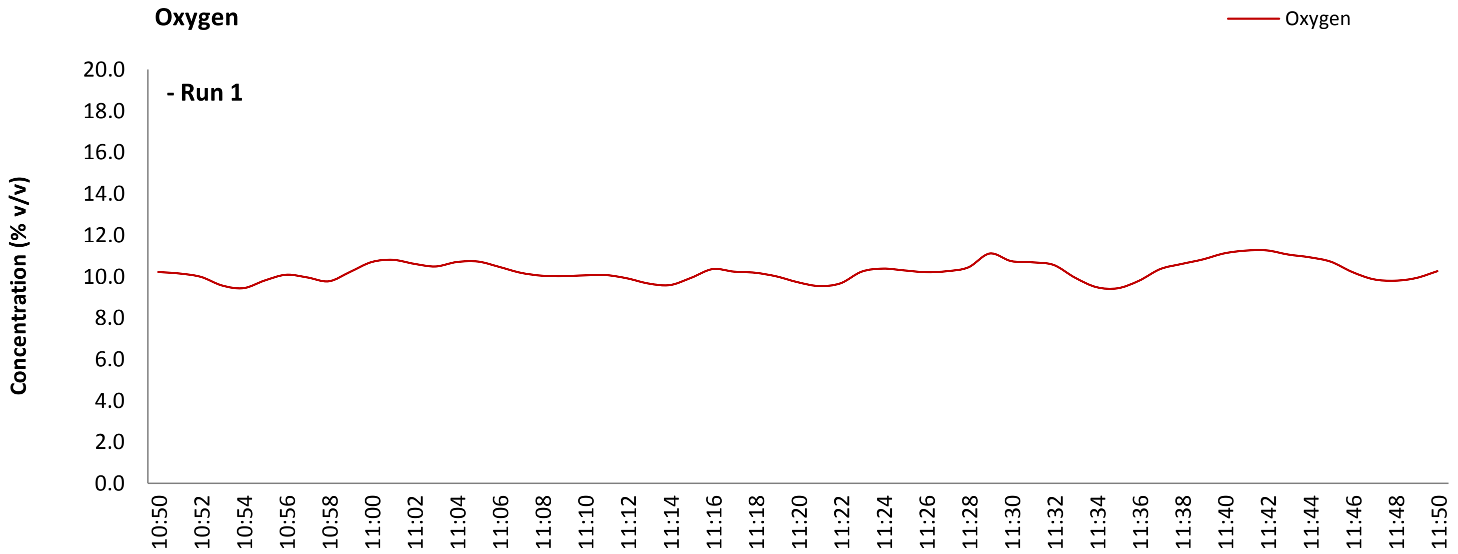
Parameter	Units	Run 1		Mean
Concentration	% v/v	10.2		10.2
Uncertainty	±% v/v	0.31		0.31

General Sampling Information

Parameter	Value	
Standard	EN 14789	
Technical Procedure	CAT-TP-21	
Probe Material	Stainless Steel	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Synthetic Air (5 Grade)	
Span Gas Reference Number	CYL 11.021	
Span Gas Expiry Date	29/05/2020	
Span Gas Start Pressure (bar)	90	
Gas Cylinder Concentration (% v/v)	21.3	NOTE: Dilution performed to achieve correct span value
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

OXYGEN: DATA TREND

Graphical Trend of Data



OXYGEN: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	
Sampling Times	-	10:50 - 11:50	
Sampling Dates	-	05/10/2017	
Instrument Range	% v/v	25.0	
Span Gas Value	% v/v	21.0	

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	
Average Temperature	°C	N/A	
Allowable Temperature	< °C	N/A	
Temperature Acceptable	-	N/A	

	Zero Drift	Units	Run 1	
CAL 1	Zero Down Sampling Line (Pre)	% v/v	0.01	
CAL 1	Zero Down Sampling Line (Post)	% v/v	0.00	
CAL 1	Zero Drift	% v/v	-0.01	
	Allowable Zero Drift	± % v/v	1.05	
	Zero Drift Acceptable	-	Yes	

	Span Drift	Units	Run 1	
CAL 1	Span Down Sampling Line (Pre)	% v/v	20.95	
CAL 1	Span Down Sampling Line (Post)	% v/v	20.97	
CAL 1	Span Drift	% v/v	0.02	
	Allowable Span Drift	± % v/v	1.05	
	Span Drift Acceptable	-	Yes	

Test Conditions	Units	Run 1	
Run Ambient Temperature Range	°C	15 - 18	

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	
There are no deviations associated with the sampling employed.	x	

OXYGEN: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1		Units
Limit value	N/A		%vol
TGN M2 Allowable MU	6.0		%
Measured concentration	11.56		%vol
Range Used	25.0		%vol
Cal gas conc.	21.3		%vol

Performance characteristics	RUN 1		Units
Response time	60		seconds
Number of readings in measurement	60		-
Repeatability at zero	0.04		% full scale
Repeatability at span level	0.04		% full scale
Deviation from linearity	0.10		% of value
Zero drift	-0.05		% full scale
Span drift	0.10		% full scale
Volume or pressure flow dependence	0.20		% of full scale
Atmospheric pressure dependence	0.30		% of value/kPa
Ambient temperature dependence	-0.07		% full scale/10K
Combined interference	0.56		% range
Dependence on voltage	0.02		% full scale/10V
Losses in the line (leak)	0.00		% of value
Uncertainty of calibration gas	2.00		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		%vol
Standard deviation of repeatability at span level	0.01		%vol
Lack of fit	0.01		%vol
Drift	0.00		%vol
Volume or pressure flow dependence	0.00		%vol
Atmospheric pressure dependence	0.02		%vol
Ambient temperature dependence	-0.01		%vol
Combined interference (from MCERTS Certificate)	0.08		%vol
Dependence on voltage	0.00		%vol
Losses in the line (leak)	0.00		%vol
Uncertainty of calibration gas	0.13		%vol

			RUN 1		Units
Measurement uncertainty		**Result**	11.56		%vol
Combined uncertainty			0.18		%vol
Expanded uncertainty	k =	1.96	0.35		%vol

	RUN 1		Units
Expanded uncertainty (no O_2) - at 95% Confidence	3.02		% of Value
Result of Compliance with Uncertainty Requirement in M2	**COMPLIANT**		-

Requirement for SRM is that Uncertainty should be 0.5%vol absolute or 6% relative whichever is the lower, on a dry gas basis. Ref EA TGN M2.

Exova Catalyst, Unit C6, Emery Court, The Embankment Business Park, Heaton Mersey, Stockport, SK4 3GL
E: toby.campbell@exova.com
Your Exova Catalyst Contact: Toby Campbell (07825 130 074)

Stack Emissions Testing Report Commissioned by
Newbridge Energy Ltd

Installation Name & Address
Blazers Fuels Ltd
Brickfield Lane
Ruthin
Denbighshire
North Wales
LL15 2TN

Stack Reference
Biomass CHP Plant Exhaust

Dates of the Monitoring Campaign
13th June 2018

Job Reference Number
CAT-4237

Report Written by
Brian Jacob Team Leader MCERTS Level 2 MM 06 693 TE1 TE2 TE3 TE4

Report Approved by
Michelle Edwards Team Leader MCERTS Level 2 MM 05 659 TE1 TE2 TE3 TE4

Report Date
18th June 2018

Version
Version 1

Signature of Report Approver

CONTENTS

Opinions and interpretations expressed herein are outside the scope of Exova Catalyst's ISO 17025 accreditation.

MONITORING OBJECTIVES

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust
13th June 2018

Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by Newbridge Energy Ltd to carry out stack emissions testing for Blazers Fuels Ltd on the Biomass CHP Plant Exhaust at Ruthin.

The aim of the monitoring campaign was to perform testing, as requested by the customer, for a number of prescribed pollutants, as part of a RHI assessment.

Special Requirements

There were no special requirements.

Target Parameters

Total Particulate Matter, Oxides of Nitrogen (as NO_2)

MONITORING RESULTS

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust
13th June 2018

where MU = Measurement Uncertainty associated with the Result

Parameter		Concentration				Mass Emission			
		Units	Result	MU +/-	Limit	Units	Result	MU +/-	Limit
Total Particulate Matter	[1]	mg/m^3	8.6	1.5	-	g/hr	74.9	14.1	-
Oxides of Nitrogen (as NO_2)	[1]	mg/m^3	155	7.3	-	g/hr	1361	95.3	-
Oxygen		% v/v	**Dry** 9.6	0.34					
Water Vapour		% v/v	10.8	0.54					
Stack Gas Temperature		°C	198						
Stack Gas Velocity		m/s	6.8	0.17					
Volumetric Flow Rate (ACTUAL)		m^3/hr	14630	757					
Volumetric Flow Rate (REF)	[1]	m^3/hr	8757	453					

NOTE: VOLUMETRIC FLOW RATE & VELOCITY DATA TAKEN FROM AN AVERAGE OF ALL OF THE ISOKINETIC RUNS.

[1] Reference Conditions (REF) are: 273K, 101.3kPa, dry gas, 11% oxygen.

RHI (RENEWABLE HEAT INCENTIVE) RESULTS

Parameter	Units	Result (NET)
Total Particulate Matter	g/GJ	4.5
Oxides of Nitrogen (as NO_2)	g/GJ	82.6

Reference Document: DEFRA Conversion of biomass boiler emission concentration data for comparison with Renewable Heat Incentive emission criteria, Issue 1

MONITORING DATE(S) & TIMES

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust
13th June 2018

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m³	4.2	g/hr	36.5	13/06/2018	10:48 - 11:04, 11:05 - 11:21	32
Total Particulate Matter	R2	mg/m³	17.6	g/hr	154	13/06/2018	11:33 - 11:49, 11:50 - 12:06	32
Total Particulate Matter	R3	mg/m³	3.9	g/hr	34.6	13/06/2018	12:16 - 12:32, 12:33 - 12:49	32
Oxides of Nitrogen (as NO_2)	R1	mg/m³	147	g/hr	1286	13/06/2018	10:48 - 11:21	33
Oxides of Nitrogen (as NO_2)	R2	mg/m³	136	g/hr	1193	13/06/2018	11:33 - 12:06	33
Oxides of Nitrogen (as NO_2)	R3	mg/m³	183	g/hr	1604	13/06/2018	12:16 - 12:49	33
Oxygen	R1	% v/v	9.1			13/06/2018	10:48 - 11:21	33
Oxygen	R2	% v/v	10.2			13/06/2018	11:33 - 12:06	33
Oxygen	R3	% v/v	9.4			13/06/2018	12:16 - 12:49	33
Velocity Traverse	R1					13/06/2018	10:02 - 10:12	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust
13th June 2018

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operation
Capacity (of 100%) and Tonnes / Hour	Full Load (Burnt power capacity 6366 kW)
Continuous or Batch Process	Continuous
Feedstock (if applicable)	Wood Chips
Abatement System	Bag Filter & Cyclone
Abatement System Running Status	On
Fuel	Wood Chips
Plume Appearance	None Visible

MONITORING & ANALYTICAL METHODS

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust
13th June 2018

	Monitoring				Analysis					
Parameter	**Standard**	**Technical Procedure**	**ISO 17025 Testing**	**Testing Lab**	**Analytical Procedure**	**Analytical Technique**	**ISO 17025 Analysis**	**Analysis Lab**	**MCERTS Testing**	**LOD (Average)**
Total Particulate Matter	EN 13284-1	CAT-TP-01	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.4 mg/m³
Water Vapour	EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.10 % v/v
Oxides of Nitrogen (as NO_2)	EN 14792	CAT-TP-21	Yes	CAT	Chemiluminescence by Horiba PG-250				Yes	0.41 mg/m³
Oxygen	EN 14789	CAT-TP-21	Yes	CAT	Dry Zirconia Cell by Horiba PG-250				Yes	0.1 %
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41	Yes	CAT	Pitot Tube and Thermocouple				Yes	1.2 m/s

ANALYSIS LABORATORIES

(with short name reference as appears in the table above)

Exova Catalyst (CAT)	ISO 17025 Accreditation Number: 4279

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
All Parameters	All Runs	There are no deviations associated with the sampling employed.

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.87
Width	m	-
Area	m²	0.59
Port Depth	cm	30
Orientation of Duct	-	Vertical
Number of Ports	-	2
Sample Port Size	-	5" Flange

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	Permanent
Inside / Outside	Inside

Platform Details

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	Yes
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	Yes
Platform has vertical base boards (approx. 0.25m high)	Yes
Platform has chains / self closing gates at top of ladders	No
There are no obstructions present which hamper insertion of sampling equipment	Yes
Safe Access Available	Yes
Easy Access Available	Yes

Sampling Location / Platform Improvement Recommendations

In the interest of improved Health and Safety, it would be advantageous to install some form of chain or self closing gate at the top of the sampling platform ladder.

EN 15259 Homogeneity Test Requirements

There is no requirement to perform a EN 15259 Homogeneity Test on this Stack.

Sampling Plane Validation Criteria (from EN 15259)

Criteria in EN 15259	Units	Traverse 1		Required	Compliant
Lowest Differential Pressure	Pa	23.0		> 5 Pa	Yes
Mean Velocity	m/s	6.47		-	-
Lowest Gas Velocity	m/s	6.30		-	-
Highest Gas Velocity	m/s	6.70		-	-
Ratio of Above	: 1	1.06		< 3 : 1	Yes
Maximum Angle of Swirl	°	14		< 15°	Yes
No Local Negative Flow	-	Yes		-	Yes

PLANT PHOTOS

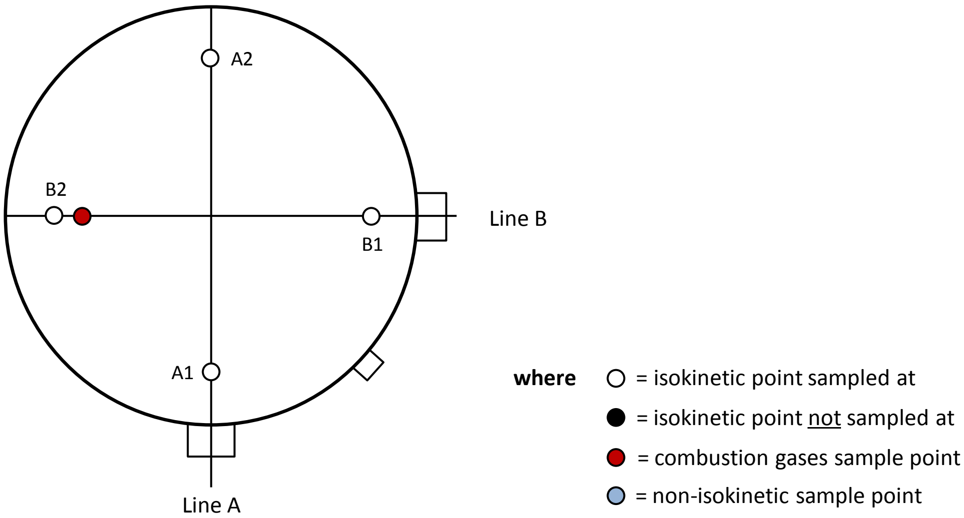
Photo 1

Photo 2

Photo 3

Photo 4

SAMPLE POINTS



APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Brian Jacob	MCERTS Level 2	MM 06 693	TE1 TE2 TE3 TE4
Trainee	Danny Williams	MCERTS Trainee	Pending	None

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	CAT 7.39
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.10
Box Thermocouples (2)	-
Umbilical (1)	CAT 3.10
Umbilical (2)	-
Oven Box (1)	-
Oven Box (2)	-
Heated Probe (1)	CAT 5.7
Heated Probe (2)	-
Heated Probe (3)	-
S-Pitot (1)	CAT 21p.43
S-Pitot (2)	-
L-Pitot	-
Site Balance	CAT 17.13
500g / 1Kg Check Weights	CAT 17.13
Last Impinger Arm	-
Callipers	CAT 23.10
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-250	CAT 9.11
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Testo 350 XL	-
JCT JCC P1 Cooler	CAT 4.135
Gasmet DX4000	-
Gasmet Sampling System	-
Bernath 3006 FID	-
M&C PSS	CAT 12.93
Mass Flow Controller (1)	CAT 6.3
Mass Flow Controller (2)	CAT 6.4
Mass View (1)	-
Mass View (2)	-
Easylogger EN-EL-12 Bit	-
Easylogger EN-EL-12 Bit	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer (1)	CAT 3.25
Digital Manometer (2)	-
Digital Temperature Meter	CAT 3.25
Stopwatch	CAT 14.53
Barometer	CAT 13.20
Stack Thermocouple (1)	CAT 4.1040
Stack Thermocouple (2)	-
Stack Thermocouple (3)	-
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	-
20m Heated Line (1)	CAT 20.69
20m Heated Line (2)	-
Dual Channel Heater Controller	-
Single Channel Heater Controller	-
Laboratory Balance	CAT 1.18 / 1.18a
Tape Measure	CAT 16.14

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	EN 13284-1	CAT-TP-01
Water Vapour	EN 14790	CAT-TP-05
Oxides of Nitrogen (as NO_2)	EN 14792	CAT-TP-21
Oxygen	EN 14789	CAT-TP-21
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41

PRELIMINARY STACK SURVEY: CALCULATIONS

General Stack Details

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	0.87
Stack Width, W	m	-
Stack Area, A	m²	0.59
Average Stack Gas Temperature, T_a	°C	157.8
Average Stack Gas Pressure	Pa	24.3
Average Stack Static Pressure, P_{static}	kPa	0.017
Average Barometric Pressure, P_b	kPa	101.6
Average Pitot Tube Calibration Coefficient, C_p	-	0.84

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m³ p	Conc kg/m³ p_i
CO_2 (Estimated)	-	10.00	8.92	0.1000	44.01	1.9635	0.19635
O_2	-	9.57	8.54	0.0957	32.00	1.4277	0.13669
N_2	-	80.43	71.76	0.8043	28.01	1.2498	1.00520
Moisture (H_2O)	-	-	10.77	0.1077	18.02	0.8037	0.08657

Where: p = M / 22.41

p_i = r x p

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m³	1.338
Wet Density (STP), P_{STW}	kg/m³	1.281
Dry Density (Actual), P_{Actual}	kg/m³	0.851
Average Wet Density (Actual), $P_{ActualW}$	kg/m³	0.814

Where: P_{STD} = sum of component concentrations, kg/m³ (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m³ (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (at each sampling point) = $P_{STW} \times (T_s / P_s) \times (P_a / T_a)$

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF [1]
Temperature	°C	157.8	0.0
Total Pressure	kPa	101.6	101.3
Moisture	%	10.77	0.00
Oxygen (Dry)	%	9.6	11.0

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m³/hr	13845
Gas Volumetric Flowrate (STP, Wet)	m³/hr	8802
Gas Volumetric Flowrate (STP, Dry)	m³/hr	7854
Gas Volumetric Flowrate REF [1]	m³/hr	8974

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID)

(1 of 1)

Parameter	Units	Value
Date of Survey	-	13/06/2018
Time of Survey	-	10:02 - 10:12
Atmospheric Pressure	kPa	101.6
Average Stack Static Pressure	Pa	17
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 200 (500Pa)	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C_p	-	0.84
Number of Lines Available	-	2
Number of Lines Used	-	2

		Sampling Line A					Sampling Line B				
Traverse Point	**Depth m**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**
STATIC (Units: Pa)		*18.0*					*16.0*				
Mean		**25.0**	**158.0**	**0.814**	**6.57**		**23.5**	**157.5**	**0.815**	**6.37**	
1	0.13	24.0	158.0	0.814	6.44	12.0	24.0	158.0	0.814	6.44	10.0
2	0.74	26.0	158.0	0.814	6.70	11.0	23.0	157.0	0.816	6.30	14.0

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID) - MEASUREMENT UNCERTAINTY

(1 of 1)

Performance characteristics (Uncertainty Components)	Uncertainty	Value	Units
Standard Uncertainty on the coefficient of the Pitot Tube	u(k)	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	u(Δpi)	1.074	Pa
- Resolution	u(res)	0.00087	
- Calibration	u(cal)	0.061	
- Drift	u(drift)	0.083	
- Lack of Fit	u(fit)	0.007	
- Overall corrections to dynamic measurements	u(Cf)	0.153	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00007	-
- $\varphi O_2,w$	-	8.543	
- $\varphi CO_2,w$	-	8.923	
- Oxygen, dry	u(ϕO_2,d)	0.293	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.306	
- Water Vapour	u(ϕH_2O)	0.550	
- Oxygen, wet	u(ϕO_2,w)	0.267	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.279	
Standard uncertainty associated with the stack temperature	u(Tc)	2.198	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.694	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	0.759	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00439	-
Standard uncertainty associated with the local velocities	u(vi)	0.149	Pa
Standard uncertainty associated with the mean velocity	u(v)	0.083	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	0.163	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	2.51	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	716.8	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00070	
- $u^2(qV,w)$	-	133762	
- $u(qV,w)$	-	365.7	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	5.18	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

Parameter	Units	Run 1	Run 2	Run 3		Mean
Concentration	mg/m³	4.2	17.6	3.9		8.6
Uncertainty	±mg/m³	1.4	1.7	1.4		1.5
Mass Emission	g/hr	36.5	154	34.6		74.9
Uncertainty	±g/hr	12.5	17.0	12.8		14.1

Parameter	Units	Run 1	Run 2	Run 3		Mean
Water Vapour	% v/v	9.9	10.1	12.3		10.8
Uncertainty	±% v/v	0.52	0.51	0.61		0.54

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.98		0.98

General Sampling Information

Parameter	Value	
Standard	EN 13284-1	
Technical Procedure	CAT-TP-01	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Glass Fibre	
Number of Sampling Lines Used	2 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	4 / 4	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1, A2, B1 & B2	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 11% oxygen.

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	Run 2	Run 3	
Absolute pressure of stack gas, P_s					
Barometric pressure, P_b	mmHg	762.0	762.0	769.5	
Stack static pressure, P_{static}	mmH_2O	1.8	1.8	2.5	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	762.1	762.1	769.7	
Volume of water vapour collected, V_{wstd}					
Total mass collected in impingers (liquid trap)	g	35.0	39.2	46.6	
Total mass collected in impingers (silica trap)	g	0.0	0.2	1.0	
Total mass of liquid collected, V_{lc}	g	35.0	39.4	47.6	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0436	0.0491	0.0593	
Volume of gas metered dry, V_{mstd}					
Volume of gas sample through gas meter, V_m	m^3	0.4300	0.4340	0.4280	
Gas meter correction factor, Y_d	-	1.0180	1.1080	1.1018	
Average dry gas meter temperature, T_m	°C	29.4	30.1	35.3	
Average pressure drop across orifice, ΔH	mmH_2O	21.5	22.9	19.5	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.3970	0.4353	0.4236	
Moisture content, B_{wo} & R_{wv}					
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0990	0.1014	0.1228	
B_{wo} as a percentage	% v/v	9.90	10.14	12.28	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	9.90	10.14	12.28	
Volume of gas metered wet, V_{mstw}					
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	0.4406	0.4844	0.4830	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$					
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	No	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	8.16	8.37	9.10	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	9.15	9.38	10.19	
% oxygen reference condition, $REF\%O_2$	% v/v	11.00	11.00	11.00	
O_2 Reference Factor wet (O_{2REFw}) = (21 - $REF\%O_2$) / (21 - $ACT\%O_{2w}$)	-	0.78	0.79	0.84	
O_2 Reference Factor dry (O_{2REFd}) = (21 - $REF\%O_2$) / (21 - $ACT\%O_{2d}$)	-	0.84	0.86	0.93	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	0.5656	0.6118	0.5749	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	0.4705	0.5058	0.4578	
Molecular weight of dry gas stream, M_d					
CO_2 (Estimated)	% v/v	10.00	6.00	6.00	
O_2	% v/v	9.15	9.38	10.19	
Total	% v/v	19.15	15.38	16.19	
N_2	% v/v	80.85	84.62	83.81	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	29.97	29.34	29.37	
Molecular weight of stack gas (wet), M_s					
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.78	28.19	27.97	
Velocity of stack gas, V_s					
Pitot tube velocity constant, K_p	-	34.97	34.97	34.97	
Velocity pressure coefficient, C_p	-	0.84	0.84	0.84	
Average of velocity heads, ΔP_{avg}	mmH_2O	2.35	2.23	2.98	
Average square root of velocity heads, $\sqrt{\Delta P}$	$\sqrt{mmH_2O}$	1.53	1.49	1.72	
Average stack gas temperature, T_s	°C	281.6	146.0	164.9	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s + 273})) / (\sqrt{(M_s)(P_s)})$	m/s	7.16	6.12	7.23	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})					
Area of stack, A_s	m^2	0.59	0.59	0.59	
$Q_a = (60)(A_s)(V_s)$	m^3/min	255.4	218.3	257.8	
Conversion factor (K/mm.Hg), C_f	-	0.3592	0.3592	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	126.1	142.6	162.7	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	113.6	128.2	142.8	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	161.9	180.1	193.7	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	134.6	148.9	154.3	
Percent isokinetic, %I					
Nozzle diameter, D_n	mm	9.02	9.02	8.11	
Nozzle area, A_n	mm^2	63.96	63.96	51.71	
Total sampling time, q	min	32	32	32	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	101.5	98.7	106.6	

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	Run 2	Run 3	
Sampling Times	-	10:48 - 11:04, 11:05 - 11:21	11:33 - 11:49, 11:50 - 12:06	12:16 - 12:32, 12:33 - 12:49	
Sampling Dates	-	13/06/2018	13/06/2018	13/06/2018	
Sampling Device	-	ISO	ISO	ISO	
Volume Sampled (REF)	m^3	0.4705	0.5058	0.4578	
Filter I.D. Number	-	47-51009	47-51011	47-51010	
Start Filter Mass	g	0.14791	0.14920	0.14805	
End Filter Mass	g	0.14861	0.15797	0.14909	
Total Mass on Filter	g	0.00070	0.00877	0.00104	
Probe Rinse I.D. Number	-	PR-47-51009	PR-47-51011	PR-47-51010	
Start Probe Rinse Mass	g	2.55829	2.54230	2.88641	
End Probe Rinse Mass	g	2.55955	2.54241	2.88717	
Total Mass in Probe Rinse	g	0.00126	0.00011	0.00076	
Total Mass Collected	mg	1.96	8.88	1.81	
Calculated Concentration	mg/m^3	4.17	17.56	3.95	
Balance Uncertainty / LOD	mg/m^3	0.40	0.38	0.42	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	13/06/2018	
Average Volume Sampled (REF)	m^3	0.4780	
Filter I.D. Number	-	47-51012	
Start Filter Mass	g	0.14914	
End Filter Mass	g	0.14952	
Total Mass on Filter	g	0.00038	
Probe Rinse I.D. Number	-	PR-47-51012	
Start Probe Rinse Mass	g	2.72771	
End Probe Rinse Mass	g	2.72780	
Total Mass in Probe Rinse	g	0.00009	
Total Mass Collected	mg	0.47	
Calculated Concentration	mg/m^3	0.98	
Balance Uncertainty / LOD	mg/m^3	0.40	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1	Run 2	Run 3	
Mean Sampling Rate	l/min	13.68	15.03	14.74	
Pre-Sampling Leak Rate	l/min	0.14	0.15	0.13	
Post-Sampling Leak Rate	l/min	0.14	0.16	0.13	
Allowable Leak Rate	l/min	0.27	0.30	0.29	
Leak Test Acceptable	-	Yes	Yes	Yes	

Water Droplets	Units	Run 1	Run 2	Run 3	
Are Water Droplets Present	-	No	No	No	

MU (Concurrent Water Vapour)	Units	Run 1	Run 2	Run 3	
Measurement Uncertainty (MU)	%	5.3	5.0	4.9	
Allowable MU	%	20	20	20	
MU Acceptable	%	Yes	Yes	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	Run 2	Run 3	
Less than 50% Faded	%	Yes	Yes	Yes	

Isokinetic Criterion Compliance	Units	Run 1	Run 2	Run 3	
Isokinetic Variation	%	101.5	98.7	106.6	
Allowable Isokinetic Range	%	95 - 115	95 - 115	95 - 115	
Isokineticity Acceptable	-	Yes	Yes	Yes	

Weighing Uncertainty Criteria	Units	Run 1	Run 2	Run 3	
Overall Weighing Uncertainty	± mg	0.33	0.33	0.33	
Overall Weighing Uncertainty	± mg/m³	0.69	0.64	0.71	
ELV [Daily ELV for IED]	mg/m³	N/A	N/A	N/A	
Allowable Weighing Uncertainty	mg/m³	N/A	N/A	N/A	
Weighing Uncertainty Acceptable	-	N/A	N/A	N/A	

Filter Temperatures	Units	Run 1	Run 2	Run 3	
Pre-Conditioning Temperature	°C	180	180	180	
Post-Conditioning Temperature	°C	160	160	160	
Maximum Filter Temperature	°C	1156	147	170	

Test Conditions	Units	Run 1	Run 2	Run 3	
Ambient Temperature Recorded?	-	Yes	Yes	Yes	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	15.00
Pre-Sampling Leak Rate	l/min	0.10
Post-Sampling Leak Rate	l/min	0.12
Allowable Leak Rate	l/min	0.30
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m³	N/A
Blank Acceptable	-	N/A

Acetone / Water Rinse Blank	Units	Blank
Acetone / Water Rinse Value	mg/l	2.7
Allowable Blank	mg/l	10
Blank Acceptable	-	Yes

Method Deviations

Nature of Deviation (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number 1	Run Number 2	Run Number 3
There are no deviations associated with the sampling employed.	wx	wx	wx

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value						Standard uncertainty				
Measured Quantities	**Symbol**	**Run 1**	**Run 2**	**Run 3**		**Symbol**	**Units**	**Run 1**	**Run 2**	**Run 3**	
Sampled Volume (Actual)	V_m	0.4300	0.4340	0.4280		uV_m	m³	0.0086	0.0087	0.0086	
Sampled Gas Temperature	T_m	302.4	303.1	308.3		uT_m	K	2.0	2.0	2.0	
Sampled Gas Pressure	ρ_m	101.6	101.6	102.6		$u\rho_m$	kPa	0.5	0.5	0.5	
Sampled Gas Humidity	H_m	0.0	0.0	0.0		uH_m	% v/v	1.0	1.0	1.0	
Leak	L	1.02	1.06	0.88		uL	%	-	-	-	
Mass of Particulate	m	1.96	8.88	1.81		um	mg	0.19	0.19	0.19	
Uncollected Mass	UCM	0.47	0.47	0.47		uUCM	mg	-	-	-	

	Uncertainty as a Percentage					
Measured Quantities	**Units**	**Run 1**	**Run 2**	**Run 3**		**Requirement of Standard**
Sampled Volume (Actual)	%	2.00	2.00	2.00		≤2%
Sampled Gas Temperature	%	0.66	0.66	0.65		≤1%
Sampled Gas Pressure	%	0.49	0.49	0.49		≤1%
Sampled Gas Humidity	%	1.00	1.00	1.00		≤1%
Leak	%	1.02	1.06	0.88		≤2%
Mass of Particulate	%	-	-	-		<5% of ELV
Uncollected Mass	%	-	-	-		-

	Uncertainty in Measurement Units						Sensitivity Coefficient			
Measured Quantities	**Symbol**	**Units**	**Run 1**	**Run 2**	**Run 3**		**Run 1**	**Run 2**	**Run 3**	
Sampled Volume (STP)	V_m	m³	0.3970	0.4353	0.4236		10.49	40.35	9.32	
Leak	L	mg/m³	0.025	0.108	0.020		1.00	1.00	1.00	
Mass of Particulate	L_r	mg	1.960	8.883	1.807		2.13	1.98	2.18	
Uncollected Mass	UCM	mg	0.27	0.27	0.27		2.13	1.98	2.18	

	Uncertainty in Result				
Measured Quantities	**Units**	**Run 1**	**Run 2**	**Run 3**	
Sampled Volume (STP)	mg/m³	0.105	0.418	0.095	
Leak	mg/m³	0.0246	0.1080	0.0201	
Mass of Particulate	mg/m³	0.4038	0.3756	0.4151	
Uncollected Mass	mg/m³	0.5767	0.5365	0.5928	

	Oxygen Correction Part of MU Budget				
Measured Quantities	**Units**	**Run 1**	**Run 2**	**Run 3**	
O_2 Correction Factor	-	0.84	0.86	0.93	
Stack Gas O_2 Content	% v/v	9.15	9.38	10.19	
MU for O_2 Correction	-	0.04	0.04	0.04	
Overall MU For O_2 Measurement	%	4.22	4.30	4.63	

Parameter	**Units**	**Run 1**	**Run 2**	**Run 3**	
Combined uncertainty	mg/m³	0.71	0.78	0.73	
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m³	1.40	1.54	1.43	
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m³	1.41	1.71	1.44	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m³	1.41	1.71	1.44	
Reported Uncertainty	mg/m³	1.41	1.71	1.44	
Expanded uncertainty (95% confidence), without Oxygen Correction	%	33.5	8.8	36.3	
Expanded uncertainty (95% confidence), with Oxygen Correction	%	33.8	9.8	36.6	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	33.8	9.8	36.6	
Reported Uncertainty	%	33.8	9.8	36.6	

OXIDES OF NITROGEN (as NO_2): RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

Parameter	Units	Run 1	Run 2	Run 3	Mean
Concentration	mg/m³	147	136	183	155
Uncertainty	±mg/m³	7.0	6.4	8.5	7.3
Mass Emission	g/hr	1286	1193	1604	1361
Uncertainty	±g/hr	90.7	83.7	111	95.3

General Sampling Information

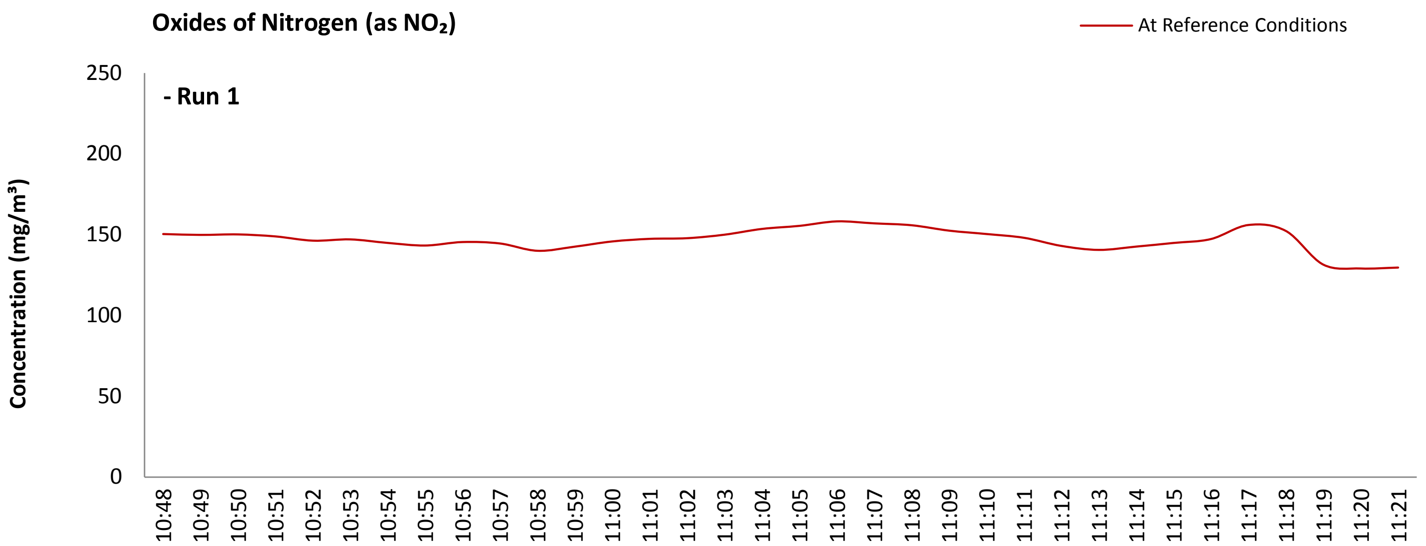
Parameter	Value	
Standard	EN 14792	
Technical Procedure	CAT-TP-21	
Probe Material	Titanium	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Date & Result of Last Converter Check	15/05/2018 - 95.3%	
Span Gas Type	Nitrogen Monoxide	
Span Gas Reference Number	CYL 12.0136	
Span Gas Expiry Date	100	
Span Gas Start Pressure (bar)	120	
Gas Cylinder Concentration (ppm)	413.6	NOTE: Dilution performed to achieve correct span value
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	B2	

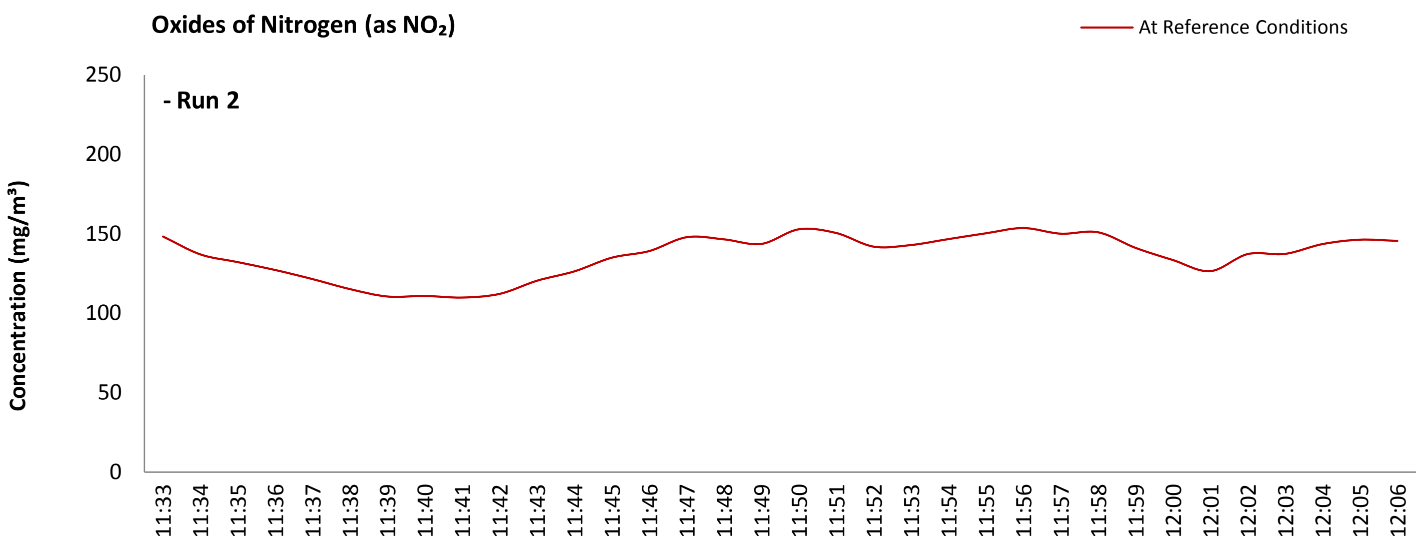
Reference Conditions

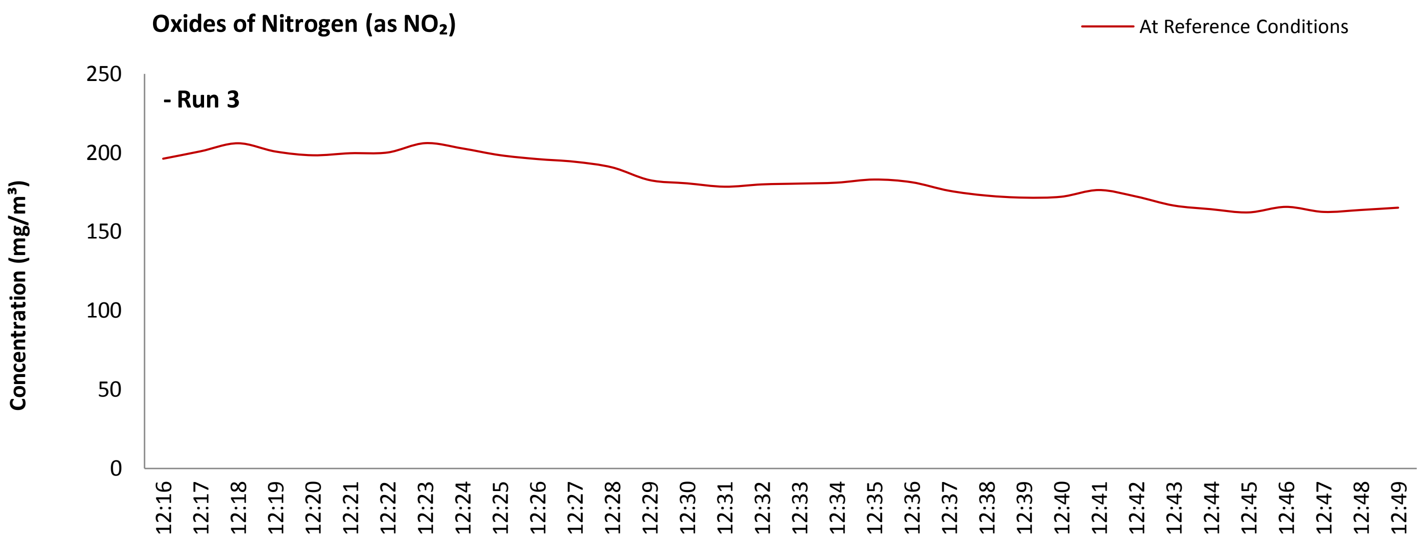
Reference Conditions are: 273K, 101.3kPa, dry gas, 11% oxygen.

OXIDES OF NITROGEN (as NO_2): DATA TREND

Graphical Trend of Data







OXIDES OF NITROGEN (as NO_2): SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	Run 2	Run 3
Sampling Times	-	10:48 - 11:21	11:33 - 12:06	12:16 - 12:49
Sampling Dates	-	13/06/2018	13/06/2018	13/06/2018
Instrument Range	ppm	500	500	500
Span Gas Value	ppm	413.6	413.6	413.6

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	Run 2	Run 3
Average Temperature	°C	2.3	2.3	2.3
Allowable Temperature	< °C	4.0	4.0	4.0
Temperature Acceptable	-	Yes	Yes	Yes

	Zero Drift	Units	Run 1	Run 2	Run 3
CAL 1	Zero at Analyser (Pre)	ppm	0.00	0.00	0.00
CAL 1	Zero at Analyser (Post)	ppm	0.60	0.60	0.60
CAL 1	Zero Drift	ppm	0.60	0.60	0.60
	Allowable Zero Drift	± ppm	20.68	20.68	20.68
	Zero Drift Acceptable	-	Yes	Yes	Yes

	Span Drift	Units	Run 1	Run 2	Run 3
CAL 1	Span at Analyser (Pre)	ppm	413.60	413.60	413.60
CAL 1	Span at Analyser (Post)	ppm	406.00	406.00	406.00
CAL 1	Span Drift	ppm	-7.60	-7.60	-7.60
	Allowable Span Drift	± ppm	20.68	20.68	20.68
	Span Drift Acceptable	-	Yes	Yes	Yes

Test Conditions	Units	Run 1	Run 2	Run 3
Run Ambient Temperature Range	°C	22 - 23	22 - 23	22 - 23

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	2	3
There are no deviations associated with the sampling employed.	x	x	x

OXIDES OF NITROGEN (as NO_2): MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	RUN 2	RUN 3	Units
Limit value	-	-	-	mg/m³ (REF)
TGN M2 Allowable MU	10.0	10.0	10.0	%
Measured concentration	174.10	158.37	197.98	mg/m³ (STP, dry)
Ration NO / NO_2	5	5	5	%
Range Used	500.0	500.0	500.0	ppm
Range Used [A]	1026.1	1026.1	1026.1	mg/m³
Cal gas conc.	413.6	413.6	413.6	ppm
Conversion	2.05	2.05	2.05	ppm to mg/m³
MCERTS Range [B]	125.0	125.0	125.0	mg/m³
Lower of [A] or [B]	125.0	125.0	125.0	mg/m³
Cal gas conc.	848.8	848.8	848.8	mg/m³

Performance characteristics	RUN 1	RUN 2	RUN 3	Units
Response time	60	60	60	seconds
Number of readings in measurement	33	33	33	-
Repeatability at zero	0.40	0.40	0.40	% full scale
Repeatability at span level	0.40	0.40	0.40	% full scale
Deviation from linearity	0.19	0.19	0.19	% of value
Zero drift	0.15	0.15	0.15	% full scale
Span drift	-1.84	-1.84	-1.84	% full scale
Volume or pressure flow dependence	0.40	0.40	0.40	% of full scale
Atmospheric pressure dependence	0.30	0.30	0.30	% of value/kPa
Ambient temperature dependence	0.18	0.18	0.18	% full scale/10K
Combined interference	0.60	0.60	0.60	% range
Dependence on voltage	0.40	0.40	0.40	% full scale/10V
Converter efficiency	95.3	95.3	95.3	%
Losses in the line (leak)	0.24	0.24	0.24	% of value
Uncertainty of calibration gas blending	1.40	1.40	1.40	% of value
Uncertainty of calibration gas	2.00	2.00	2.00	% of value

Performance characteristic	RUN 1	RUN 2	RUN 3	Units
Standard deviation of repeatability at zero	use rep at span	use rep at span	use rep at span	mg/m³
Standard deviation of repeatability at span level	0.07	0.07	0.07	mg/m³
Lack of fit	0.14	0.14	0.14	mg/m³
Drift	-1.14	-0.97	-1.39	mg/m³
Volume or pressure flow dependence	0.00	0.00	0.00	mg/m³
Atmospheric pressure dependence	0.11	0.11	0.11	mg/m³
Ambient temperature dependence	0.03	0.03	0.03	mg/m³
Combined interference (from MCERTS Certificate)	0.43	0.43	0.43	mg/m³
Dependence on voltage	0.05	0.05	0.05	mg/m³
Converter efficiency	0.24	0.21	0.27	mg/m³
Losses in the line (leak)	0.24	0.22	0.28	mg/m³
Uncertainty of calibration gas blending	1.41	1.28	1.60	mg/m³
Uncertainty of calibration gas	2.01	1.83	2.29	mg/m³

			RUN 1	RUN 2	RUN 3	Units
Measurement uncertainty		**Result**	174.10	158.37	197.98	mg/m³
Combined uncertainty			2.80	2.54	3.21	mg/m³
Expanded uncertainty	k =	1.96	5.49	4.97	6.28	mg/m³
Uncertainty corrected to std conds. (O_2)			4.63	4.28	5.82	mg/m³ (REF)

	RUN 1	RUN 2	RUN 3	Units
Expanded uncertainty (no O_2) - at 95% Confidence	3.15	3.14	3.17	% of Value
Expanded uncertainty (no O_2) - at 95% Confidence	N/A	N/A	N/A	% at ELV
Overall Allowable uncertainty (no O_2) - at 95% Confidence	N/A	N/A	N/A	% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**	**N/A**	**N/A**	-

	RUN 1	RUN 2	RUN 3	Units
Expanded uncertainty (with O_2) - at 95% Confidence	4.78	4.73	4.63	% of Value
Expanded uncertainty (with O_2) - at 95% Confidence	N/A	N/A	N/A	% at ELV
Overall Allowable uncertainty (with O_2) - at 95% Confidence	N/A	N/A	N/A	% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**	**N/A**	**N/A**	-

Requirement for SRM is that Uncertainty should be <10% of the value at the ELV, on a dry gas basis, or if O_2 correction is applied less than 10% + the uncertainty associated with the O_2 correction (using sqrt of sum squares to add uncertainty components). Ref EA TGN M2.

OXYGEN: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

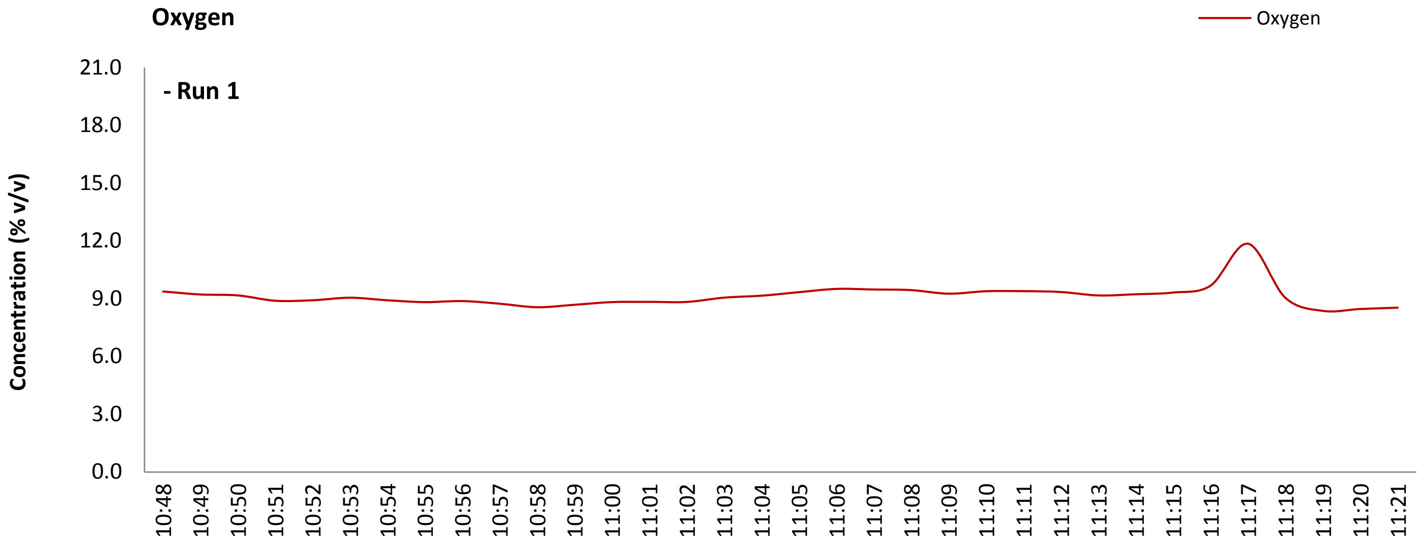
Parameter	Units	Run 1	Run 2	Run 3	Mean
Concentration	% v/v	9.1	9.4	10.2	9.6
Uncertainty	±% v/v	0.33	0.33	0.34	0.33

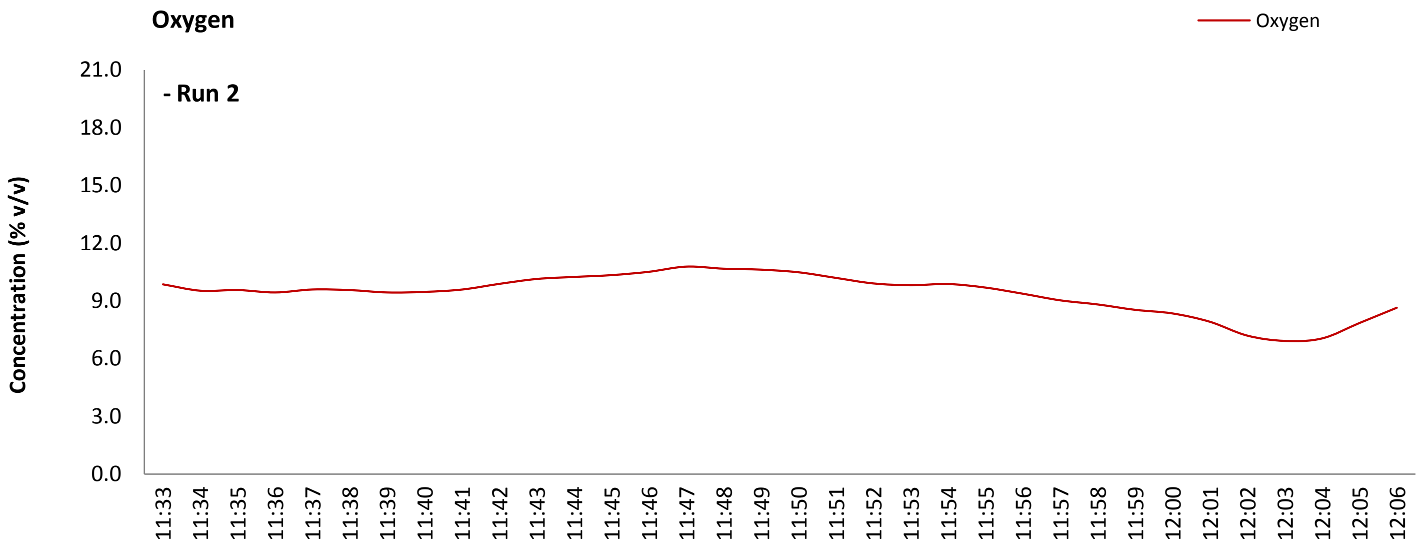
General Sampling Information

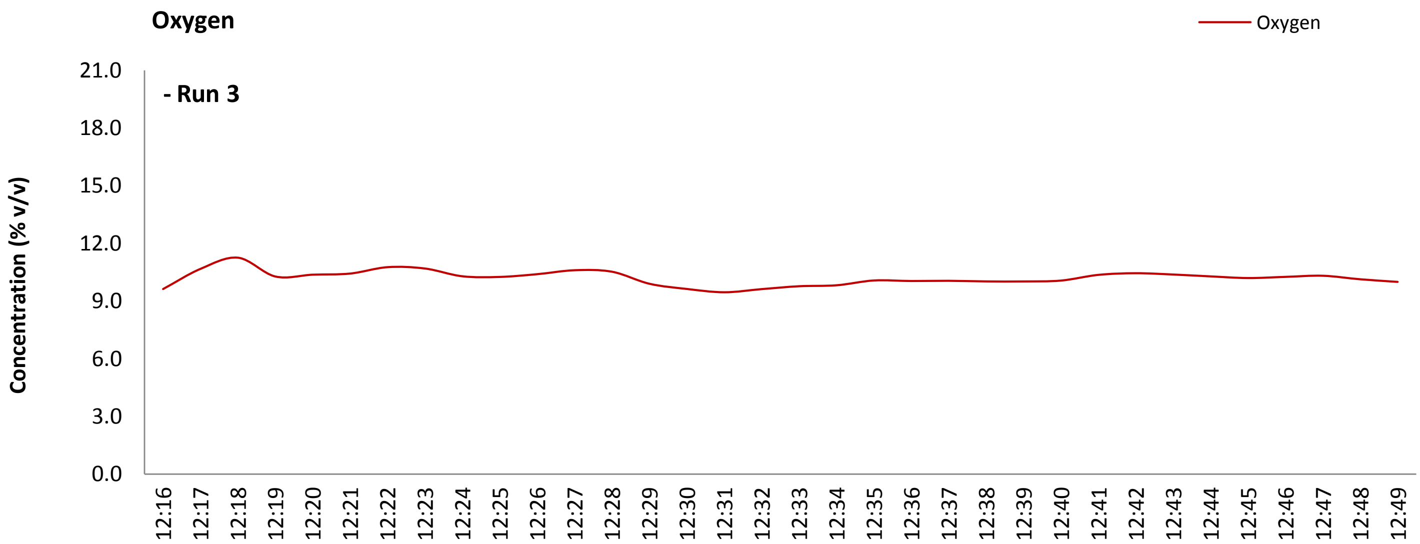
Parameter	Value	
Standard	EN 14789	
Technical Procedure	CAT-TP-21	
Probe Material	Titanium	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Synthetic Air (5 Grade)	
Span Gas Reference Number	CYL 11.0307	
Span Gas Expiry Date	11/10/2022	
Span Gas Start Pressure (bar)	50	
Gas Cylinder Concentration (% v/v)	21.62	NOTE: Dilution performed to achieve correct span value
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	B2	

OXYGEN: DATA TREND

Graphical Trend of Data







OXYGEN: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	Run 2	Run 3
Sampling Times	-	10:48 - 11:21	11:33 - 12:06	12:16 - 12:49
Sampling Dates	-	13/06/2018	13/06/2018	13/06/2018
Instrument Range	% v/v	25	25	25
Span Gas Value	% v/v	11.00	11.00	11.00

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	Run 2	Run 3
Average Temperature	°C	2.3	2.3	2.3
Allowable Temperature	< °C	4.0	4.0	4.0
Temperature Acceptable	-	Yes	Yes	Yes

	Zero Drift	Units	Run 1	Run 2	Run 3
CAL 1	Zero at Analyser (Pre)	% v/v	0.00	0.00	0.00
CAL 1	Zero at Analyser (Post)	% v/v	0.06	0.06	0.06
CAL 1	Zero Drift	% v/v	0.06	0.06	0.06
	Allowable Zero Drift	± % v/v	0.55	0.55	0.55
	Zero Drift Acceptable	-	Yes	Yes	Yes

	Span Drift	Units	Run 1	Run 2	Run 3
CAL 1	Span at Analyser (Pre)	% v/v	10.85	10.83	10.85
CAL 1	Span at Analyser (Post)	% v/v	10.82	10.82	10.82
CAL 1	Span Drift	% v/v	-0.03	-0.03	-0.03
	Allowable Span Drift	± % v/v	0.55	0.55	0.55
	Span Drift Acceptable	-	Yes	Yes	Yes

Test Conditions	Units	Run 1	Run 2	Run 3
Run Ambient Temperature Range	°C	22 - 23	22 - 23	22 - 23

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	Run Number 2	Run Number 3
There are no deviations associated with the sampling employed.	x	x	x

OXYGEN: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	RUN 2	RUN 3	Units
Limit value	N/A	N/A	N/A	%vol
TGN M2 Allowable MU	6.0	6.0	6.0	%
Measured concentration	9.15	9.38	10.19	%vol
Range Used	25.0	25.0	25.0	%vol
Cal gas conc.	21.6	21.6	21.6	%vol

Performance characteristics	RUN 1	RUN 2	RUN 3	Units
Response time	60	60	60	seconds
Number of readings in measurement	33	33	33	-
Repeatability at zero	0.04	0.04	0.04	% full scale
Repeatability at span level	0.04	0.04	0.04	% full scale
Deviation from linearity	0.11	0.11	0.11	% of value
Zero drift	0.55	0.55	0.55	% full scale
Span drift	-0.28	-0.28	-0.28	% full scale
Volume or pressure flow dependence	0.20	0.20	0.20	% of full scale
Atmospheric pressure dependence	0.30	0.30	0.30	% of value/kPa
Ambient temperature dependence	-0.07	-0.07	-0.07	% full scale/10K
Combined interference	0.56	0.56	0.56	% range
Dependence on voltage	0.02	0.02	0.02	% full scale/10V
Losses in the line (leak)	0.18	0.18	0.18	% of value
Uncertainty of calibration gas	2.00	2.00	2.00	% of value

Performance characteristic	RUN 1	RUN 2	RUN 3	Units
Standard deviation of repeatability at zero	use rep at span	use rep at span	use rep at span	%vol
Standard deviation of repeatability at span level	0.01	0.01	0.01	%vol
Lack of fit	0.02	0.02	0.02	%vol
Drift	0.05	0.05	0.05	%vol
Volume or pressure flow dependence	0.00	0.00	0.00	%vol
Atmospheric pressure dependence	0.02	0.02	0.02	%vol
Ambient temperature dependence	-0.01	-0.01	-0.01	%vol
Combined interference (from MCERTS Certificate)	0.08	0.08	0.08	%vol
Dependence on voltage	0.00	0.00	0.00	%vol
Losses in the line (leak)	0.01	0.01	0.01	%vol
Uncertainty of calibration gas	0.11	0.11	0.12	%vol

			RUN 1	RUN 2	RUN 3	Units
Measurement uncertainty		**Result**	9.15	9.38	10.19	%vol
Combined uncertainty			0.17	0.17	0.18	%vol
Expanded uncertainty	k =	1.96	0.33	0.33	0.34	%vol

	RUN 1	RUN 2	RUN 3	Units
Expanded uncertainty (no O_2) - at 95% Confidence	3.60	3.54	3.37	% of Value
Result of Compliance with Uncertainty Requirement in M2	**COMPLIANT**	**COMPLIANT**	**COMPLIANT**	-

Requirement for SRM is that Uncertainty should be 0.5%vol absolute or 6% relative whichever is the lower, on a dry gas basis. Ref EA TGN M2.

Exova Catalyst, Unit C6, Emery Court, The Embankment Business Park, Heaton Mersey, Stockport, SK4 3GL
E: toby.campbell@exova.com
Your Exova Catalyst Contact: Toby Campbell (07825 130 074)

Stack Emissions Testing Report Commissioned by
Newbridge Energy Ltd

Installation Name & Address
Blazers Fuels Ltd
Brickfield Lane
Ruthin
Denbighshire
North Wales
LL15 2TN

Stack Reference
Belt Dryer No.1

Dates of the Monitoring Campaign
13th - 14th June 2018

Job Reference Number
CAT-4238

Report Written by
Brian Jacob Team Leader MCERTS Level 2 MM 06 693 TE1 TE2 TE3 TE4

Report Approved by
Michelle Edwards Team Leader MCERTS Level 2 MM 05 659 TE1 TE2 TE3 TE4

Report Date
19th June 2018

Version
Version 1

Signature of Report Approver
MEdwards

CONTENTS

Opinions and interpretations expressed herein are outside the scope of Exova Catalyst's ISO 17025 accreditation.

MONITORING OBJECTIVES

Blazers Fuels Ltd, Ruthin
Belt Dryer No.1
13th - 14th June 2018

Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by Newbridge Energy Ltd to carry out stack emissions testing for Blazers Fuels Ltd on the Belt Dryer No.1 at Ruthin.

The aim of the monitoring campaign was to perform testing, as requested by the customer, for a number of prescribed pollutants. There are no emission limits set for any of the pollutants at this time.

Special Requirements

There were no special requirements.

Target Parameters

Total Particulate Matter, PM_{10}, $PM_{2.5}$

MONITORING RESULTS

Blazers Fuels Ltd, Ruthin
Belt Dryer No.1
13th - 14th June 2018

where MU = Measurement Uncertainty associated with the Result

Parameter		Concentration				Mass Emission			
		Units	Result	MU +/-	Limit	Units	Result	MU +/-	Limit
Total Particulate Matter	[1]	mg/m³	3.4	1.7	-	g/hr	261	131	-
PM_{10}	[1]	mg/m³	0.94	0.60	-	g/hr	72.4	46.2	-
$PM_{2.5}$	[1]	mg/m³	0.68	0.69	-	g/hr	52.9	53.7	-
Oxygen	% v/v Wet 20.25	% v/v	Dry 21.0	0.53					
Water Vapour		% v/v	3.7	0.20					
Stack Gas Temperature		°C	30.0						
Stack Gas Velocity		m/s	7.6	0.11					
Volumetric Flow Rate (ACTUAL)		m³/hr	85720	4080					
Volumetric Flow Rate (REF)	[1]	m³/hr	77450	3686					

NOTE: VOLUMETRIC FLOW RATE & VELOCITY DATA TAKEN FROM AN AVERAGE OF ALL OF THE ISOKINETIC RUNS.

[1] Reference Conditions (REF) are: 273K, 101.3kPa, without correction for water vapour content.

MONITORING DATE(S) & TIMES

Blazers Fuels Ltd, Ruthin
Belt Dryer No.1
13th - 14th June 2018

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m³	4.0	g/hr	306	13/06/2018	14:53 - 15:23	30
Total Particulate Matter	R2	mg/m³	2.8	g/hr	215	13/06/2018	15:40 - 16:10	30
PM_{10}	R1	mg/m³	0.94	g/hr	72.4	14/06/2018	09:48 - 10:18	30
$PM_{2.5}$	R1	mg/m³	0.68	g/hr	52.9	14/06/2018	09:48 - 10:18	30
Oxygen	R1	% v/v	20.3			13/06/2018	14:53 - 15:23	30
Oxygen	R2	% v/v	20.3			13/06/2018	15:40 - 16:10	30
Oxygen	R3	% v/v	20.2			14/06/2018	09:48 - 10:18	30
Velocity Traverse	R1					13/06/2018	14:30 - 14:45	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Blazers Fuels Ltd, Ruthin
Belt Dryer No.1
13th - 14th June 2018

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operation
Capacity (of 100%) and Tonnes / Hour	4 - 5 Tonne / Hour
Continuous or Batch Process	Continuous
Feedstock (if applicable)	Wood Chips
Abatement System	None
Abatement System Running Status	N/A
Fuel	Waste Heat From CHP
Plume Appearance	None Visible

MONITORING & ANALYTICAL METHODS

Blazers Fuels Ltd, Ruthin
Belt Dryer No.1
13th - 14th June 2018

Parameter	Monitoring				Analysis				MCERTS Testing	LOD (Average)
	Standard	Technical Procedure	ISO 17025 Testing	Testing Lab	Analytical Procedure	Analytical Technique	ISO 17025 Analysis	Analysis Lab		
Total Particulate Matter	EN 13284-1	CAT-TP-01	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.42 mg/m³
PM_{10}	BS EN ISO 23210	CAT-TP-18	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.28 mg/m³
$PM_{2.5}$	BS EN ISO 23210	CAT-TP-18	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.35 mg/m³
Water Vapour	EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.10 % v/v
Oxygen	EN 14789	CAT-TP-21	Yes	CAT	Dry Zirconia Cell by Horiba PG-250				Yes	0.1 %
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41	Yes	CAT	Pitot Tube and Thermocouple				Yes	1.2 m/s

ANALYSIS LABORATORIES

(with short name reference as appears in the table above)

Exova Catalyst (CAT)	ISO 17025 Accreditation Number: 4279

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
Total Particulate Matter	All Runs	Due to the restricted access, it was not possible to sample at all of the sample points on the available sampling lines.

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	2.00
Width	m	-
Area	m²	3.14
Port Depth	cm	15
Orientation of Duct	-	Vertical
Number of Ports	-	2
Sample Port Size	-	4" BSP

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	MEWP
Inside / Outside	Outside

Platform Details

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	No
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	Yes
Platform has vertical base boards (approx. 0.25m high)	Yes
Platform has chains / self closing gates at top of ladders	Yes
There are no obstructions present which hamper insertion of sampling equipment	No
Safe Access Available	Yes
Easy Access Available	Yes

Sampling Location / Platform Improvement Recommendations

All platforms should be designed in accordance with the requirements in the Environment Agency's Technical Guidance Note M1 and EN 15259.

EN 15259 Homogeneity Test Requirements

There is no requirement to perform a EN 15259 Homogeneity Test on this Stack.

Sampling Plane Validation Criteria (from EN 15259)

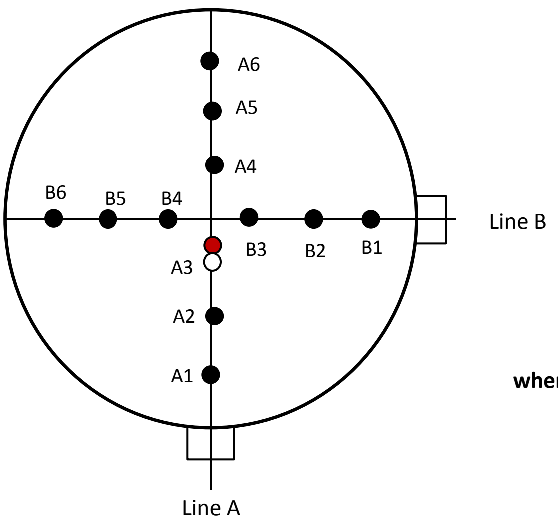
Criteria in EN 15259	Units	Traverse 1		Required	Compliant
Lowest Differential Pressure	Pa	17.0		> 5 Pa	Yes
Mean Velocity	m/s	5.44		-	-
Lowest Gas Velocity	m/s	4.56		-	-
Highest Gas Velocity	m/s	6.36		-	-
Ratio of Above	: 1	1.39		< 3 : 1	Yes
Maximum Angle of Swirl	°	14		< 15°	Yes
No Local Negative Flow	-	Yes		-	Yes

PLANT PHOTOS

Photo 1

Photo 2

SAMPLE POINTS



where ○ = isokinetic point sampled at
● = isokinetic point not sampled at
● = combustion gases sample point
● = non-isokinetic sample point

APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Brian Jacob	MCERTS Level 2	MM 06 693	TE1 TE2 TE3 TE4
Trainee	Danny Williams	MCERTS Trainee	Pending	None

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	CAT 7.39
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.10
Box Thermocouples (2)	-
Umbilical (1)	CAT 3.10
Umbilical (2)	-
Oven Box (1)	-
Oven Box (2)	-
Heated Probe (1)	CAT 5.7
Heated Probe (2)	-
Heated Probe (3)	-
S-Pitot (1)	CAT 21p.43
S-Pitot (2)	-
L-Pitot	-
Site Balance	CAT 17.13
500g / 1Kg Check Weights	CAT 17.13
Last Impinger Arm	-
Callipers	CAT 23.10
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-250	CAT 9.11
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Testo 350 XL	-
JCT JCC P1 Cooler	CAT 4.135
Gasmet DX4000	-
Gasmet Sampling System	-
Bernath 3006 FID	-
M&C PSS	CAT 12.93
Mass Flow Controller (1)	CAT 6.3
Mass Flow Controller (2)	CAT 6.4
Mass View (1)	-
Mass View (2)	-
Easylogger EN-EL-12 Bit	-
Easylogger EN-EL-12 Bit	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer (1)	CAT 3.25
Digital Manometer (2)	-
Digital Temperature Meter	CAT 3.25
Stopwatch	CAT 14.53
Barometer	CAT 13.20
Stack Thermocouple (1)	CAT 4.140
Stack Thermocouple (2)	-
Stack Thermocouple (3)	-
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	-
20m Heated Line (1)	CAT 20.69
20m Heated Line (2)	-
Dual Channel Heater Controller	-
Single Channel Heater Controller	-
Laboratory Balance	CAT 1.18 / 1.18a
Tape Measure	CAT 16.14

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	EN 13284-1	CAT-TP-01
PM_{10}	BS EN ISO 23210	CAT-TP-18
$PM_{2.5}$	BS EN ISO 23210	CAT-TP-18
Water Vapour	EN 14790	CAT-TP-05
Oxygen	EN 14789	CAT-TP-21
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41

PRELIMINARY STACK SURVEY: CALCULATIONS

General Stack Details

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	2.00
Stack Width, W	m	-
Stack Area, A	m²	3.14
Average Stack Gas Temperature, T_a	°C	30.1
Average Stack Gas Pressure	Pa	24.3
Average Stack Static Pressure, P_{static}	kPa	0.021
Average Barometric Pressure, P_b	kPa	101.6
Average Pitot Tube Calibration Coefficient, C_p	-	0.84

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m³ p	Conc kg/m³ p_i
CO_2 (Estimated)	-	0.06	0.06	0.0006	44.01	1.9635	0.00118
O_2	-	21.03	20.25	0.2103	32.00	1.4277	0.30031
N_2	-	78.91	75.95	0.7891	28.01	1.2498	0.98619
Moisture (H_2O)	-	-	3.75	0.0375	18.02	0.8037	0.03013

Where: p = M / 22.41

p_i = r x p

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m³	1.288
Wet Density (STP), P_{STW}	kg/m³	1.270
Dry Density (Actual), P_{Actual}	kg/m³	1.164
Average Wet Density (Actual), $P_{ActualW}$	kg/m³	1.147

Where: P_{STD} = sum of component concentrations, kg/m³ (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m³ (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (at each sampling point) = $P_{STW} \times (T_s / P_s) \times (P_a / T_a)$

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF [1]
Temperature	°C	30.1	0.0
Total Pressure	kPa	101.6	101.3
Moisture	%	3.75	3.75

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m³/hr	61480
Gas Volumetric Flowrate (STP, Wet)	m³/hr	55553
Gas Volumetric Flowrate (STP, Dry)	m³/hr	53471
Gas Volumetric Flowrate REF [1]	m³/hr	55553

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID)

(1 of 1)

Parameter	Units	Value
Date of Survey	-	13/06/2018
Time of Survey	-	14:30 - 14:45
Atmospheric Pressure	kPa	101.6
Average Stack Static Pressure	Pa	21
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 200 (500Pa)	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C_p	-	0.84
Number of Lines Available	-	2
Number of Lines Used	-	2

		Sampling Line A					Sampling Line B				
Traverse Point	**Depth m**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**
STATIC (Units: Pa)		*20.0*					*22.0*				
Mean		**25.3**	**30.1**	**1.147**	**5.54**		**23.3**	**30.1**	**1.147**	**5.33**	
1	0.09	17.0	30.0	1.147	4.56	10.0	20.0	30.1	1.147	4.95	12.0
2	0.29	28.0	30.0	1.147	5.86	12.0	24.0	30.1	1.147	5.42	14.0
3	0.59	33.0	30.1	1.147	6.36	13.0	28.0	30.0	1.147	5.86	14.0
4	1.41	30.0	30.2	1.147	6.06	12.0	26.0	30.0	1.147	5.64	13.0
5	1.71	24.0	30.2	1.147	5.42	14.0	23.0	30.0	1.147	5.31	12.0
6	1.91	20.0	30.2	1.147	4.95	14.0	19.0	30.1	1.147	4.83	10.0

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID) - MEASUREMENT UNCERTAINTY

(1 of 1)

Performance characteristics (Uncertainty Components)	Uncertainty	Value	Units
Standard Uncertainty on the coefficient of the Pitot Tube	u(k)	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	u(Δpi)	1.074	Pa
- Resolution	u(res)	0.00087	
- Calibration	u(cal)	0.062	
- Drift	u(drift)	0.083	
- Lack of Fit	u(fit)	0.007	
- Overall corrections to dynamic measurements	u(Cf)	0.153	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00003	-
- φO_2,w	-	20.246	
- φCO_2,w	-	0.058	
- Oxygen, dry	u(ϕO_2,d)	0.644	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.002	
- Water Vapour	u(ϕH_2O)	0.191	
- Oxygen, wet	u(ϕO_2,w)	0.621	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.002	
Standard uncertainty associated with the stack temperature	u(Tc)	1.546	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.694	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	0.759	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00618	-
Standard uncertainty associated with the local velocities	u(vi)	0.124	Pa
Standard uncertainty associated with the mean velocity	u(v)	0.041	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	0.080	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	1.47	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	2926.0	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00059	
- $u^2(qV,w)$	-	2228549	
- u(qV,w)	-	1492.8	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	4.76	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Belt Dryer No.1

Sample Runs

Parameter	Units	Run 1	Run 2		Mean
Concentration	mg/m³	4.0	2.8		3.4
Uncertainty	±mg/m³	1.7	1.7		1.7
Mass Emission	g/hr	306	215		261
Uncertainty	±g/hr	133	129		131

Parameter	Units	Run 1	Run 2		Mean
Water Vapour	% v/v	3.8	4.4		4.1
Uncertainty	±% v/v	0.22	0.24		0.23

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	1.3		1.3

General Sampling Information

Parameter	Value	
Standard	EN 13284-1	
Technical Procedure	CAT-TP-01	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Glass Fibre	
Number of Sampling Lines Used	1 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 12	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A3	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	Run 2	
Absolute pressure of stack gas, P_s				
Barometric pressure, P_b	mmHg	762.0	762.0	
Stack static pressure, P_{static}	mmH_2O	2.0	2.0	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	762.2	762.2	
Volume of water vapour collected, V_{wstd}				
Total mass collected in impingers (liquid trap)	g	9.4	14.4	
Total mass collected in impingers (silica trap)	g	4.2	1.6	
Total mass of liquid collected, V_{lc}	g	13.6	16.0	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0169	0.0199	
Volume of gas metered dry, V_{mstd}				
Volume of gas sample through gas meter, V_m	m^3	0.4570	0.4650	
Gas meter correction factor, Y_d	-	1.0180	1.0180	
Average dry gas meter temperature, T_m	°C	26.0	25.1	
Average pressure drop across orifice, ΔH	mmH_2O	25.3	23.2	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.4269	0.4356	
Moisture content, B_{wo} & R_{wv}				
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0382	0.0438	
B_{wo} as a percentage	% v/v	3.82	4.38	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	3.82	4.38	
Volume of gas metered wet, V_{mstw}				
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	0.4439	0.4556	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$				
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	N/A	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	N/A	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	N/A	
Molecular weight of dry gas stream, M_d				
CO_2 (Estimated)	% v/v	0.06	0.06	
O_2	% v/v	21.07	21.10	
Total	% v/v	21.13	21.16	
N_2	% v/v	78.87	78.84	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.85	28.85	
Molecular weight of stack gas (wet), M_s				
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.44	28.38	
Velocity of stack gas, V_s				
Pitot tube velocity constant, K_p	-	34.97	34.97	
Velocity pressure coefficient, C_p	-	0.84	0.84	
Average of velocity heads, ΔP_{avg}	mmH_2O	8.27	7.60	
Average square root of velocity heads, $\sqrt{\Delta P}$	$\sqrt{mmH_2O}$	2.88	2.76	
Average stack gas temperature, T_s	°C	30.0	30.0	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s + 273})) / (\sqrt{(M_s)(P_s)})$	m/s	9.99	9.58	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})				
Area of stack, A_s	m^2	3.14	3.14	
$Q_a = (60)(A_s)(V_s)$	m^3/min	1882.6	1806.9	
Conversion factor (K/mm.Hg), C_f	-	0.3592	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	1700.9	1632.6	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	1636.0	1561.2	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	N/A	
Percent isokinetic, %I				
Nozzle diameter, D_n	mm	5.90	5.90	
Nozzle area, A_n	mm^2	27.34	27.34	
Total sampling time, q	min	30	30	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	100.0	106.9	

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	Run 2	
Sampling Times	-	14:53 - 15:23	15:40 - 16:10	
Sampling Dates	-	13/06/2018	13/06/2018	
Sampling Device	-	ISO	ISO	
Volume Sampled (REF)	m³	0.4439	0.4556	
Filter I.D. Number	-	47-50224	47-51013	
Start Filter Mass	g	0.14805	0.14628	
End Filter Mass	g	0.14934	0.14675	
Total Mass on Filter	g	0.00129	0.00047	
Probe Rinse I.D. Number	-	PR-47-50224	PR-47-51013	
Start Probe Rinse Mass	g	2.74241	2.57773	
End Probe Rinse Mass	g	2.74287	2.57853	
Total Mass in Probe Rinse	g	0.00046	0.00080	
Total Mass Collected	mg	1.75	1.27	
Calculated Concentration	mg/m³	3.95	2.78	
Balance Uncertainty / LOD	mg/m³	0.43	0.42	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	13/06/2018	
Average Volume Sampled (REF)	m³	0.4497	
Filter I.D. Number	-	47-51014	
Start Filter Mass	g	0.14939	
End Filter Mass	g	0.14977	
Total Mass on Filter	g	0.00038	
Probe Rinse I.D. Number	-	PR-47-51014	
Start Probe Rinse Mass	g	2.59436	
End Probe Rinse Mass	g	2.59456	
Total Mass in Probe Rinse	g	0.00020	
Total Mass Collected	mg	0.58	
Calculated Concentration	mg/m³	1.29	
Balance Uncertainty / LOD	mg/m³	0.42	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1	Run 2	
Mean Sampling Rate	l/min	15.51	15.78	
Pre-Sampling Leak Rate	l/min	0.13	0.14	
Post-Sampling Leak Rate	l/min	0.14	0.13	
Allowable Leak Rate	l/min	0.31	0.32	
Leak Test Acceptable	-	Yes	Yes	

Water Droplets	Units	Run 1	Run 2	
Are Water Droplets Present	-	No	No	

MU (Concurrent Water Vapour)	Units	Run 1	Run 2	
Measurement Uncertainty (MU)	%	5.7	5.5	
Allowable MU	%	20	20	
MU Acceptable	%	Yes	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	Run 2	
Less than 50% Faded	%	Yes	Yes	

Isokinetic Criterion Compliance	Units	Run 1	Run 2	
Isokinetic Variation	%	100.0	106.9	
Allowable Isokinetic Range	%	95 - 115	95 - 115	
Isokineticity Acceptable	-	Yes	Yes	

Weighing Uncertainty Criteria	Units	Run 1	Run 2	
Overall Weighing Uncertainty	± mg	0.33	0.33	
Overall Weighing Uncertainty	± mg/m³	0.73	0.71	
ELV [Daily ELV for IED]	mg/m³	N/A	N/A	
Allowable Weighing Uncertainty	mg/m³	N/A	N/A	
Weighing Uncertainty Acceptable	-	N/A	N/A	

Filter Temperatures	Units	Run 1	Run 2	
Pre-Conditioning Temperature	°C	180	180	
Post-Conditioning Temperature	°C	160	160	
Maximum Filter Temperature	°C	30	30	

Test Conditions	Units	Run 1	Run 2	
Ambient Temperature Recorded?	-	Yes	Yes	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	15.00
Pre-Sampling Leak Rate	l/min	0.11
Post-Sampling Leak Rate	l/min	0.14
Allowable Leak Rate	l/min	0.30
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m^3	N/A
Blank Acceptable	-	N/A

Acetone / Water Rinse Blank	Units	Blank
Acetone / Water Rinse Value	mg/l	2.7
Allowable Blank	mg/l	10
Blank Acceptable	-	Yes

Method Deviations

Nature of Deviation (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number 1	Run Number 2
Due to the restricted access, it was not possible to sample at all of the sample points on the available sampling lines.	x	x

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value			Standard uncertainty			
	Symbol	Run 1	Run 2	Symbol	Units	Run 1	Run 2
Sampled Volume (Actual)	V_m	0.4570	0.4650	uV_m	m^3	0.0091	0.0093
Sampled Gas Temperature	T_m	299.0	298.1	uT_m	K	2.0	2.0
Sampled Gas Pressure	ρ_m	101.6	101.6	$u\rho_m$	kPa	0.5	0.5
Sampled Gas Humidity	H_m	0.0	0.0	uH_m	% v/v	1.0	1.0
Leak	L	0.90	0.82	uL	%	-	-
Mass of Particulate	m	1.75	1.27	um	mg	0.19	0.19
Uncollected Mass	UCM	0.58	0.58	uUCM	mg	-	-

Measured Quantities	Uncertainty as a Percentage			
	Units	Run 1	Run 2	Requirement of Standard
Sampled Volume (Actual)	%	2.00	2.00	≤2%
Sampled Gas Temperature	%	0.67	0.67	≤1%
Sampled Gas Pressure	%	0.49	0.49	≤1%
Sampled Gas Humidity	%	1.00	1.00	≤1%
Leak	%	0.90	0.82	≤2%
Mass of Particulate	%	-	-	<5% of ELV
Uncollected Mass	%	-	-	-

Measured Quantities	Uncertainty in Measurement Units				Sensitivity Coefficient	
	Symbol	Units	Run 1	Run 2	Run 1	Run 2
Sampled Volume (STP)	V_m	m^3	0.4269	0.4356	9.25	6.38
Leak	L	mg/m^3	0.021	0.013	1.00	1.00
Mass of Particulate	L_r	mg	1.753	1.267	2.25	2.20
Uncollected Mass	UCM	mg	0.33	0.33	2.25	2.20

Measured Quantities	Uncertainty in Result		
	Units	Run 1	Run 2
Sampled Volume (STP)	mg/m^3	0.099	0.070
Leak	mg/m^3	0.0206	0.0132
Mass of Particulate	mg/m^3	0.4281	0.4171
Uncollected Mass	mg/m^3	0.7544	0.7350

Measured Quantities	Oxygen Correction Part of MU Budget		
	Units	Run 1	Run 2
O_2 Correction Factor	-	N/A	N/A
Stack Gas O_2 Content	% v/v	N/A	N/A
MU for O_2 Correction	-	N/A	N/A
Overall MU For O_2 Measurement	%	N/A	N/A

Parameter	Units	Run 1	Run 2
Combined uncertainty	mg/m^3	0.87	0.85
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	1.71	1.66
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	1.71	1.66
Reported Uncertainty	mg/m^3	1.71	1.66
Expanded uncertainty (95% confidence), without Oxygen Correction	%	43.3	59.8
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	43.3	59.8
Reported Uncertainty	%	43.3	59.8

PM_{10}: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Belt Dryer No.1

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.94		0.94
Uncertainty	±mg/m³	0.60		0.60
Mass Emission	g/hr	72.4		72.4
Uncertainty	±g/hr	46.2		46.2

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	3.6		3.6
Uncertainty	±% v/v	0.18		0.18

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.28		0.28

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	BS EN ISO 23210	
Technical Procedure	CAT-TP-18	
Sizing Device	TCR Tecora MSSI 3-Stage Cascade Impactor	
Sizing Device Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A3	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

PM_{10}: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	762.0	
Stack static pressure, P_{static}	mmH_2O	2.0	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	762.2	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	22.1	
Total mass collected in impingers (silica trap)	g	5.2	
Total mass of liquid collected, V_{lc}	g	27.3	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0340	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	0.9380	
Gas meter correction factor, Y_d	-	1.0180	
Average dry gas meter temperature, T_m	°C	17.1	
Average pressure drop across orifice, ΔH	mmH_2O	192.7	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.9176	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0357	
B_{wo} as a percentage	% v/v	3.57	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	3.57	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	0.9516	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2 (Estimated)	% v/v	0.06	
O_2	% v/v	20.94	
Total	% v/v	21.00	
N_2	% v/v	79.00	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.85	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.46	
Velocity of stack gas, V_{spt}			
Velocity pressure coefficient, C_p	-	0.84	
Average stack gas temperature, T_s	°C	30.0	
Velocity of stack gas (pre-test from traverse), V_{spt}	m/s	5.37	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	3.14	
$Q_a = (60)(A_s)(V_s)$	m^3/min	1012.6	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	914.9	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	882.2	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	11.91	
Nozzle area, A_n	mm^2	111.36	
Total sampling time, q	min	30	
Velocity at nozzle, V_n	m/s	5.21	
$\%I = V_n / V_{spt} \times 100$	%	97.0	

PM_{10}: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	09:48 - 10:18	
Sampling Dates	-	14/06/2018	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	0.9516	
2nd Stage of Cascade Impactor (PM_{10} to $PM_{2.5}$)			
Filter I.D. Number (2nd Stage)	-	PM2 - 01613	
Start Filter Mass (2nd Stage)	g	0.11849	
End Filter Mass (2nd Stage)	g	0.11873	
Total Mass	g	0.00024	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3 - 01613	
Start Filter Mass (3rd Stage)	g	0.15439	
End Filter Mass (3rd Stage)	g	0.15504	
Total Mass	g	0.00065	
Total Mass Collected	mg	0.89	
Calculated Concentration	mg/m^3	0.94	
Balance Uncertainty / LOD	mg/m^3	0.28	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	14/06/2018	
Average Volume Sampled (REF)	m^3	0.9516	
2nd Stage of Cascade Impactor (PM_{10} to $PM_{2.5}$)			
Filter I.D. Number (2nd Stage)	-	PM2 - 01706	
Start Filter Mass (2nd Stage)	g	0.13087	
End Filter Mass (2nd Stage)	g	0.13093	
Total Mass	g	0.00006	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3 - 01706	
Start Filter Mass (3rd Stage)	g	0.15429	
End Filter Mass (3rd Stage)	g	0.15438	
Total Mass	g	0.00009	
Total Mass Collected	mg	0.15	
Calculated Concentration	mg/m^3	0.16	
Balance Uncertainty / LOD	mg/m^3	0.28	

PM_{10}: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1	
Expected Sampling Rate	l/min	40.00	
Pre-Sampling Leak Rate	l/min	0.11	
Allowable Leak Rate	l/min	0.80	
Leak Test Acceptable	-	Yes	

Water Droplets	Units	Run 1	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	Units	Run 1	
Measurement Uncertainty (MU)	%	5.0	
Allowable MU	%	20	
MU Acceptable	%	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	
Less than 50% Faded	%	Yes	

Isokinetic Criterion Compliance	Units	Run 1	
Isokinetic Variation	%	97.0	
Allowable Isokinetic Range	%	90 - 130	
Isokineticity Acceptable	-	Yes	

Filter Temperatures	Units	Run 1	
Pre-Conditioning Temperature	°C	180	
Post-Conditioning Temperature	°C	160	
Maximum Filter Temperature	°C	30	

Test Conditions	Units	Run 1	
Ambient Temperature Recorded?	-	Yes	

Cut Size	Units	Run 1	
D_{50} Cut Size	µm	10.00	
Allowable D_{50} Cut Size	µm	9 - 11	
D_{50} Cut Size Acceptable	-	Yes	

PM_{10}: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	40.00	
Pre-Sampling Leak Rate	l/min	0.19	
Allowable Leak Rate	l/min	0.80	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m³	N/A	
Blank Acceptable	-	N/A	

Method Deviations

Nature of Deviation	Run Number	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	1	
There are no deviations associated with the sampling employed.	wx	

PM_{10}: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value				Standard uncertainty			
Measured Quantities	**Symbol**	**Run 1**			**Symbol**	**Units**	**Run 1**	
Sampled Volume (Actual)	V_m	0.9380			uV_m	m^3	0.0188	
Sampled Gas Temperature	T_m	290.1			uT_m	K	2.0	
Sampled Gas Pressure	ρ_m	101.6			$u\rho_m$	kPa	0.5	
Sampled Gas Humidity	H_m	0.0			uH_m	% v/v	1.0	
Leak	L	0.28			uL	%	-	
Mass of Particulate	m	0.89			um	mg	0.27	
Uncollected Mass	UCM	0.15			uUCM	mg	-	
Particulate Sizing	PS	10.00			uPS	%	-	

	Uncertainty as a Percentage			
Measured Quantities	**Units**	**Run 1**		**Requirement of Standard**
Sampled Volume (Actual)	%	2.0000		≤2%
Sampled Gas Temperature	%	0.7		≤1%
Sampled Gas Pressure	%	0.5		≤1%
Sampled Gas Humidity	%	1.0		≤1%
Leak	%	0.28		≤2%
Mass of Particulate	%	-		<5% of ELV
Uncollected Mass	%	-		-
Particulate Sizing	%	10.00		-

	Uncertainty in Measurement Units					Sensitivity Coefficient	
Measured Quantities	**Symbol**	**Units**	**Run 1**			**Run 1**	
Sampled Volume (STP)	V_m	m^3	0.9176			1.02	
Leak	L	mg/m^3	0.001			1.00	
Mass of Particulate	L_r	mg	0.890			1.05	
Uncollected Mass	UCM	mg	0.09			1.05	
Particulate Sizing	PS	mg	0.05			1.00	

	Uncertainty in Result		
Measured Quantities	**Units**	**Run 1**	
Sampled Volume (STP)	mg/m^3	0.023	
Leak	mg/m^3	0.0015	
Mass of Particulate	mg/m^3	0.2837	
Uncollected Mass	mg/m^3	0.0910	
Particulate Sizing	mg/m^3	0.0540	

	Oxygen Correction Part of MU Budget		
Measured Quantities	**Units**	**Run 1**	
O_2 Correction Factor	-	N/A	
Stack Gas O_2 Content	% v/v	N/A	
MU for O_2 Correction	-	N/A	
Overall MU For O_2 Measurement	%	N/A	

Parameter	**Units**	**Run 1**	
Combined uncertainty	mg/m^3	0.30	
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.60	
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.60	
Reported Uncertainty	mg/m^3	0.60	
Expanded uncertainty (95% confidence), without Oxygen Correction	%	63.6	
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	63.6	
Reported Uncertainty	%	63.6	

$PM_{2.5}$: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Belt Dryer No.1

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.68		0.68
Uncertainty	±mg/m³	0.69		0.69
Mass Emission	g/hr	52.9		52.9
Uncertainty	±g/hr	53.7		53.7

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	3.6		3.6
Uncertainty	±% v/v	0.18		0.18

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.35		0.35

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	BS EN ISO 23210	
Technical Procedure	CAT-TP-18	
Sizing Device	TCR Tecora MSSI 3-Stage Cascade Impactor	
Sizing Device Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A3	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

$PM_{2.5}$: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	762.0	
Stack static pressure, P_{static}	mmH_2O	2.0	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	762.2	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	22.1	
Total mass collected in impingers (silica trap)	g	5.2	
Total mass of liquid collected, V_{lc}	g	27.3	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0340	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	0.9380	
Gas meter correction factor, Y_d	-	1.0180	
Average dry gas meter temperature, T_m	°C	17.1	
Average pressure drop across orifice, ΔH	mmH_2O	192.7	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.9176	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0357	
B_{wo} as a percentage	% v/v	3.57	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	3.57	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	0.9516	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet (O_{2REFw}) = (21 - $REF\%O_2$) / (21 - $ACT\%O_{2w}$)	-	N/A	
O_2 Reference Factor dry (O_{2REFd}) = (21 - $REF\%O_2$) / (21 - $ACT\%O_{2d}$)	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2 (Estimated)	% v/v	0.06	
O_2	% v/v	20.94	
Total	% v/v	21.00	
N_2	% v/v	79.00	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.85	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.46	
Velocity of stack gas, V_{spt}			
Velocity pressure coefficient, C_p	-	0.84	
Average stack gas temperature, T_s	°C	30.0	
Velocity of stack gas (pre-test from traverse), V_{spt}	m/s	5.37	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	3.14	
$Q_a = (60)(A_s)(V_s)$	m^3/min	1012.6	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	914.9	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	882.2	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	11.91	
Nozzle area, A_n	mm^2	111.36	
Total sampling time, q	min	30	
Velocity at nozzle, V_n	m/s	5.21	
$\%I = V_n / V_{spt} \times 100$	%	97.0	

$PM_{2.5}$: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	09:48 - 10:18	
Sampling Dates	-	14/06/2018	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	0.9516	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3 - 01613	
Start Filter Mass (3rd Stage)	g	0.15439	
End Filter Mass (3rd Stage)	g	0.15504	
Total Mass	g	0.00065	
Total Mass Collected	mg	0.65	
Calculated Concentration	mg/m^3	0.68	
Balance Uncertainty / LOD	mg/m^3	0.35	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	14/06/2018	
Average Volume Sampled (REF)	m^3	0.9516	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3 - 01706	
Start Filter Mass (3rd Stage)	g	0.15429	
End Filter Mass (3rd Stage)	g	0.15438	
Total Mass	g	0.00009	
Total Mass Collected	mg	0.09	
Calculated Concentration	mg/m^3	0.09	
Balance Uncertainty / LOD	mg/m^3	0.35	

$PM_{2.5}$: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	**Units**	**Run 1**	
Expected Sampling Rate	l/min	40.00	
Pre-Sampling Leak Rate	l/min	0.11	
Allowable Leak Rate	l/min	0.80	
Leak Test Acceptable	-	Yes	

Water Droplets	**Units**	**Run 1**	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	**Units**	**Run 1**	
Measurement Uncertainty (MU)	%	5.0	
Allowable MU	%	20	
MU Acceptable	%	Yes	

Silica Gel (Concurrent Water Vapour)	**Units**	**Run 1**	
Less than 50% Faded	%	Yes	

Isokinetic Criterion Compliance	**Units**	**Run 1**	
Isokinetic Variation	%	97.0	
Allowable Isokinetic Range	%	90 - 130	
Isokineticity Acceptable	-	Yes	

Filter Temperatures	**Units**	**Run 1**	
Pre-Conditioning Temperature	°C	180	
Post-Conditioning Temperature	°C	160	
Maximum Filter Temperature	°C	30	

Test Conditions	**Units**	**Run 1**	
Ambient Temperature Recorded?	-	Yes	

Cut Size	**Units**	**Run 1**	
D_{50} Cut Size	µm	2.52	
Allowable D_{50} Cut Size	µm	2.25 - 2.75	
D_{50} Cut Size Acceptable	-	Yes	

$PM_{2.5}$: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	40.00	
Pre-Sampling Leak Rate	l/min	0.19	
Allowable Leak Rate	l/min	0.80	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m^3	N/A	
Blank Acceptable	-	N/A	

Method Deviations

Nature of Deviation	Run Number	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	1	
There are no deviations associated with the sampling employed.	wx	

$PM_{2.5}$: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value			Standard uncertainty		
Measured Quantities	Symbol	Run 1		Symbol	Units	Run 1
Sampled Volume (Actual)	V_m	0.9380		uV_m	m^3	0.0188
Sampled Gas Temperature	T_m	290.1		uT_m	K	2.0
Sampled Gas Pressure	ρ_m	101.6		$u\rho_m$	kPa	0.5
Sampled Gas Humidity	H_m	0.0		uH_m	% v/v	1.0
Leak	L	0.28		uL	%	-
Mass of Particulate	m	0.65		um	mg	0.33
Uncollected Mass	UCM	0.09		uUCM	mg	-
Particulate Sizing	PS	10.00		uPS	%	-

	Uncertainty as a Percentage		
Measured Quantities	Units	Run 1	Requirement of Standard
Sampled Volume (Actual)	%	2.0000	≤2%
Sampled Gas Temperature	%	0.7	≤1%
Sampled Gas Pressure	%	0.5	≤1%
Sampled Gas Humidity	%	1.0	≤1%
Leak	%	0.28	≤2%
Mass of Particulate	%	-	<5% of ELV
Uncollected Mass	%	-	-
Particulate Sizing	%	10.00	-

	Uncertainty in Measurement Units			Sensitivity Coefficient
Measured Quantities	Symbol	Units	Run 1	Run 1
Sampled Volume (STP)	V_m	m^3	0.9176	0.74
Leak	L	mg/m^3	0.001	1.00
Mass of Particulate	L_r	mg	0.650	1.05
Uncollected Mass	UCM	mg	0.05	1.05
Particulate Sizing	PS	mg	0.04	1.00

	Uncertainty in Result	
Measured Quantities	Units	Run 1
Sampled Volume (STP)	mg/m^3	0.017
Leak	mg/m^3	0.0011
Mass of Particulate	mg/m^3	0.3468
Uncollected Mass	mg/m^3	0.0546
Particulate Sizing	mg/m^3	0.0394

	Oxygen Correction Part of MU Budget	
Measured Quantities	Units	Run 1
O_2 Correction Factor	-	N/A
Stack Gas O_2 Content	% v/v	N/A
MU for O_2 Correction	-	N/A
Overall MU For O_2 Measurement	%	N/A

Parameter	Units	Run 1
Combined uncertainty	mg/m^3	0.35
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.69
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.69
Reported Uncertainty	mg/m^3	0.69
Expanded uncertainty (95% confidence)	%	101.5
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	101.5
Reported Uncertainty	%	101.5

OXYGEN: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Belt Dryer No.1

Sample Runs

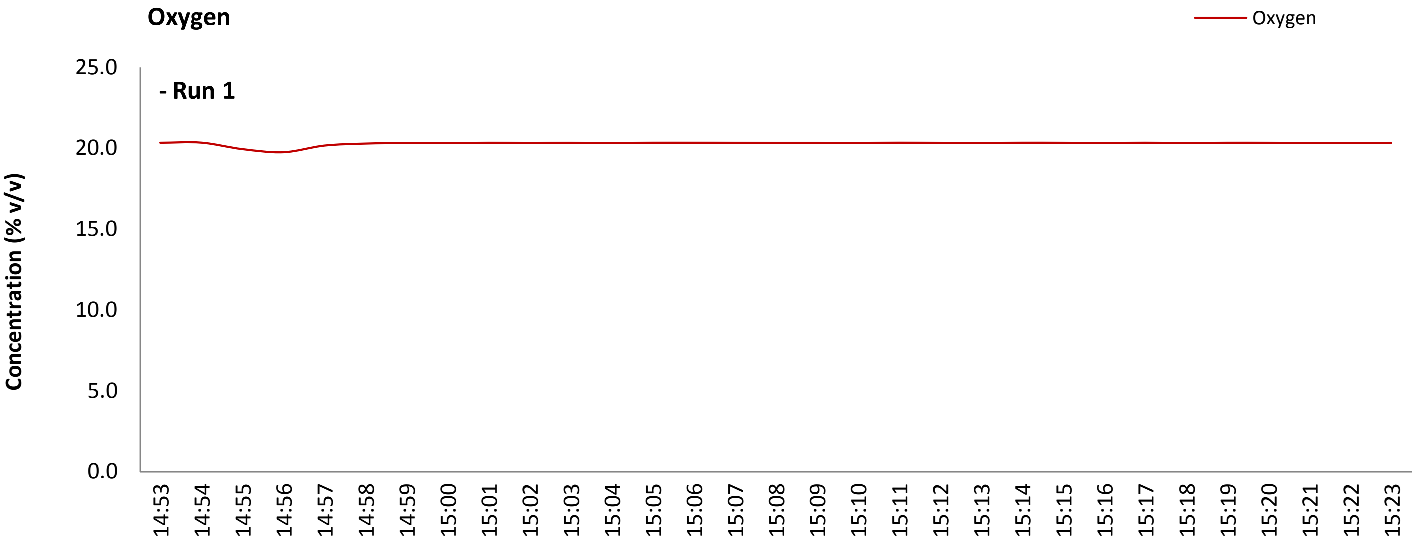
Parameter	Units	Run 1	Run 2	Run 3	Mean
Concentration	% v/v	20.3	20.3	20.2	20.2
Uncertainty	±% v/v	0.51	0.51	0.52	0.51

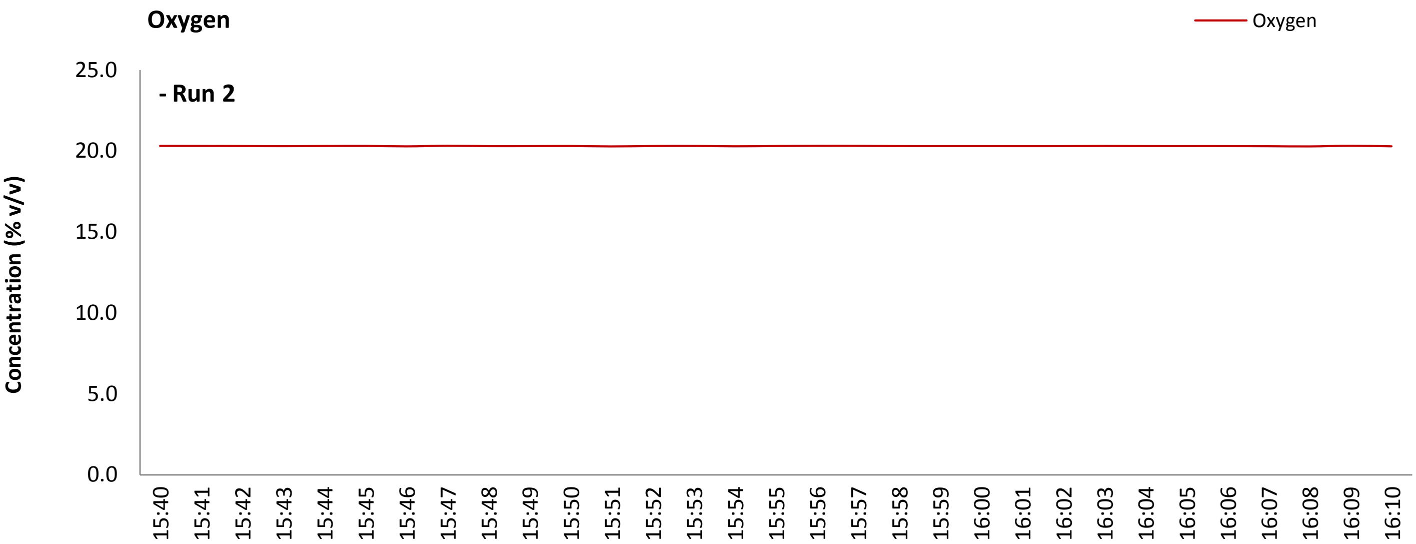
General Sampling Information

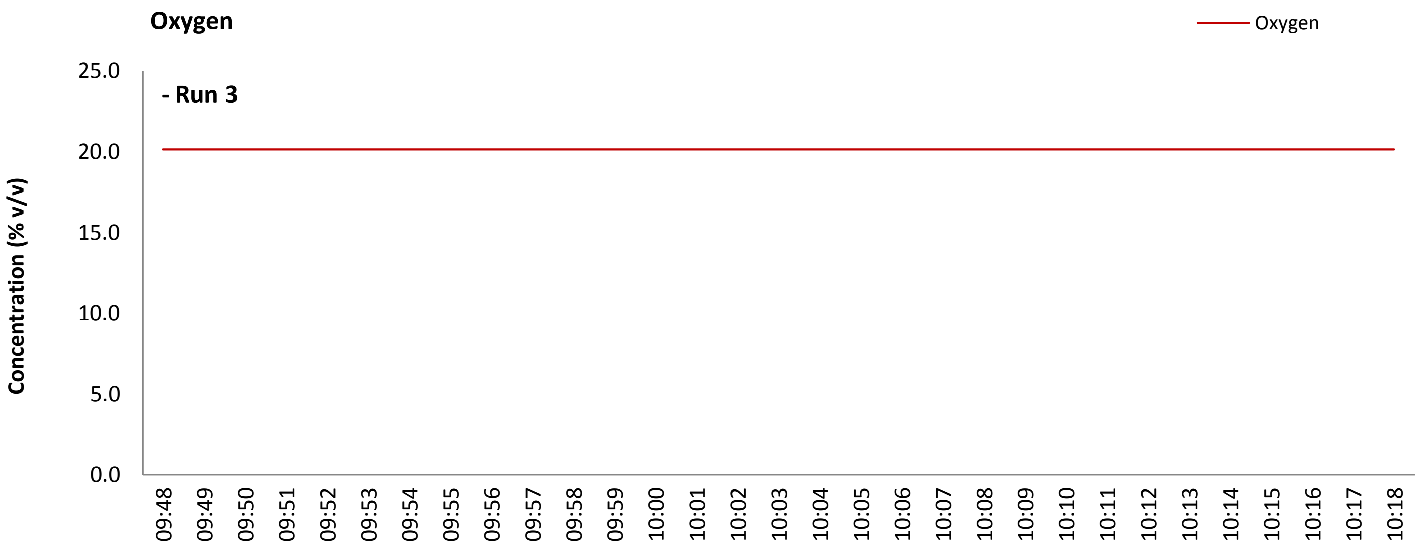
Parameter	Value	
Standard	EN 14789	
Technical Procedure	CAT-TP-21	
Probe Material	Titanium	
Filtration Type / Size	0.3µm Plane Glass Fibre	
Heated Head Filter Used	No	
Heated Line Temperature	Orsat Used	
Span Gas Type	Synthetic Air (5 Grade)	
Span Gas Reference Number	CYL 11.0307	
Span Gas Expiry Date	11/10/2022	
Span Gas Start Pressure (bar)	50	
Gas Cylinder Concentration (% v/v)	21.62	
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A3	

OXYGEN: DATA TREND

Graphical Trend of Data







OXYGEN: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	Run 2	Run 3
Sampling Times	-	14:53 - 15:23	15:40 - 16:10	09:48 - 10:18
Sampling Dates	-	13/06/2018	13/06/2018	14/06/2018
Instrument Range	% v/v	25	25	25
Span Gas Value	% v/v	21.62	21.62	21.62

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	Run 2	Run 3
Average Temperature	°C	N/A	N/A	N/A
Allowable Temperature	< °C	N/A	N/A	N/A
Temperature Acceptable	-	N/A	N/A	N/A

	Zero Drift	Units	Run 1	Run 2	Run 3
CAL 1	Zero at Analyser (Pre)	% v/v	0.00	0.00	0.00
CAL 1	Zero at Analyser (Post)	% v/v	0.04	0.04	0.04
CAL 1	Zero Drift	% v/v	0.04	0.04	0.04
	Allowable Zero Drift	± % v/v	1.08	1.08	1.08
	Zero Drift Acceptable	-	Yes	Yes	Yes

	Span Drift	Units	Run 1	Run 2	Run 3
CAL 1	Span at Analyser (Pre)	% v/v	21.62	21.60	21.62
CAL 1	Span at Analyser (Post)	% v/v	21.62	21.62	21.66
CAL 1	Span Drift	% v/v	0.00	0.00	0.04
	Allowable Span Drift	± % v/v	1.08	1.08	1.08
	Span Drift Acceptable	-	Yes	Yes	Yes

Test Conditions	Units	Run 1	Run 2	Run 3
Run Ambient Temperature Range	°C	22 - 24	22 - 24	20 - 22

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	2	3
There are no deviations associated with the sampling employed.	x	x	x

OXYGEN: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	RUN 2	RUN 3	Units
Limit value	N/A	N/A	N/A	%vol
TGN M2 Allowable MU	6.0	6.0	6.0	%
Measured concentration	21.07	21.10	20.94	%vol
Range Used	25.0	25.0	25.0	%vol
Cal gas conc.	21.6	21.6	21.6	%vol

Performance characteristics	RUN 1	RUN 2	RUN 3	Units
Response time	60	60	60	seconds
Number of readings in measurement	30	30	30	-
Repeatability at zero	0.04	0.04	0.04	% full scale
Repeatability at span level	0.04	0.04	0.04	% full scale
Deviation from linearity	0.11	0.11	0.11	% of value
Zero drift	0.19	0.19	0.19	% full scale
Span drift	0.00	0.00	0.19	% full scale
Volume or pressure flow dependence	0.20	0.20	0.20	% of full scale
Atmospheric pressure dependence	0.30	0.30	0.30	% of value/kPa
Ambient temperature dependence	-0.07	-0.07	-0.07	% full scale/10K
Combined interference	0.56	0.56	0.56	% range
Dependence on voltage	0.02	0.02	0.02	% full scale/10V
Losses in the line (leak)	0.09	0.09	0.09	% of value
Uncertainty of calibration gas	2.00	2.00	2.00	% of value

Performance characteristic	RUN 1	RUN 2	RUN 3	Units
Standard deviation of repeatability at zero	use rep at span	use rep at span	use rep at span	%vol
Standard deviation of repeatability at span level	0.01	0.01	0.01	%vol
Lack of fit	0.02	0.02	0.02	%vol
Drift	0.02	0.02	0.05	%vol
Volume or pressure flow dependence	0.00	0.00	0.00	%vol
Atmospheric pressure dependence	0.02	0.02	0.02	%vol
Ambient temperature dependence	-0.01	-0.01	-0.01	%vol
Combined interference (from MCERTS Certificate)	0.08	0.08	0.08	%vol
Dependence on voltage	0.00	0.00	0.00	%vol
Losses in the line (leak)	0.01	0.01	0.01	%vol
Uncertainty of calibration gas	0.24	0.24	0.24	%vol

			RUN 1	RUN 2	RUN 3	Units
Measurement uncertainty		**Result**	21.07	21.10	20.94	%vol
Combined uncertainty			0.27	0.27	0.27	%vol
Expanded uncertainty	k =	1.96	0.53	0.53	0.54	%vol

	RUN 1	RUN 2	RUN 3	Units
Expanded uncertainty (no O_2) - at 95% Confidence	2.53	2.53	2.56	% of Value
Result of Compliance with Uncertainty Requirement in M2	**COMPLIANT**	**COMPLIANT**	**COMPLIANT**	-

Requirement for SRM is that Uncertainty should be 0.5%vol absolute or 6% relative whichever is the lower, on a dry gas basis. Ref EA TGN M2.

Exova Catalyst, Unit C6, Emery Court, The Embankment Business Park, Heaton Mersey, Stockport, SK4 3GL
E: toby.campbell@exova.com
Your Exova Catalyst Contact: Toby Campbell (07825 130 074)

Stack Emissions Testing Report Commissioned by
Newbridge Energy Ltd

Installation Name & Address
Blazers Fuels Ltd
Brickfield Lane
Ruthin
Denbighshire
North Wales
LL15 2TN

Stack Reference
Belt Dryer No. 2

Dates of the Monitoring Campaign
14th June 2018

Job Reference Number
CAT-4238

Report Written by
Brian Jacob Team Leader MCERTS Level 2 MM 06 693 TE1 TE2 TE3 TE4

Report Approved by
Michelle Edwards Team Leader MCERTS Level 2 MM 05 659 TE1 TE2 TE3 TE4

Report Date
19th June 2018

Version
Version 1

Signature of Report Approver
MEdwards

CONTENTS

Opinions and interpretations expressed herein are outside the scope of Exova Catalyst's ISO 17025 accreditation.

Executive Summary

(Page 1 of 7)

MONITORING OBJECTIVES

Blazers Fuels Ltd, Ruthin
Belt Dryer No. 2
14th June 2018

Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by Newbridge Energy Ltd to carry out stack emissions testing for Blazers Fuels Ltd on the Belt Dryer No. 2 at Ruthin.

The aim of the monitoring campaign was to perform testing, as requested by the customer, for a number of prescribed pollutants. There are no emission limits set for any of the pollutants at this time.

Special Requirements

There were no special requirements.

Target Parameters

Total Particulate Matter, PM_{10}, $PM_{2.5}$

MONITORING RESULTS

Blazers Fuels Ltd, Ruthin
Belt Dryer No. 2
14th June 2018

where MU = Measurement Uncertainty associated with the Result

Parameter				Concentration Units	Concentration Result		Concentration MU +/-	Concentration Limit	Mass Emission Units	Mass Emission Result	Mass Emission MU +/-	Mass Emission Limit
Total Particulate Matter			[1]	mg/m^3		7.5	2.6	-	g/hr	1780	620	-
PM_{10}			[1]	mg/m^3		0.24	0.72	-	g/hr	56.7	171	-
$PM_{2.5}$			[1]	mg/m^3		0.29	0.87	-	g/hr	69.3	206	-
Oxygen	% v/v	Wet	19.96	% v/v	Dry	20.9	0.53					
Water Vapour				% v/v		4.7	0.24					
Stack Gas Temperature				°C		30.0						
Stack Gas Velocity				m/s		23.1	0.21					
Volumetric Flow Rate (ACTUAL)				m^3/hr		261631	12079					
Volumetric Flow Rate (REF)			[1]	m^3/hr		237738	10976					

NOTE: VOLUMETRIC FLOW RATE & VELOCITY DATA TAKEN FROM AN AVERAGE OF ALL OF THE ISOKINETIC RUNS.

[1] Reference Conditions (REF) are: 273K, 101.3kPa, without correction for water vapour content.

MONITORING DATE(S) & TIMES

Blazers Fuels Ltd, Ruthin
Belt Dryer No. 2
14th June 2018

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m³	3.0	g/hr	702	14/06/2018	10:55 - 11:25	30
Total Particulate Matter	R2	mg/m³	12.0	g/hr	2859	14/06/2018	11:35 - 12:05	30
PM_{10}	R1	mg/m³	0.24	g/hr	56.7	14/06/2018	12:14 - 12:44	30
$PM_{2.5}$	R1	mg/m³	0.29	g/hr	69.3	14/06/2018	12:14 - 12:44	30
Oxygen	R1	% v/v	20.0			14/06/2018	10:55 - 11:25	30
Oxygen	R2	% v/v	20.0			14/06/2018	11:35 - 12:05	30
Oxygen	R3	% v/v	19.9			14/06/2018	12:14 - 12:44	30
Velocity Traverse	R1					14/06/2018	10:10 - 10:30	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Blazers Fuels Ltd, Ruthin
Belt Dryer No. 2
14th June 2018

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operation
Capacity (of 100%) and Tonnes / Hour	4 - 5 Tonne / Hour
Continuous or Batch Process	Continuous
Feedstock (if applicable)	Wood Chips
Abatement System	N/A
Abatement System Running Status	N/A
Fuel	Waste Heat From CHP
Plume Appearance	None Visible

MONITORING & ANALYTICAL METHODS

Blazers Fuels Ltd, Ruthin
Belt Dryer No. 2
14th June 2018

	Monitoring				Analysis					
Parameter	**Standard**	**Technical Procedure**	**ISO 17025 Testing**	**Testing Lab**	**Analytical Procedure**	**Analytical Technique**	**ISO 17025 Analysis**	**Analysis Lab**	**MCERTS Testing**	**LOD (Average)**
Total Particulate Matter	EN 13284-1	CAT-TP-01	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.4 mg/m³
PM_{10}	BS EN ISO 23210	CAT-TP-18	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.24 mg/m³
$PM_{2.5}$	BS EN ISO 23210	CAT-TP-18	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.29 mg/m³
Water Vapour	EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.1 % v/v
Oxygen	EN 14789	CAT-TP-21	Yes	CAT	Dry Zirconia Cell by Horiba PG-250				Yes	0.1 %
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41	Yes	CAT	Pitot Tube and Thermocouple				Yes	1.2 m/s

ANALYSIS LABORATORIES

(with short name reference as appears in the table above)

Exova Catalyst (CAT)	ISO 17025 Accreditation Number: 4279

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
Total Particulate Matter	All Runs	Due to the restricted access, it was not possible to sample at all of the sample points on the available sampling lines.
Total Particulate Matter	All Runs	In order to maintain isokinetic sampling, a nozzle size smaller than that specified in the Standard was used.
Total Particulate Matter / PM_{10} / $PM_{2.5}$	All Runs	The sample points where the angle of swirl was > 15° were omitted from the sampling exercise.

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	2.00
Width	m	-
Area	m²	3.14
Port Depth	cm	15
Orientation of Duct	-	Vertical
Number of Ports	-	2
Sample Port Size	-	4" BSP

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	MEWP
Inside / Outside	Outside

Platform Details

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	No
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	Yes
Platform has vertical base boards (approx. 0.25m high)	Yes
Platform has chains / self closing gates at top of ladders	Yes
There are no obstructions present which hamper insertion of sampling equipment	No
Safe Access Available	Yes
Easy Access Available	Yes

Sampling Location / Platform Improvement Recommendations

The sampling location does not meet all of the Flow Criteria requirements in the Environment Agency's Technical Guidance Note M1 and EN 15259 (see Validation Criteria Table below).

EN 15259 Homogeneity Test Requirements

There is no requirement to perform a EN 15259 Homogeneity Test on this Stack.

Sampling Plane Validation Criteria (from EN 15259)

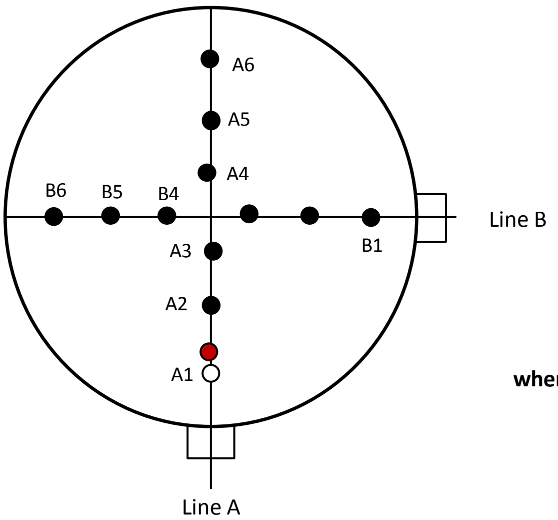
Criteria in EN 15259	Units	Traverse 1		Required	Compliant
Lowest Differential Pressure	Pa	370.0		> 5 Pa	Yes
Mean Velocity	m/s	22.35		-	-
Lowest Gas Velocity	m/s	21.22		-	-
Highest Gas Velocity	m/s	23.30		-	-
Ratio of Above	: 1	1.10		< 3 : 1	Yes
Maximum Angle of Swirl	°	23		< 15°	No
No Local Negative Flow	-	Yes		-	Yes

PLANT PHOTOS

Photo 1

Photo 2

SAMPLE POINTS



where ○ = isokinetic point sampled at

● = isokinetic point not sampled at

● = combustion gases sample point

● = non-isokinetic sample point

APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Brian Jacob	MCERTS Level 2	MM 06 693	TE1 TE2 TE3 TE4
Trainee	Danny Williams	MCERTS Trainee	Pending	None

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	CAT 7.39
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.10
Box Thermocouples (2)	-
Umbilical (1)	CAT 3.10
Umbilical (2)	-
Oven Box (1)	-
Oven Box (2)	-
Heated Probe (1)	CAT 5.7
Heated Probe (2)	-
Heated Probe (3)	-
S-Pitot (1)	CAT 21p.43
S-Pitot (2)	-
L-Pitot	-
Site Balance	CAT 17.13
500g / 1Kg Check Weights	CAT 17.13
Last Impinger Arm	-
Callipers	CAT 23.10
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-250	CAT 9.11
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Testo 350 XL	-
JCT JCC P1 Cooler	CAT 4.135
Gasmet DX4000	-
Gasmet Sampling System	-
Bernath 3006 FID	-
M&C PSS	CAT 12.93
Mass Flow Controller (1)	CAT 6.3
Mass Flow Controller (2)	CAT 6.4
Mass View (1)	-
Mass View (2)	-
Easylogger EN-EL-12 Bit	-
Easylogger EN-EL-12 Bit	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer (1)	CAT 3.25
Digital Manometer (2)	-
Digital Temperature Meter	CAT 3.25
Stopwatch	CAT 14.53
Barometer	CAT 13.20
Stack Thermocouple (1)	CAT 4.140
Stack Thermocouple (2)	-
Stack Thermocouple (3)	-
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	-
20m Heated Line (1)	CAT 20.69
20m Heated Line (2)	-
Dual Channel Heater Controller	-
Single Channel Heater Controller	-
Laboratory Balance	CAT 1.18 / 1.18a
Tape Measure	CAT 16.14

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	EN 13284-1	CAT-TP-01
PM_{10}	BS EN ISO 23210	CAT-TP-18
$PM_{2.5}$	BS EN ISO 23210	CAT-TP-18
Water Vapour	EN 14790	CAT-TP-05
Oxygen	EN 14789	CAT-TP-21
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41

PRELIMINARY STACK SURVEY: CALCULATIONS

General Stack Details

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	2.00
Stack Width, W	m	-
Stack Area, A	m²	3.14
Average Stack Gas Temperature, T_a	°C	30.3
Average Stack Gas Pressure	Pa	410.8
Average Stack Static Pressure, P_{static}	kPa	2.179
Average Barometric Pressure, P_b	kPa	100.6
Average Pitot Tube Calibration Coefficient, C_p	-	0.84

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m³ p	Conc kg/m³ p_i
CO_2 (Estimated)	-	0.06	0.06	0.0006	44.01	1.9635	0.00118
O_2	-	20.94	19.96	0.2094	32.00	1.4277	0.29900
N_2	-	79.00	75.28	0.7900	28.01	1.2498	0.98734
Moisture (H_2O)	-	-	4.71	0.0471	18.02	0.8037	0.03786

Where: p = M / 22.41

p_i = r x p

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m³	1.288
Wet Density (STP), P_{STW}	kg/m³	1.265
Dry Density (Actual), P_{Actual}	kg/m³	1.176
Average Wet Density (Actual), $P_{ActualW}$	kg/m³	1.155

Where: P_{STD} = sum of component concentrations, kg/m³ (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m³ (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (at each sampling point) = $P_{STW} \times (T_s / P_s) \times (P_a / T_a)$

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF [1]
Temperature	°C	30.3	0.0
Total Pressure	kPa	102.8	101.3
Moisture	%	4.71	4.71

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m³/hr	252750
Gas Volumetric Flowrate (STP, Wet)	m³/hr	230852
Gas Volumetric Flowrate (STP, Dry)	m³/hr	219979
Gas Volumetric Flowrate REF [1]	m³/hr	230852

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID)

(1 of 1)

Parameter	Units	Value
Date of Survey	-	14/06/2018
Time of Survey	-	10:10 - 10:30
Atmospheric Pressure	kPa	100.6
Average Stack Static Pressure	Pa	2179
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 200 (500Pa)	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C_p	-	0.84
Number of Lines Available	-	2
Number of Lines Used	-	2

		Sampling Line A					Sampling Line B				
Traverse Point	**Depth m**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**
STATIC (Units: Pa)		*2145.0*					*2212.0*				
Mean		**410.8**	**30.2**	**1.155**	**22.35**		**410.7**	**30.3**	**1.155**	**22.34**	
1	0.09	400.0	30.1	1.156	22.06	14.0	370.0	30.3	1.155	21.22	15.0
2	0.29	420.0	30.2	1.155	22.60	14.0	389.0	30.3	1.155	21.76	20.0
3	0.59	440.0	30.2	1.155	23.14	14.0	422.0	30.2	1.155	22.66	23.0
4	1.41	440.0	30.3	1.155	23.14	13.0	436.0	30.3	1.155	23.03	18.0
5	1.71	389.0	30.3	1.155	21.76	14.0	446.0	30.3	1.155	23.30	14.0
6	1.91	376.0	30.3	1.155	21.39	14.0	401.0	30.3	1.155	22.09	15.0

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID) - MEASUREMENT UNCERTAINTY

(1 of 1)

Performance characteristics (Uncertainty Components)	**Uncertainty**	**Value**	**Units**
Standard Uncertainty on the coefficient of the Pitot Tube	u(k)	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	u(Δpi)	7.891	Pa
- Resolution	u(res)	0.00087	
- Calibration	u(cal)	17.567	
- Drift	u(drift)	0.083	
- Lack of Fit	u(fit)	43.617	
- Overall corrections to dynamic measurements	u(Cf)	61.268	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00003	-
- φO_2,w	-	19.957	
- φCO_2,w	-	0.057	
- Oxygen, dry	u(ϕO_2,d)	0.641	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.002	
- Water Vapour	u(ϕH_2O)	0.240	
- Oxygen, wet	u(ϕO_2,w)	0.613	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.002	
Standard uncertainty associated with the stack temperature	u(Tc)	1.547	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.781	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	5.580	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00622	-
Standard uncertainty associated with the local velocities	u(vi)	0.231	Pa
Standard uncertainty associated with the mean velocity	u(v)	0.104	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	0.203	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	0.91	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	11668.6	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00055	
- $u^2(qV,w)$	-	35442408	
- u(qV,w)	-	5953.4	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	4.62	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Belt Dryer No. 2

Sample Runs

Parameter	Units	Run 1	Run 2		Mean
Concentration	mg/m³	3.0	12.0		7.5
Uncertainty	±mg/m³	2.5	2.7		2.6
Mass Emission	g/hr	702	2859		1780
Uncertainty	±g/hr	591	650		620

Parameter	Units	Run 1	Run 2		Mean
Water Vapour	% v/v	5.0	4.6		4.8
Uncertainty	±% v/v	0.27	0.25		0.26

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	1.1		1.1

General Sampling Information

Parameter	Value	
Standard	EN 13284-1	
Technical Procedure	CAT-TP-01	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Glass Fibre	
Number of Sampling Lines Used	1 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 12	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	Run 2
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	754.5	754.5
Stack static pressure, P_{static}	mmH_2O	224.3	224.3
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	771.0	771.0
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	15.0	11.2
Total mass collected in impingers (silica trap)	g	4.1	6.1
Total mass of liquid collected, V_{lc}	g	19.1	17.3
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0238	0.0216
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	0.4740	0.4760
Gas meter correction factor, Y_d	-	1.0180	1.0180
Average dry gas meter temperature, T_m	°C	19.8	20.9
Average pressure drop across orifice, ΔH	mmH_2O	28.7	28.5
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.4479	0.4481
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0505	0.0459
B_{wo} as a percentage	% v/v	5.05	4.59
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	5.04	4.59
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	0.4717	0.4696
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	No
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	N/A
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	N/A
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	N/A
O_2 Reference Factor wet (O_{2REFw}) = (21 - $REF\%O_2$) / (21 - $ACT\%O_{2w}$)	-	N/A	N/A
O_2 Reference Factor dry (O_{2REFd}) = (21 - $REF\%O_2$) / (21 - $ACT\%O_{2d}$)	-	N/A	N/A
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	N/A
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	N/A
Molecular weight of dry gas stream, M_d			
CO_2 (Estimated)	% v/v	0.06	0.06
O_2	% v/v	20.95	20.96
Total	% v/v	21.01	21.02
N_2	% v/v	78.99	78.98
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.85	28.85
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.30	28.35
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	-	34.97	34.97
Velocity pressure coefficient, C_p	-	0.84	0.84
Average of velocity heads, ΔP_{avg}	mmH_2O	43.43	43.00
Average square root of velocity heads, $\sqrt{\Delta P}$	$\sqrt{mmH_2O}$	6.59	6.56
Average stack gas temperature, T_s	°C	30.0	30.0
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s + 273})) / (\sqrt{(M_s)(P_s)})$	m/s	22.81	22.68
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	3.14	3.14
$Q_a = (60)(A_s)(V_s)$	m^3/min	4300.5	4275.4
Conversion factor (K/mm.Hg), C_f	-	0.3592	0.3592
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	3930.7	3907.8
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	3732.4	3728.4
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	N/A
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	N/A
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	4.02	4.02
Nozzle area, A_n	mm^2	12.69	12.69
Total sampling time, q	min	30	30
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	99.0	99.1

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	Run 2	
Sampling Times	-	10:55 - 11:25	11:35 - 12:05	
Sampling Dates	-	14/06/2018	14/06/2018	
Sampling Device	-	ISO	ISO	
Volume Sampled (REF)	m^3	0.4719	0.4696	
Filter I.D. Number	-	47-50386	47-48600	
Start Filter Mass	g	0.14802	0.15968	
End Filter Mass	g	0.14908	0.16429	
Total Mass on Filter	g	0.00106	0.00461	
Probe Rinse I.D. Number	-	PR-47-50386	PR-47-48600	
Start Probe Rinse Mass	g	2.72826	2.90723	
End Probe Rinse Mass	g	2.72859	2.90827	
Total Mass in Probe Rinse	g	0.00033	0.00104	
Total Mass Collected	mg	1.39	5.65	
Calculated Concentration	mg/m^3	2.95	12.02	
Balance Uncertainty / LOD	mg/m^3	0.40	0.40	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	14/06/2018	
Average Volume Sampled (REF)	m^3	0.4707	
Filter I.D. Number	-	47-49819	
Start Filter Mass	g	0.15065	
End Filter Mass	g	0.15114	
Total Mass on Filter	g	0.00049	
Probe Rinse I.D. Number	-	PR-47-49819	
Start Probe Rinse Mass	g	2.86523	
End Probe Rinse Mass	g	2.86526	
Total Mass in Probe Rinse	g	0.00004	
Total Mass Collected	mg	0.53	
Calculated Concentration	mg/m^3	1.13	
Balance Uncertainty / LOD	mg/m^3	0.40	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1	Run 2
Mean Sampling Rate	l/min	16.08	16.15
Pre-Sampling Leak Rate	l/min	0.10	0.19
Post-Sampling Leak Rate	l/min	0.11	0.21
Allowable Leak Rate	l/min	0.32	0.32
Leak Test Acceptable	-	Yes	Yes

Water Droplets	Units	Run 1	Run 2
Are Water Droplets Present	-	No	No

MU (Concurrent Water Vapour)	Units	Run 1	Run 2
Measurement Uncertainty (MU)	%	5.3	5.5
Allowable MU	%	20	20
MU Acceptable	%	Yes	Yes

Silica Gel (Concurrent Water Vapour)	Units	Run 1	Run 2
Less than 50% Faded	%	Yes	Yes

Isokinetic Criterion Compliance	Units	Run 1	Run 2
Isokinetic Variation	%	99.0	99.1
Allowable Isokinetic Range	%	95 - 115	95 - 115
Isokineticity Acceptable	-	Yes	Yes

Weighing Uncertainty Criteria	Units	Run 1	Run 2
Overall Weighing Uncertainty	± mg	0.33	0.33
Overall Weighing Uncertainty	± mg/m³	0.69	0.69
ELV [Daily ELV for IED]	mg/m³	N/A	N/A
Allowable Weighing Uncertainty	mg/m³	N/A	N/A
Weighing Uncertainty Acceptable	-	N/A	N/A

Filter Temperatures	Units	Run 1	Run 2
Pre-Conditioning Temperature	°C	180	180
Post-Conditioning Temperature	°C	160	160
Maximum Filter Temperature	°C	30	30

Test Conditions	Units	Run 1	Run 2
Ambient Temperature Recorded?	-	Yes	Yes

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	15.00	
Pre-Sampling Leak Rate	l/min	0.11	
Post-Sampling Leak Rate	l/min	0.14	
Allowable Leak Rate	l/min	0.30	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m^3	N/A	
Blank Acceptable	-	N/A	

Acetone / Water Rinse Blank	Units	Blank
Acetone / Water Rinse Value	mg/l	2.7
Allowable Blank	mg/l	10
Blank Acceptable	-	Yes

Method Deviations

Nature of Deviation	Run Number		
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	1	2	
Due to the restricted access, it was not possible to sample at all of the sample points on the available sampling lines.	x	x	
In order to maintain isokinetic sampling, a nozzle size smaller than that specified in the Standard was used.	x	x	
The sample points where the angle of swirl was > 15° were omitted from the sampling exercise.	x	x	

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value Symbol	Value Run 1	Value Run 2		Standard uncertainty Symbol	Units	Run 1	Run 2
Sampled Volume (Actual)	V_m	0.4740	0.4760		uV_m	m³	0.0095	0.0095
Sampled Gas Temperature	T_m	292.8	293.9		uT_m	K	2.0	2.0
Sampled Gas Pressure	ρ_m	102.8	102.8		$u\rho_m$	kPa	0.5	0.5
Sampled Gas Humidity	H_m	0.0	0.0		uH_m	% v/v	1.0	1.0
Leak	L	0.68	1.30		uL	%	-	-
Mass of Particulate	m	1.39	5.65		um	mg	0.19	0.19
Uncollected Mass	UCM	0.53	0.53		uUCM	mg	-	-

Measured Quantities	Uncertainty as a Percentage Units	Run 1	Run 2	Requirement of Standard
Sampled Volume (Actual)	%	2.00	2.00	≤2%
Sampled Gas Temperature	%	0.68	0.68	≤1%
Sampled Gas Pressure	%	0.49	0.49	≤1%
Sampled Gas Humidity	%	1.00	1.00	≤1%
Leak	%	0.68	1.30	≤2%
Mass of Particulate	%	-	-	<5% of ELV
Uncollected Mass	%	-	-	-

Measured Quantities	Uncertainty in Measurement Units Symbol	Units	Run 1	Run 2	Sensitivity Coefficient Run 1	Sensitivity Coefficient Run 2
Sampled Volume (STP)	V_m	m³	0.4481	0.4481	6.59	26.84
Leak	L	mg/m³	0.012	0.090	1.00	1.00
Mass of Particulate	L_r	mg	1.393	5.647	2.12	2.13
Uncollected Mass	UCM	mg	0.31	0.31	2.12	2.13

Measured Quantities	Uncertainty in Result Units	Run 1	Run 2
Sampled Volume (STP)	mg/m³	0.073	0.300
Leak	mg/m³	0.0117	0.0903
Mass of Particulate	mg/m³	0.4026	0.4046
Uncollected Mass	mg/m³	0.6485	0.6516

Measured Quantities	Oxygen Correction Part of MU Budget Units	Run 1	Run 2
O_2 Correction Factor	-	N/A	N/A
Stack Gas O_2 Content	% v/v	N/A	N/A
MU for O_2 Correction	-	N/A	N/A
Overall MU For O_2 Measurement	%	N/A	N/A

Parameter	Units	Run 1	Run 2
Combined uncertainty	mg/m³	0.77	0.83
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m³	1.50	1.62
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m³	N/A	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m³	2.48	2.68
Reported Uncertainty	mg/m³	2.48	2.68
Expanded uncertainty (95% confidence), without Oxygen Correction	%	50.9	13.5
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	84.0	22.3
Reported Uncertainty	%	84.0	22.3

PM_{10}: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Belt Dryer No. 2

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.24		0.24
Uncertainty	±mg/m³	0.72		0.72
Mass Emission	g/hr	56.7		56.7
Uncertainty	±g/hr	171		171

NOTE: Where the maximum Blank concentration is higher than the Sample concentration, the maximum Blank concentration has been reported.

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	4.7		4.7
Uncertainty	±% v/v	0.23		0.23

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.24		0.24

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	BS EN ISO 23210	
Technical Procedure	CAT-TP-18	
Sizing Device	TCR Tecora MSSI 3-Stage Cascade Impactor	
Sizing Device Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

PM_{10}: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	762.0	
Stack static pressure, P_{static}	mmH_2O	2.0	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	762.2	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	35.6	
Total mass collected in impingers (silica trap)	g	6.7	
Total mass of liquid collected, V_{lc}	g	42.3	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0527	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	1.1170	
Gas meter correction factor, Y_d	-	1.0180	
Average dry gas meter temperature, T_m	°C	20.8	
Average pressure drop across orifice, ΔH	mmH_2O	192.7	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	1.0791	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0466	
B_{wo} as a percentage	% v/v	4.66	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	4.66	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	1.1318	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet (O_{2REFw}) = (21 - $REF\%O_2$) / (21 - $ACT\%O_{2w}$)	-	N/A	
O_2 Reference Factor dry (O_{2REFd}) = (21 - $REF\%O_2$) / (21 - $ACT\%O_{2d}$)	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2 (Estimated)	% v/v	0.06	
O_2	% v/v	20.80	
Total	% v/v	20.86	
N_2	% v/v	79.14	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.84	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.34	
Velocity of stack gas, V_{spt}			
Velocity pressure coefficient, C_p	-	0.84	
Average stack gas temperature, T_s	°C	30.0	
Velocity of stack gas (pre-test from traverse), V_{spt}	m/s	23.52	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	3.14	
$Q_a = (60)(A_s)(V_s)$	m^3/min	4433.1	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	4005.4	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	3818.8	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	5.93	
Nozzle area, A_n	mm^2	27.65	
Total sampling time, q	min	30	
Velocity at nozzle, V_n	m/s	25.16	
$\%I = V_n / V_{spt} \times 100$	%	107.0	

PM_{10}: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	12:14 - 12:44	
Sampling Dates	-	14/06/2018	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	1.1318	
2nd Stage of Cascade Impactor (PM_{10} to $PM_{2.5}$)			
Filter I.D. Number (2nd Stage)	-	PM2-01700	
Start Filter Mass (2nd Stage)	g	0.13260	
End Filter Mass (2nd Stage)	g	0.13264	
Total Mass	g	0.00004	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3-01700	
Start Filter Mass (3rd Stage)	g	0.14933	
End Filter Mass (3rd Stage)	g	0.14932	
Total Mass	g	-0.00001	
Total Mass Collected	mg	0.03	
Calculated Concentration	mg/m^3	0.03	
Balance Uncertainty / LOD	mg/m^3	0.24	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	14/06/2018	
Average Volume Sampled (REF)	m^3	1.1318	
2nd Stage of Cascade Impactor (PM_{10} to $PM_{2.5}$)			
Filter I.D. Number (2nd Stage)	-	PM2-01697	
Start Filter Mass (2nd Stage)	g	0.13210	
End Filter Mass (2nd Stage)	g	0.13212	
Total Mass	g	0.00002	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3-01697	
Start Filter Mass (3rd Stage)	g	0.15477	
End Filter Mass (3rd Stage)	g	0.15485	
Total Mass	g	0.00008	
Total Mass Collected	mg	0.10	
Calculated Concentration	mg/m^3	0.09	
Balance Uncertainty / LOD	mg/m^3	0.24	

PM_{10}: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	**Units**	**Run 1**	
Expected Sampling Rate	l/min	40.00	
Pre-Sampling Leak Rate	l/min	0.11	
Allowable Leak Rate	l/min	0.80	
Leak Test Acceptable	-	Yes	

Water Droplets	**Units**	**Run 1**	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	**Units**	**Run 1**	
Measurement Uncertainty (MU)	%	5.0	
Allowable MU	%	20	
MU Acceptable	%	Yes	

Silica Gel (Concurrent Water Vapour)	**Units**	**Run 1**	
Less than 50% Faded	%	Yes	

Isokinetic Criterion Compliance	**Units**	**Run 1**	
Isokinetic Variation	%	107.0	
Allowable Isokinetic Range	%	90 - 130	
Isokineticity Acceptable	-	Yes	

Filter Temperatures	**Units**	**Run 1**	
Pre-Conditioning Temperature	°C	180	
Post-Conditioning Temperature	°C	160	
Maximum Filter Temperature	°C	30	

Test Conditions	**Units**	**Run 1**	
Ambient Temperature Recorded?	-	Yes	

Cut Size	**Units**	**Run 1**	
D_{50} Cut Size	µm	10.00	
Allowable D_{50} Cut Size	µm	9 - 11	
D_{50} Cut Size Acceptable	-	Yes	

PM_{10}: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	40.00	
Pre-Sampling Leak Rate	l/min	0.19	
Allowable Leak Rate	l/min	0.80	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m^3	N/A	
Blank Acceptable	-	N/A	

Method Deviations

Nature of Deviation (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number 1	
One out of two sampling lines was used due to sampling location restrictions.	x	
Due to the restricted access, it was not possible to sample at all of the sample points on the available sampling lines.	x	
The sample points where the angle of swirl was > 15° were omitted from the sampling exercise.	x	

PM_{10}: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value				Standard uncertainty			
Measured Quantities	**Symbol**	**Run 1**			**Symbol**	**Units**	**Run 1**	
Sampled Volume (Actual)	V_m	1.1170			uV_m	m^3	0.0223	
Sampled Gas Temperature	T_m	293.8			uT_m	K	2.0	
Sampled Gas Pressure	ρ_m	101.6			$u\rho_m$	kPa	0.5	
Sampled Gas Humidity	H_m	0.0			uH_m	% v/v	1.0	
Leak	L	0.28			uL	%	-	
Mass of Particulate	m	0.27			um	mg	0.27	
Uncollected Mass	UCM	0.10			uUCM	mg	-	
Particulate Sizing	PS	10.00			uPS	%	-	

	Uncertainty as a Percentage			
Measured Quantities	**Units**	**Run 1**		**Requirement of Standard**
Sampled Volume (Actual)	%	2.0000		≤2%
Sampled Gas Temperature	%	0.7		≤1%
Sampled Gas Pressure	%	0.5		≤1%
Sampled Gas Humidity	%	1.0		≤1%
Leak	%	0.28		≤2%
Mass of Particulate	%	-		<5% of ELV
Uncollected Mass	%	-		-
Particulate Sizing	%	10.00		-

	Uncertainty in Measurement Units					Sensitivity Coefficient	
Measured Quantities	**Symbol**	**Units**	**Run 1**			**Run 1**	
Sampled Volume (STP)	V_m	m^3	1.0791			0.22	
Leak	L	mg/m^3	0.000			1.00	
Mass of Particulate	L_r	mg	0.270			0.88	
Uncollected Mass	UCM	mg	0.06			0.88	
Particulate Sizing	PS	mg	0.01			1.00	

	Uncertainty in Result		
Measured Quantities	**Units**	**Run 1**	
Sampled Volume (STP)	mg/m^3	0.006	
Leak	mg/m^3	0.0004	
Mass of Particulate	mg/m^3	0.2386	
Uncollected Mass	mg/m^3	0.0510	
Particulate Sizing	mg/m^3	0.0138	

	Oxygen Correction Part of MU Budget		
Measured Quantities	**Units**	**Run 1**	
O_2 Correction Factor	-	N/A	
Stack Gas O_2 Content	% v/v	N/A	
MU for O_2 Correction	-	N/A	
Overall MU For O_2 Measurement	%	N/A	

Parameter	**Units**	**Run 1**	
Combined uncertainty	mg/m^3	0.24	
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.48	
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.72	
Reported Uncertainty	mg/m^3	0.72	
Expanded uncertainty (95% confidence), without Oxygen Correction	%	200.8	
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	301.2	
Reported Uncertainty	%	301.2	

$PM_{2.5}$: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Belt Dryer No. 2

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.29		0.29
Uncertainty	±mg/m³	0.87		0.87
Mass Emission	g/hr	69.3		69.3
Uncertainty	±g/hr	206		206

NOTE: Where the maximum Blank concentration is higher than the Sample concentration, the maximum Blank concentration has been reported.

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	4.7		4.7
Uncertainty	±% v/v	0.23		0.23

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.29		0.29

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	BS EN ISO 23210	
Technical Procedure	CAT-TP-18	
Sizing Device	TCR Tecora MSSI 3-Stage Cascade Impactor	
Sizing Device Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

$PM_{2.5}$: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	762.0	
Stack static pressure, P_{static}	mmH_2O	2.0	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	762.2	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	35.6	
Total mass collected in impingers (silica trap)	g	6.7	
Total mass of liquid collected, V_{lc}	g	42.3	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0527	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	1.1170	
Gas meter correction factor, Y_d	-	1.0180	
Average dry gas meter temperature, T_m	°C	20.8	
Average pressure drop across orifice, ΔH	mmH_2O	192.7	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	1.0791	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0466	
B_{wo} as a percentage	% v/v	4.66	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	4.66	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	1.1318	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2 (Estimated)	% v/v	0.06	
O_2	% v/v	20.80	
Total	% v/v	20.86	
N_2	% v/v	79.14	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.84	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.34	
Velocity of stack gas, V_{spt}			
Velocity pressure coefficient, C_p	-	0.84	
Average stack gas temperature, T_s	°C	30.0	
Velocity of stack gas (pre-test from traverse), V_{spt}	m/s	23.52	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	3.14	
$Q_a = (60)(A_s)(V_s)$	m^3/min	4433.1	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	4005.4	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	3818.8	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	5.93	
Nozzle area, A_n	mm^2	27.65	
Total sampling time, q	min	30	
Velocity at nozzle, V_n	m/s	25.16	
$\%I = V_n / V_{spt} \times 100$	%	107.0	

$PM_{2.5}$: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	12:14 - 12:44	
Sampling Dates	-	14/06/2018	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	1.1318	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3-01700	
Start Filter Mass (3rd Stage)	g	0.14933	
End Filter Mass (3rd Stage)	g	0.14932	
Total Mass	g	-0.00001	
Total Mass Collected	mg	-0.01	
Calculated Concentration	mg/m^3	-0.01	
Balance Uncertainty / LOD	mg/m^3	0.29	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	14/06/2018	
Average Volume Sampled (REF)	m^3	1.1318	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3-01697	
Start Filter Mass (3rd Stage)	g	0.15477	
End Filter Mass (3rd Stage)	g	0.15485	
Total Mass	g	0.00008	
Total Mass Collected	mg	0.08	
Calculated Concentration	mg/m^3	0.07	
Balance Uncertainty / LOD	mg/m^3	0.29	

$PM_{2.5}$: QUALITY ASSURANCE

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Sample Runs

Leak Test Results	Units	Run 1	
Expected Sampling Rate	l/min	40.00	
Pre-Sampling Leak Rate	l/min	0.11	
Allowable Leak Rate	l/min	0.80	
Leak Test Acceptable	-	Yes	

Water Droplets	Units	Run 1	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	Units	Run 1	
Measurement Uncertainty (MU)	%	5.0	
Allowable MU	%	20	
MU Acceptable	%	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	
Less than 50% Faded	%	Yes	

Isokinetic Criterion Compliance	Units	Run 1	
Isokinetic Variation	%	107.0	
Allowable Isokinetic Range	%	90 - 130	
Isokineticity Acceptable	-	Yes	

Filter Temperatures	Units	Run 1	
Pre-Conditioning Temperature	°C	180	
Post-Conditioning Temperature	°C	160	
Maximum Filter Temperature	°C	30	

Test Conditions	Units	Run 1	
Ambient Temperature Recorded?	-	Yes	

Cut Size	Units	Run 1	
D_{50} Cut Size	µm	2.52	
Allowable D_{50} Cut Size	µm	2.25 - 2.75	
D_{50} Cut Size Acceptable	-	Yes	

$PM_{2.5}$: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	40.00	
Pre-Sampling Leak Rate	l/min	0.19	
Allowable Leak Rate	l/min	0.80	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m^3	N/A	
Blank Acceptable	-	N/A	

Method Deviations

Nature of Deviation	Run Number	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	1	
One out of two sampling lines was used due to sampling location restrictions.	x	
Due to the restricted access, it was not possible to sample at all of the sample points on the available sampling lines.	x	
The sample points where the angle of swirl was > 15° were omitted from the sampling exercise.	x	

$PM_{2.5}$: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value Symbol	Value Run 1	Standard uncertainty Symbol	Units	Run 1
Sampled Volume (Actual)	V_m	1.1170	uV_m	m^3	0.0223
Sampled Gas Temperature	T_m	293.8	uT_m	K	2.0
Sampled Gas Pressure	ρ_m	101.6	$u\rho_m$	kPa	0.5
Sampled Gas Humidity	H_m	0.0	uH_m	% v/v	1.0
Leak	L	0.28	uL	%	-
Mass of Particulate	m	0.33	um	mg	0.33
Uncollected Mass	UCM	0.08	uUCM	mg	-
Particulate Sizing	PS	10.00	uPS	%	-

Measured Quantities	Uncertainty as a Percentage Units	Run 1	Requirement of Standard
Sampled Volume (Actual)	%	2.0000	≤2%
Sampled Gas Temperature	%	0.7	≤1%
Sampled Gas Pressure	%	0.5	≤1%
Sampled Gas Humidity	%	1.0	≤1%
Leak	%	0.28	≤2%
Mass of Particulate	%	-	<5% of ELV
Uncollected Mass	%	-	-
Particulate Sizing	%	10.00	-

Measured Quantities	Uncertainty in Measurement Units Symbol	Units	Run 1	Sensitivity Coefficient Run 1
Sampled Volume (STP)	V_m	m^3	1.0791	0.27
Leak	L	mg/m^3	0.000	1.00
Mass of Particulate	L_r	mg	0.330	0.88
Uncollected Mass	UCM	mg	0.05	0.88
Particulate Sizing	PS	mg	0.02	1.00

Measured Quantities	Uncertainty in Result Units	Run 1
Sampled Volume (STP)	mg/m^3	0.007
Leak	mg/m^3	0.0005
Mass of Particulate	mg/m^3	0.2916
Uncollected Mass	mg/m^3	0.0408
Particulate Sizing	mg/m^3	0.0168

Measured Quantities	Oxygen Correction Part of MU Budget Units	Run 1
O_2 Correction Factor	-	N/A
Stack Gas O_2 Content	% v/v	N/A
MU for O_2 Correction	-	N/A
Overall MU For O_2 Measurement	%	N/A

Parameter	Units	Run 1
Combined uncertainty	mg/m^3	0.29
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.58
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.87
Reported Uncertainty	mg/m^3	0.87
Expanded uncertainty (95% confidence)	%	198.3
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	297.4
Reported Uncertainty	%	297.4

OXYGEN: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Belt Dryer No. 2

Sample Runs

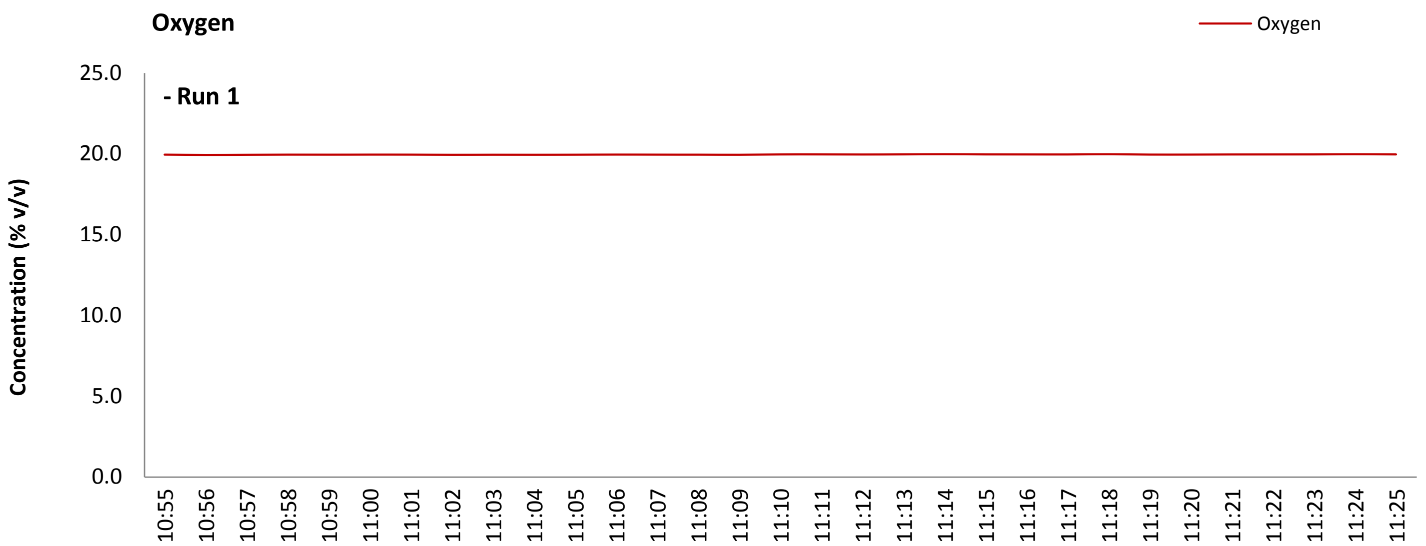
Parameter	Units	Run 1	Run 2	Run 3	Mean
Concentration	% v/v	20.0	20.0	19.9	20.0
Uncertainty	±% v/v	0.51	0.51	0.50	0.51

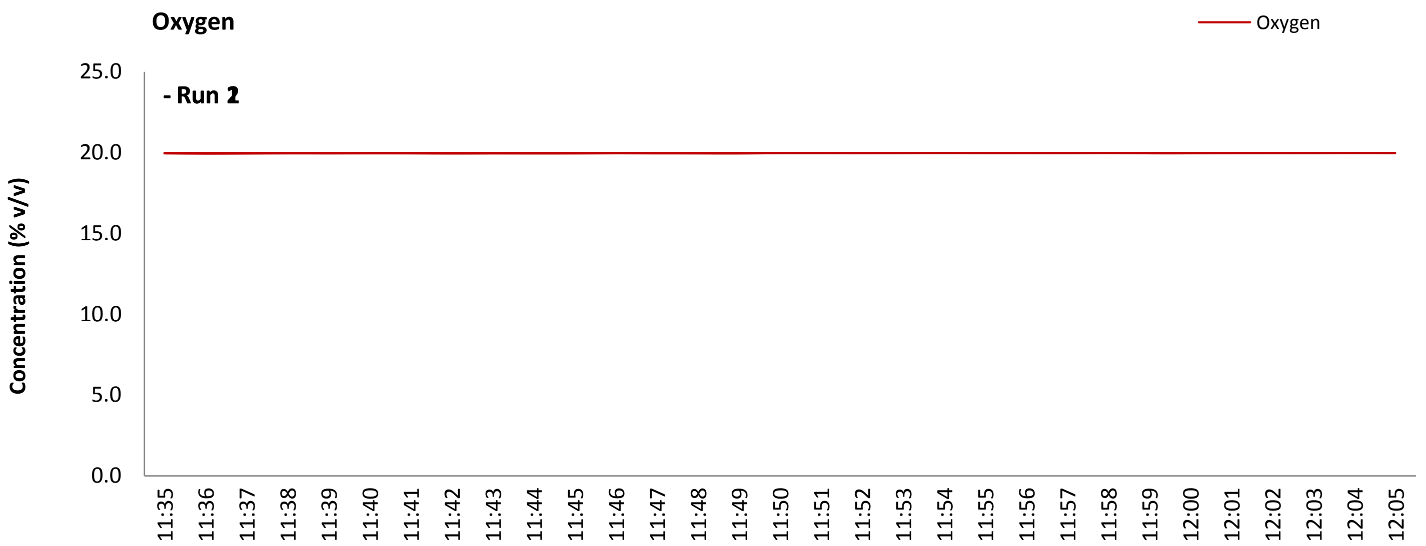
General Sampling Information

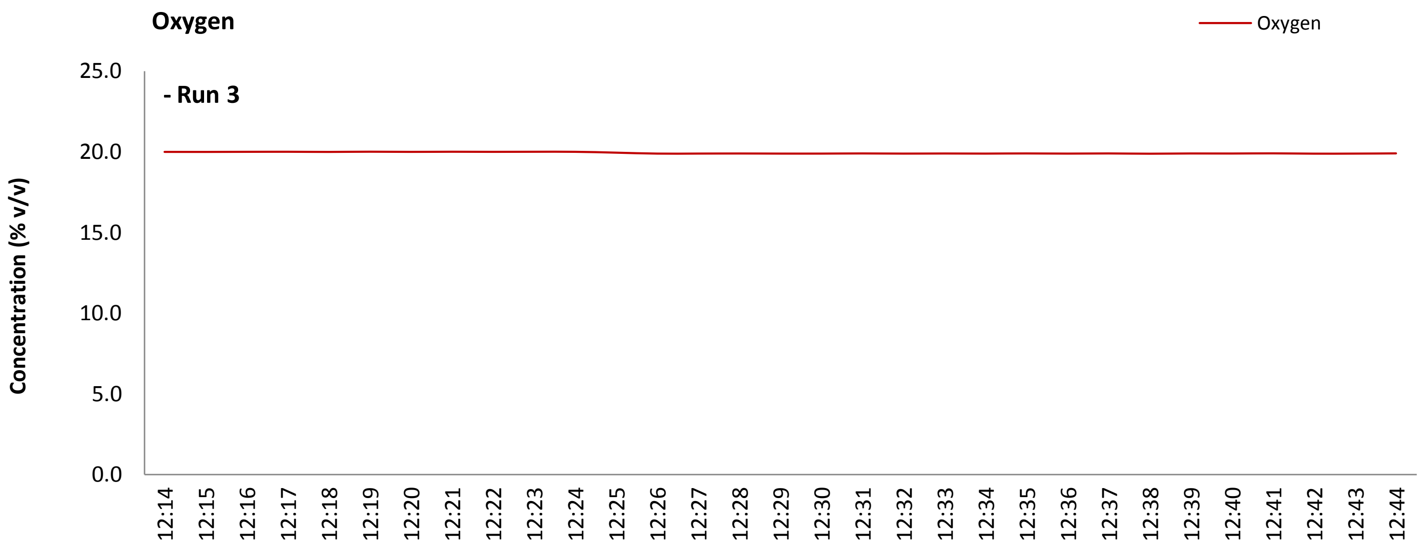
Parameter	Value	
Standard	EN 14789	
Technical Procedure	CAT-TP-21	
Probe Material	Titanium	
Filtration Type / Size	0.3µm Plane Glass Fibre	
Heated Head Filter Used	No	
Heated Line Temperature	Orsat Used	
Span Gas Type	Synthetic Air (5 Grade)	
Span Gas Reference Number	CYL 11.0307	
Span Gas Expiry Date	11/10/2022	
Span Gas Start Pressure (bar)	50	
Gas Cylinder Concentration (% v/v)	21.62	
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

OXYGEN: DATA TREND

Graphical Trend of Data







OXYGEN: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	Run 2	Run 3
Sampling Times	-	10:55 - 11:25	11:35 - 12:05	12:14 - 12:44
Sampling Dates	-	14/06/2018	14/06/2018	14/06/2018
Instrument Range	% v/v	25	25	25
Span Gas Value	% v/v	21.62	21.62	21.62

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	Run 2	Run 3
Average Temperature	°C	N/A	N/A	N/A
Allowable Temperature	< °C	N/A	N/A	N/A
Temperature Acceptable	-	N/A	N/A	N/A

	Zero Drift	Units	Run 1	Run 2	Run 3
CAL 1	Zero at Analyser (Pre)	% v/v	0.00	0.00	0.00
CAL 1	Zero at Analyser (Post)	% v/v	0.04	0.04	0.04
CAL 1	Zero Drift	% v/v	0.04	0.04	0.04
	Allowable Zero Drift	± % v/v	1.08	1.08	1.08
	Zero Drift Acceptable	-	Yes	Yes	Yes

	Span Drift	Units	Run 1	Run 2	Run 3
CAL 1	Span at Analyser (Pre)	% v/v	21.62	21.57	21.62
CAL 1	Span at Analyser (Post)	% v/v	21.59	21.59	21.59
CAL 1	Span Drift	% v/v	-0.03	-0.03	-0.03
	Allowable Span Drift	± % v/v	1.08	1.08	1.08
	Span Drift Acceptable	-	Yes	Yes	Yes

Test Conditions	Units	Run 1	Run 2	Run 3
Run Ambient Temperature Range	°C	20 - 22	20 - 22	20 - 22

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	Run Number 2	Run Number 3
There are no deviations associated with the sampling employed.	x	x	x

OXYGEN: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	RUN 2	RUN 3	Units
Limit value	N/A	N/A	N/A	%vol
TGN M2 Allowable MU	6.0	6.0	6.0	%
Measured concentration	20.95	20.96	20.92	%vol
Range Used	25.0	25.0	25.0	%vol
Cal gas conc.	21.6	21.6	21.6	%vol

Performance characteristics	RUN 1	RUN 2	RUN 3	Units
Response time	60	60	60	seconds
Number of readings in measurement	30	30	30	-
Repeatability at zero	0.04	0.04	0.04	% full scale
Repeatability at span level	0.04	0.04	0.04	% full scale
Deviation from linearity	0.11	0.11	0.11	% of value
Zero drift	0.19	0.19	0.19	% full scale
Span drift	-0.14	-0.14	-0.14	% full scale
Volume or pressure flow dependence	0.20	0.20	0.20	% of full scale
Atmospheric pressure dependence	0.30	0.30	0.30	% of value/kPa
Ambient temperature dependence	-0.07	-0.07	-0.07	% full scale/10K
Combined interference	0.56	0.56	0.56	% range
Dependence on voltage	0.02	0.02	0.02	% full scale/10V
Losses in the line (leak)	0.23	0.23	0.23	% of value
Uncertainty of calibration gas	2.00	2.00	2.00	% of value

Performance characteristic	RUN 1	RUN 2	RUN 3	Units
Standard deviation of repeatability at zero	use rep at span	use rep at span	use rep at span	%vol
Standard deviation of repeatability at span level	0.01	0.01	0.01	%vol
Lack of fit	0.02	0.02	0.02	%vol
Drift	0.01	0.01	0.01	%vol
Volume or pressure flow dependence	0.00	0.00	0.00	%vol
Atmospheric pressure dependence	0.02	0.02	0.02	%vol
Ambient temperature dependence	-0.01	-0.01	-0.01	%vol
Combined interference (from MCERTS Certificate)	0.08	0.08	0.08	%vol
Dependence on voltage	0.00	0.00	0.00	%vol
Losses in the line (leak)	0.03	0.03	0.03	%vol
Uncertainty of calibration gas	0.24	0.24	0.24	%vol

			RUN 1	RUN 2	RUN 3	Units
Measurement uncertainty		**Result**	20.95	20.96	20.92	%vol
Combined uncertainty			0.27	0.27	0.27	%vol
Expanded uncertainty	k =	1.96	0.53	0.53	0.53	%vol

	RUN 1	RUN 2	RUN 3	Units
Expanded uncertainty (no O_2) - at 95% Confidence	2.53	2.53	2.53	% of Value
Result of Compliance with Uncertainty Requirement in M2	**COMPLIANT**	**COMPLIANT**	**COMPLIANT**	-

Requirement for SRM is that Uncertainty should be 0.5%vol absolute or 6% relative whichever is the lower, on a dry gas basis. Ref EA TGN M2.

Appendix D

Environmental Management System (EMS)

Environmental Management System Manual

Issue	Description	Date
1	Initial Release	19/06/2018

IMPORTANT NOTE

All EMS documents are maintained and controlled in accordance with the procedures of the company's Environmental Management System.

Prepared by:	Steve Swygart	Date: 19/06/2018
Approved by:	Darren Davies	Date: 19/06/2018

CONTENTS

SCOPE

Newbridge Energy has implemented an environmental management system (EMS) that is compliant with the International Standard ISO 14001:2015. The EMS is applicable to the CHP Plant activities undertaken at the Ruthin NB1 site. The EMS implements the Environmental Policy Statement that has been made by Newbridge Energy.

1. INTRODUCTION

In aiming to achieve sound environmental performance, Newbridge Energy has recognised the need for a systematic approach to environmental management and the continual improvement of such an approach. Therefore, it has devised an Environmental Management System (EMS) in order to provide a consistent process for addressing environmental concerns through the allocation of resources, the assignment of responsibilities and the ongoing evaluation of practices, procedures and processes.

The purpose of this manual is to act as a signposting document to other environmental management system documents. The EMS documents have the following structure -

Level 1	EMS Scope & Description : Register of Environment Aspects : Legislation Register Index : Register of Communications :	(Manual EMS02 & 02A) (EMS03) (GMS-03-01) (IMSP01)
Level 2	EMS core procedures relating to the support of Level 1 documents	(EMP series)
Level 3	Operational controls (e.g. Work Instructions, EW series) relating to managing environmental aspects of site activities and operations.	
Level 4	Environment records and reports.	

Due to commonisation opportunities between the EMS, the Quality Management and Occupational Health & Safety Management Systems provided by the latest versions of the relevant ISO standards, such commonised documents have the prefix IMSP (Integrated Management System Procedure).

2. DEFINITIONS

EMS Environmental Management System

Environmental Aspect An element of the company’s activities, products, or services that can interact with the environment.

Environmental Impact Any change to the environment, whether adverse or beneficial, wholly or partially resulting from the company’s products, or services.

Significant Environmental Aspect An environmental aspect that has or can have a significant impact upon the environment i.e. can cause environmental harm or nuisance.

Continual Improvement The process of enhancing the EMS, to improve its suitability and effectiveness. This may or may not take place simultaneously in all areas of activity.

3. POLICY & CONTEXT

Newbridge Energy has an Environmental Policy, which is detailed in EMS01.

Newbridge Energy is committed to preventing pollution and eliminating the negative impact of site activities upon the environment. The Policy is reviewed annually at the Management Review meeting.

The Policy addresses specific site environmental issues by providing a framework for setting and reviewing environmental objectives and targets.

The Policy is distributed to all employees either directly, or by displaying on notice boards. A copy of the Policy is provided to new employees as part of the recruitment induction programme. The Policy is made available to public via the website, to customers, suppliers and contractors either upon request, or as part of the tender/procurement/supplier evaluation process.

The context of the organisation, the internal and external issues that it faces, together with the needs and expectations of interested parties has been commonised with the ISO 9001 : 2015 QMS requirement and is defined in IMSP20, 21, 22 & 23.

A Core Process document (EMS02A) seeks to define the overall inter-relationship of the EMS and its operational procedures in terms of the above requirements and the intended outcomes of the EMS.

4. ENVIRONMENTAL ASPECTS

The evaluation of Newbridge Energy’s impact on the environment is a key part of the company's policy setting and planning. Evaluation is carried out on an ongoing basis and, to be effective, is dependant on the commitment and co-operation of all staff. Evaluation covers normal and abnormal operations such as maintenance and emergency situations and includes the activities of contractors, workplace equipment and facilities, including proposed activities. Environmental aspect evaluations are undertaken or updated in the event of change in legislation, working environment, raw materials, equipment or personnel and are reviewed annually by the SHEQ Manager in the event of any change to working practices.

Key requirements:

4.1 Procedure EMP03 has been developed for the assessment of environmental aspects and is implemented by Newbridge Energy.
4.2 Through the Register of Environmental Aspects (EMS03), Newbridge Energy has identified all of its activities and determined which are potentially significant.
4.3 The Register of Environmental Aspects is reviewed at management review meetings or as and when activities change.
4.4 The Register of Environmental Aspects is reviewed on an annual basis or if there are significant changes to Newbridge Energy Ltd's activities.
4.5 EMP18 defines the lifecycle of the CHP Plant from raw material processing, through to heat usage and power generation, and onto waste disposal.

5. LEGISLATIVE COMPLIANCE AND OTHER REQUIREMENTS

The SHEQ Manager identifies all relevant legislation, regulations, Codes of Practice and protocols applicable to Newbridge Energy that impact on the environment, and also risks associated to occupational health and safety; see Legislation Compliance Procedure GMS-03. Relevant legislation can be found in the Legislation Register Index (GMS-03-01), which summarises all of the legislation applicable to the Ruthin NB1 site. The scope and purpose of the Legislation and its relevance to plant operations is covered by each Legislation Sheet (GMS-03-02).

The Company Directors are ultimately responsible for ensuring effective implementation of all relevant legislation. It is the responsibility of all employees to ensure that legislative requirements are met.

On an annual basis, the SHEQ Manager will conduct a full review of the Register to assess its completeness and relevance using the Environmental Legislation Compliance Review (GMS-03-04), which is kept as documented information.

Key requirements:

5.1 Newbridge Energy Ltd has established a Legislation Register Index (GMS-03-01).
5.2 The register includes all relevant UK legislation (and applicable EC Directives, etc) that are applicable to Newbridge Energy's activities.
5.3 The Register is updated regularly and amendments are recorded in accordance with Procedure GMS-03. If no amendment is required during the review, this is also noted.
5.4 Communication of legislative information to employees is essential to ensure compliance and therefore all employees have access to the Register.
5.5 It is the responsibility of all employees to ensure that legislation requirements are met.

6. OBJECTIVES AND TARGETS

The SHEQ Manager will prepare and maintain the Objectives & Targets programme and agree it with the Chairman, Site Director and Operations Manager; see EMP04. Objectives shall be derived from the EMS Policy, Environmental Aspects Register, and regulatory requirements, as well as financial, operational and business requirements with the aim of continuous improvement of the environmental performance of the company.

Each objective will have targets set, and progress towards these targets will be monitored and reported in the Board Pack.

Key requirements:

6.1 Objectives and targets are set by Newbridge Energy at Board level, together with Newbridge Energy Senior Management Team and are detailed in the Environmental Management Programme Targets & Objectives (EMP04A).

6.2 The Management Programme is held by the SHEQ Manager and is communicated to employees as required on notice boards and in team briefings.

6.3 The objectives and targets take due consideration of legal requirements, the significant environmental aspects, the technical options, the financial, operational and business requirements and the views of all stakeholders.

6.4 Achievement of the Management Programme is reviewed at monthly Board Meetings and at Management Review.

7. ORGANISATION AND RESPONSIBILITIES

The Company Directors have overall responsibility for the provision, promotion and maintenance of an effective EMS Policy and continuous improvement programme and will, via the Site Director, ensure that the requirements of this EMS Manual are addressed and integrated into all management and business decisions, so that the the environmental policy and environmental objectives are compatible with the context and strategic direction of the organization. The Directors will support other site management roles to demonstrate their leadership as it applies to their areas of responsibility.

Site Director shall ensure that there is adequately directed and supported resource to carry out the day-to-day operation of the EMS, and that there is an effective communication link to highlight the both the importance of the EMS and that the need to conformance to its requirements.

8. ENVIRONMENTAL DUTIES OF PERSONNEL

The environmental duties of employees will be defined by the Site Director and approved by the Chairman. Specifically :

8.1 Procedure EMP06 has been prepared to define the environmental duties of personnel.

8.2 The duties of those employees with essential environmental responsibilities (e.g. SHEQ Manager) are to be covered by others whenever they are absent.

9. TRAINING, AWARENESS & COMPETENCE

It is company policy that all employees are aware, by training, of the requirements of the company EMS; the significant environmental aspects of their work; and their responsibilities with respect to protection of the environment and minimising wastage. Employee recruitment / promotion is based upon competency, comprising skills, knowledge, aptitude, training and experience. An induction programme provides all new recruits and, if appropriate, contractors with environmental awareness training. Additional, on-the-job training and more specialist formal training, is provided as determined by the employees' manager. It is the responsibility of managers to identify and address training needs and for maintaining records of training provided.
An environmental training needs matrix (EMP05A) has been prepared to ensure appropriate awareness of the requirements of the company EMS exists at all management levels. In addition, those with specific environmental duties will be deemed competent on the basis of training in the procedures and requirements of the EMS. The training matrix and the Staff Training & Competency Matrix (IMSP-10) will be reviewed by the Compliance Manager on an annual basis, or as required.

Key requirements:

9.1 All new employees and sub-contractors engaged within the company shall receive an induction that includes environmental issues.
9.2 All personnel whose work may create a significant impact upon the environment shall receive appropriate training.
9.3 The training needs of employees shall be identified and highlighted in the training matrix, EMP05A and also in IMSP-10. These shall be reviewed on an annual basis, or as required.
9.4 The training highlighted within the training matrices will be implemented and recorded.

10. COMMUNICATION

The company ensures that all employees, contractors and visitors are informed of matters relating to the EMS through meetings, notice boards, company flyers, etc. The company Environmental Policy is displayed throughout the factory.

Internal communications between employees may be in the form of incidents or complaints (through the ESOC System), aspect evaluation, or general enquiry and will be dealt with by the SHEQ Manager, with the Site Director notified as appropriate. External communications may come to the company in the form of written or verbal enquiries or complaints. A communications matrix, describing on what, when, with whom and how, is detailed in IMSP01.

EMS documents (e.g. significant environmental aspects) are not communicated externally, though the Environmental Policy Statement (EMP01) will be provided upon request.

Key Requirements:

10.1 Newbridge Energy Ltd has established a Register of Communications (IMSP01A) and a procedure (IMSP01) for its maintenance.
10.2 Internal communication is initially via the ESOC System and EHS Committee meetings, the timing and agenda for which shall be prepared by the SHEQ Manager.
10.3 EHS Committee meetings will, as a minimum, discuss the following:

- Previous meeting actions
- Management Programme
- Audits and non-compliance
- Matters arising

10.4 Environmental issues can also be communicated by notice boards, Line management Team Briefs, Posters, E-mails or Training.
10.5 Should any employee have a suggestion or notice any environmental hazards or issues, they can communicate these via the ESOC System.
10.6 All documentation relating to external communication and regulatory visits, which refer to environmental issues, is logged within the Register of Communications and is actioned as appropriate by the Site Director or SHEQ Manager.
10.7 Should a complaint or form of communication be likely to result in regulatory or media attention, then the SHEQ Manager shall contact the FCS Director and Chairman as soon as is practicable.
10.8 Newbridge Energy presents its Environmental Policy Statement to external interested parties via its website.

11. DOCUMENTED INFORMATION

Newbridge Energy's Environmental Management System comprises this EMS Manual and accompanying registers of Environmental Aspects, Legislation, and Communication. These registers are supported by the :

- EMS (Objectives & Targets) programme
- Internal audits programme
- EMS procedures
- Operational controls, e.g. work instructions; and
- Environmental records.

The environmental manual (EMS02) is maintained by the SHEQ Manager and describes the organisation for implementing and maintaining the Environmental Policy, environmental systems and associated procedures. It serves as a signposting document to other EMS documents, the Quality Management System and production operational controls. Linked to Manual EMS02, are the Register of Environmental Aspects (EMS03), the Legislation Register Index (GMS-03-01), and the Communications Register (IMSP01A). These four documents are collectively referred to as "Level 1" documents. In some instances, the descriptions in manual EMS02 require further, more detailed, instruction or clarification and this is provided in separate procedures, identified with a reference number in the form of EMP/xx; these procedures are referred to as “Level 2” documents.

Most environmental controls, requirements, information & instructions will be included in the plant (i.e. production equipment) operating instructions, visual work instruction training and administration procedures, which are prepared by the CHP Manager. It is the responsibility of CHP Manager to consult with the SHEQ Manager when preparing these operational controls. However, the SHEQ Manager will, from time-to-time, prepare specific environmental procedures relating to issues such as waste management. These environmental controls will be identified with a reference number in the form of EWxxx and are referred to as “Level 3” EMS documents.

In addition, the SHEQ Manager will establish, by procedure or other means, the performance criteria required for records; including standards required for sampling and analysis, acceptable limits / tolerances on measurements, demonstrating conformity to EMS procedures, etc. Records deemed by the SHEQ Manager as necessary for demonstrating environmental performance (e.g. electricity and heat meter readings) or continuing policy compliance (correct disposal of waste streams) are referred to as “Level 4” documents.

All EMS documentation is controlled and maintained using the environmental management system. The SHEQ Manager will prepare a list of all EMS documents, records and procedures that are controlled within the Environmental Management System; this list will be held and maintained in accordance with a document control procedure. The list shall include the title of the document and a unique reference number (and the holder and its location if appropriate). The SHEQ Manager will issue unique reference numbers for Aspect Appraisal and Non-Conformance reporting forms. The SHEQ Manager will also establish, by discussions with managers and interested parties (e.g. Local Authority EHO, National Resources Wales) the environmental records required to be maintained to demonstrate compliance with Policy and the broader requirements of the EMS (e.g. maintaining Key Performance Indicators, demonstrating legal compliance, etc).

Key Requirements:

11.1 Procedure EMP07 has been developed for identifying EMS documentation. This procedure highlights documentation that is to be either “maintained” or “retained” as required by the 2015 version of ISO 14001.

11.2 All EMS documents are controlled and distributed in accordance with company environmental management system, which requires:

- All documents to be dated;
- All documents to have a unique reference number (to be specified by the SHEQ Manager) and a revision number; and
- All documents to have page numbers.

11.3 All documents are kept electronically only.

11.4 All records and documents are retained by relevant parties in a manner that allows the information contained to be made available, whilst affording maximum protection from deterioration.

11.5 The electronic storage of documents is audited as part of the internal audit programme to ensure that the information contained centrally is up to date.
11.6 The SHEQ Manager is the only person permitted to change the electronic version of the system documents and retains an electronic version of superseded documents.
11.7 Retention periods for obsolete documents and records are noted within the EMS.
11.8 The SHEQ Manager is the authorised person for making amendments to EMS documents.
11.9 Amendments are issued by the allocation of a revision status.
11.10 Amendments are discussed with/communicated to relevant staff.

12. OPERATIONAL CONTROLS

The adequacy of operational controls (e.g. training, equipment operating instructions, maintenance records) for minimising the environmental impact of site activities is assessed during the Environmental Aspects Appraisal process. The appraisal process ensures that all production operations and activities are carried out under controlled conditions and that operating criteria for protection of the environment are understood and documented. Recommendations from the appraisal process may require the amendment of existing plant operating instructions to include specific EMS requirements (e.g. record electricity consumption) or may require the preparation of a new EMS procedure or work instruction to specifically address environmental issues or concerns.

Operational procedures will identify the methodology for minimising environmental impact and include information to be obtained; sampling; test methods; frequency of measurement; criteria for acceptance and non-conformance actions; plant operating criteria; records and data handling.

Key Requirements :

12.1 Operational control procedures have been developed which relate to the significant environmental aspects of site activities. EMS-04 is the over-arching process document that defines environmental planning on site at Ruthin NB1.
12.2 A secure network drive holds master copies of EMS procedures.
12.3 EMS procedures, instructions, etc are communicated and or issued to relevant employees by the line management structure.
12.4 Contractors are also subject to relevant operational controls.

13. EMERGENCY PREPAREDNESS AND RESPONSE

All employees are responsible for taking immediate action following and abnormal operation of equipment, fire & spillages in order to minimise harm to the environment (including human health, and property). The action to be taken is defined in procedures; instruction in which will be arranged, as appropriate, by managers. Managers are also responsible for assessing the training/awareness needs of contractors working on the site.

In the event of the factory needed to be evacuated due to an emergency, procedure IMSP03 (Emergency Preparedness and Response) is to be followed. The potential for abnormal and emergency conditions is assessed during the environmental aspects appraisal process and documented on the Accident Management Plan, which is maintained by the SHEQ Manager. The Plan is updated in the event of an incident, change of policy or legislation, corrective action reports or revised aspect appraisal, though, is also reviewed annually by the SHEQ Manager. The plan is test periodically and update if appropriate.

Records are maintained via the ESOC System, of all incidents and emergency situations. If appropriate, the Site Director may request that a formal incident report is prepared which may include, as appropriate, sketches of the location of the incident, positions of drains and other sensitive receptors, actions taken and proposed measures to prevent a reoccurrence of the incident. The SHEQ Manager is responsible for notifying the Local Authority EHO / NRW of the incident, if appropriate.

Key Requirements:

13.1 Procedure EMP08 has been developed for maintaining an environmental Accident & Emergency Plan. Procedure EMP09 has been developed for maintaining a Site Closure Plan (EMP09A) that identifies potential hazards associated with plant decommissioning. The plans (and any procedures arising from the plans) are reviewed, and revised if necessary, annually or following the occurrence of accidental or emergency situations, significant modifications to plant and equipment, or process change.

13.2 Newbridge Energy, where practicable, will periodically test areas of the Accident & Emergency Plan, and maintain a record of the outcome of such tests.

13.3 Newbridge Energy maintains a Business Continuity Plan, updated annually, which documents measures to prevent, respond to and recover from a disaster.

14. PERFORMANCE EVALUATION

The SHEQ Manager will maintain :

a) A list of all environmental monitoring requirements, stipulating where the monitoring records are held; the frequency of monitoring; the standards for sampling, analysis, and equipment calibration; and information to be sent to regulators
b) A record of information to be provided to regulators
c) Procedures detailing the standards required for monitoring, analysis & calibration.

Managers will monitor and maintain records of plant operation and performance (including issues relating to contractors/suppliers/customers) and will notify the SHEQ Manager of any deviation that could cause a breach of legislation or otherwise impact upon the environment. The managers will review the recommendations arising from the Environmental Aspects Appraisal process and amend operating procedures or monitoring requirements accordingly.

Key Requirements:

14.1 Procedures EMP10 & EMP11 have been developed for identifying environmental monitoring requirements.

14.2 The SHEQ Manager will collate monitoring data for internal discussion at EHS Committee meetings and for demonstrating to regulatory bodies, and other stakeholders, continued compliance with permits, consents, and other statutory requirements.

14.3 For the purposes of establishing and maintaining the environmental performance of site activities the following parameters (Key Performance Indicators, KPIs) are monitored or measured:

- Water consumption
- Waste generation
- Energy use (e.g. electricity, gas, etc.)
- Raw material consumption and efficiency usage

14.4 For the purposes of maintaining the EMS, the SHEQ Manager monitors :

- Changes in environmental legislation relevant to site activities
- Progress in achieving the Objectives & Targets programme

15. AUDIT AND REVIEW

The EMS is audited annually in accordance with the audit programme prepared by the SHEQ Manager. The aim is to ensure conformance to policy, procedures, relevant legislation and management programmes, considering any changes to risks and opportunities that may have occurred. The SHEQ Manager will agree the audit programme with managers, including when the audits are to take place, the scope of the audits and the competent person(s) to undertake them.

Audits are scheduled on the basis of the status and significance of the operational area and environmental issue. Auditors are free from bias and other influences that could affect their objectivity and have received specific training in EMS auditing. Two types of audit are conducted a) systems audits and b) operational controls audits (including compliance with legislation & policy). Priority audits may be introduced in response to incidents or observations. The SHEQ Manager retains master copies of internal audit reports.

Changes to UK legislation and other commitments (e.g. planning conditions) are reviewed by the SHEQ Manager and recorded in the Register of Legislation. The Register of Legislation is consulted during the Environmental Aspects Appraisal process to ensure compliance with requirements. As part of the EMS internal audit process, the Register of Environmental Aspects is reviewed annually to ensure it is up-to-date and that listed aspects are fully compliant with relevant legislation, regulation, and other requirements as detailed in the Register of Legislation.

Key Requirements:

15.1 Newbridge Energy has a programme for internal audits (IMSP-02), which is implemented in accordance with IMSP-09.
15.2 The SHEQ Manager retains the audit and non-conformance reports.
15.3 Non-conformance and Corrective and Preventative Action can be identified and undertaken outside of the audit process as and when required, via the ESOC System.

16.0 MANAGEMENT REVIEW

The management review of the EMS is held annually and attended by the Chairman, Directors and Senior Management Team. Its purpose is to assist the organisation to develop a system that will deliver continual improvement in environmental performance and to ensure the continuing suitability, adequacy and effectiveness of the system and its procedures, and that the EMS achieves its intended results; see procedure EMP19.

The SHEQ Manager is responsible for preparing the review meeting agenda and presenting a summary of the previous years' environmental performance at the meeting, in-line with EMP19, addressing a review of policy, results of audits, communications, changes in needs and expectations of interested parties, effectiveness of actions to address risks and opportunities, objectives & targets progress, status of corrective actions, follow-up from previous management reviews, changing developments (e.g. legislation), and recommendations for improvements, amongst other topics.

Minutes of the meeting and the Review document will be retained as documented information, and the Directors will be responsible for ensuring timely action regarding any decisions or recommendations from the Review.

17. IMPROVEMENT

Non-conformances are classified as a non-compliance with a specific requirement of the EMS; an action contravening a specific system or procedure (e.g. breach of a consent condition); an observation which indicates an environmental aspect not previously identified; a recorded incident/accident; and other situation that contravenes legislation, policy or objectives & targets.

Departmental managers are responsible for initiating corrective actions in relation to deficiencies identified during inspections and audits, or reports filed in relation to actual or potential occurrences, and for checking their satisfactory completion. Managers are responsible for responding to, and documenting, environmental incidents, accidents, and non-compliances with operating procedures and for reporting details via the ESOC System.

Key Requirements:

17.1 Procedure EMP17 has been developed for recording non-conformance with the requirements of the EMS.
17.2 Non-conformances may arise from internal audits of the EMS (EMP11) or be identified during normal operations.
17.3 Non-conformances may also represent failings of the documented or implemented EMS, or legislative non-compliance.
17.4 All non-conformances are investigated (see Section 8 for responsibilities) and closed out in an appropriate and timely manner.
17.5 Corrective action should be taken to correct the immediate non-conformance and preventive action taken to implement changes to avoid repetition of the actual or similar non-conformances.
17.6 Procedure EMP-20 has been developed to show the key inputs and their relationship into the company's EMS improvement strategy.

Appendix E

Environmental Risk Assessment

MCP / Generator: Ruthin

Unique Identifier: Newbridge Energy 2885

Environmental Risk Assessment

Table 1: Site Sensitivity and Receptor Locations					
Receptors	**Search Radius**	**Name**	**Distance from Site**	**Direction from Site**	**Grid Reference**
Human Health					
Air Quality Management Area	2km	none			
Local human population *(full details in AQA)*[1,2]	1km	Glasdir School	275m	S	311673 358718
		properties on Stry Yr Ehedydd	275m	SE	311731 358743
		properties on Stryd Yr Wennol	175Mm	SSE	311799 358892
		properties on Stryd Yr Alarch	215m	SE	311886 358937
		Golf Links Farm	395m	W	311195 358842
		Granary, Tyddan Isaf	405m	NW	311112 359186
		Bodlondeb	530m	NW	311221 359538
		properties on Cae Seren / Y Parc	615m	SE	311921 358456
		properties on Canol Y Dre	735m	SE	312326 358695
		Ruthin Livestock Market	115m	SW	311543 358868
		public footpath	270m	E	311904 359136
Nature Conservation[3]					
International designated sites (SACs, SPAs, Ramsar etc)	10km	Llwyn SAC	8.8km	NW	308403 363827 *(nearest point)*
		Alyn Valley Woods SAC	7.5km	NE	318174 362477 317734 364887 *(nearest points)*
National Designated Sites (SSSIs)	2km	none			

Notes:

1: full details on receptors and locations are provided in Air Quality Assessment (AQA) Report, prepared by Smith Grant LLP, ref: R2298D-R02-v4, 18th July 2018; other receptors may be present within 1km which are subsumed by the listed receptors

2: considers receptors where members of the public may be present for 1 hour or more; does not consider workplaces

3: details are provided in Air Quality Assessment Report, prepared by Smith Grant LLP, ref: R2298D-R02-v4, 18th July 2018; supplementary details and assessment on international designated sites provided in Addendum R2298D-R06-v1, 14th February 2020

Table 2: Assessment of Air Emissions Risks							
ID	**Source**	**Pathway**	**Receptor**	**Risk Management**	**Probability of Exposure**	**Consequences**	**Overall Risk**
001	Releases of NO_x / NO_2	Air transport then inhalation	harm to human health – respiratory irritation and illness	Point source emissions to air with emission limits for NO_x Management and operation of activities in accordance with a management system (includes inspection and maintenance of equipment, record keeping, staff training)	**Low** – AQA identified potential pollution contributions from CHP plant at nearby receptors to be ***negligible***	**Low** – all predicted resulting total NO_2 concentrations predicted to be well below the relevant short-term and long-term Air Quality Assessment Levels (AQAL)	**Insignificant** - AQA did not identify any significant adverse impacts on local human population
002	Releases of NO_x / NO_2	Air transport and deposition	harm to protected ecological sites through toxic contamination, nutrient enrichment, disturbance etc	Point source emissions to air with emission limits for NO_x Management and operation of activities in accordance with a management system (includes inspection and maintenance of equipment, record keeping, staff training)	**Low** – AQA & Addendum identified potential pollution contributions from CHP plant at nearby receptors to be ***negligible***	**Low** – all predicted resulting total NO_2 concentrations predicted to be well below the relevant short-term and long-term Air Quality Assessment Levels (AQAL)	**Insignificant** - AQA did not identify any significant adverse impacts on local human population

AQA - Air Quality Assessment Report, prepared by Smith Grant LLP, ref: R2298A-R03-v3, 31st October 2017; note AQA based on OEM provided emissions data; monitoring demonstrates CHP plant achieves lower emissions

Addendum – prepared by Smith Grant LLP; ref: R2298D-R06-v1, 14th February 2020

Appendix F

Air Quality Assessment

Contaminated Land
Air Quality
Environmental Audit

SMITH GRANT Environmental Consultancy LLP

Partnership No: OC 00776

ADDITIONAL WOOD DRYING FACILITY AND ASSOCIATED CHP PLANT, BLAZER'S FUELS, RUTHIN, DENBIGHSHIRE

AIR QUALITY ASSESSMENT

Planning Ref: 02/2018/0497

for: AXIS / NEWBRIDGE ENERGY LTD

July 2018

R2298D-R02-v4

Smith Grant LLP, Station House, Station Road, Ruabon, Wrexham, LL14 6DL
tel: 01978 822367 fax: 01978 824718 e-mail: consult@smithgrant.co.uk web: www.smithgrant.co.uk
Members: K E Hawkins (Chairman), B J Thomas, A F Smith

DOCUMENT CONTROL SHEET

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Client:	Axis / Newbridge Energy Ltd
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Drafted by	F Hartley BSc	Consultant	pp	18.07.18
Checked	K Hawkins BSc MSc MIAQM CEnv	Partner		18.07.18

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ADDITIONAL WOOD DRYING FACILITY AND ASSOCIATED CHP PLANT, BLAZER'S FUELS, RUTHIN, DENBIGHSHIRE

AIR QUALITY ASSESSMENT

For: Axis / Newbridge Energy Ltd

Contents

Drawings

Appendices

1 Introduction

1.1 Newbridge Energy Limited (NEL) has submitted a planning application (ref: 02/2018/0497) to Denbighshire County Council (DCC) for the installation of an additional dryer and associated combined heat and power (CHP) plant at their existing wood-drying facility in Ruthin. The plant is to enhance the existing drying and CHP capacity at the facility.

1.2 Site details are:

Table 1.1: Site Details

Address	Blazer's Fuels,
National Grid Reference	311600 359000
Local Authority	Denbighshire County Council (DCC)
Nature of Current Site	manufacture of wood pellets and fuel
Proposed Development	installation of additional CHP plant and drying plant

1.3 Axis, acting on behalf of NEL, instructed Smith Grant LLP (SGP) to undertake an air quality assessment (AQA) to assess the potential impacts of the aerial emissions associated with the proposals. SGP initially provided a preliminary AQA in support of the planning application (report ref: R2298D-R01-v2, 17th May 2018). This comprised a review of the site setting, the development proposals, and of the findings and conclusions of a previous assessment for a similar facility, and presentation of a preliminary assessment of potential impacts. This has now been supplemented by atmospheric dispersion modelling of the stack emissions associated with the proposed development.

1.4 To provide a comprehensive and robust assessment modelling has been undertaken of the existing facility stack emissions and the proposed future stack emissions. The results have been used to determine the changes that would occur due to the proposals and assessment of the associated potential impacts.

1.5 This following report replaces the previously submitted preliminary AQA. The report summarises the methodology, findings and conclusions of the assessment.

1.6 SGP is an environmental consultancy specialising in air quality assessments. The report author, Katrina Hawkins, Partner, is a Member of the Institute of Air Quality Management (IAQM).

2 Technical and Legislative Context

2.1 Technical Context

2.1.1 The principal aerial pollutants of interest with regards to the combustion of biomass are oxides of nitrogen (NOx; comprises nitrogen dioxide (NO_2) and nitric oxide (NO)) and particulate matter of diameter less than 10 µm (PM_{10}). On release to the atmosphere NO usually rapidly oxidises to NO_2. The drying process will give rise to emissions of particulate matter.

2.1.2 Airborne particulate matter is made up of condensed phase (solid or liquid) particles suspended in the atmosphere and ranges in size from a few nanometres to around 100µm. Particulate matter (PM) can give rise to both soiling effects through dust deposition (referred to as 'disamenity dust') and human health effects through suspended particles.

2.1.3 Dust soiling will arise from the deposition of particulate matter in all size fractions, but will mostly be associated with particulate matter of diameter greater than 30 µm. Particles below 10µm (referred to as PM_{10}) correspond to the inhalable fraction of particulate matter. PM_{10} includes both fine (those particles of diameter below 2.5 µm; referred to as $PM_{2.5}$) and coarse (diameter between 2.5-10µm; $PM_{2.5-10}$) fractions of airborne particulate matter which normally arise from different sources.

2.1.4 Haulage transport to and from a facility will also result in emissions of primarily oxides of nitrogen (NO_x; comprises nitrogen dioxide (NO_2) and nitric oxide (NO)) and particulate matter of diameter less than 10 µm (PM_{10}).

2.2 Legislative Context

2.2.1 Ambient air quality standards in the UK are established in the UK through the combination of transposition of European legislation and additional UK legislation and requirements. A series of Limit and Target Values are established through the European legislation on the UK as a whole (referred to as AAD values) and responsibility for meeting these is devolved to the national administrations; the Department for Environment, Food and Rural Affairs (Defra) co-ordinates assessment and air quality plans for the UK as a whole.

2.2.2 The Air Quality Strategy 2007 includes targets and objectives (referred to as AQOs) for the UK for specified pollutants deemed to pose a risk for human health or other receptors and to ensure that international commitments are met. The objectives are a statement of policy intentions or targets. There is no legal requirement to meet these objectives except in so far as these mirror equivalent legally binding limit values in EU legislation. Standards are also imposed on the UK through the Air Quality Standards Regulations 2010 which implement the 2008 EU ambient air quality objective. AQOs are included for PM_{10}, NO_x, NO_2, SO_2 and the VOCs benzene and 1,3-butadiene.

2.2.3 In addition, Part IV of the Environment Act 1995 imposes a duty on local authorities in the UK to review existing and projected air quality in their area. Any location likely to exceed established UK Air Quality Objectives (AQOs) must be declared an Air Quality Management Area (AQMA) and an Action Plan prepared and implemented, with the aim of achieving the objectives. This process is referred to as Local Air Quality Management (LAQM). The LAQM process is supported by national statutory policy[1], which is published by each country within the UK separately, and technical guidance[2] provided by Defra at a UK level.

2.2.4 The applicable EU limit and target values and UK AQOs relevant to the site and proposed development with regards to protection of human health, referred to in this report as Air Quality Assessment Levels (AQALs), are summarised in Table 2.1. below.

Table 2.1: Relevant Air Quality Assessment Levels (AQALs)

Pollutant	AQAL	Averaging Period	Source
NO_2	40 µg/m³	annual mean	AAD Limit Value / AQO
	200 µg/m³	hourly mean, not to be exceeded more than 18 times per annum	AAD Limit Value / AQO
PM_{10}	40 µg/m³	annual mean	AAD Limit Value / AQO
	50 µg/m³	24 hour mean, not to be exceeded more than 35 times per annum	AAD Limit Value / AQO
$PM_{2.5}$	25 µg/m³	annual mean	AAD Limit Value / AQO[1]
	% reduction relative to average exposure indicator (AEI), dependant on initial concentration; to at least 18 µg/m³	annual mean	AAD Target Value / AQO[1]

1: standards not included within LAQM system

2.2.5 For the purposes of the AQALs ambient air refers to the outdoor air and excludes workplaces where members of the pubic do not have regular access. Advice is given in Defra guidance[5] as to where the UK AQOs should apply as summarised below; slightly different compliance requirements are provided for EU limit and target values:

[1] Defra, Local Air Quality Management, Policy Guidance (PG(W)17), June 2017
[2] Defra, Local Air Quality Management, Technical Guidance (TG16), February 2018

Table 2.2: Summary of where the AQOs should apply

averaging period	objective should apply at
annual mean	all locations where members of the public might be regularly exposed; including facades of residential properties, schools, hospitals, care homes etc
24-hour mean and 8-hr mean	all locations where the annual mean objectives apply together with hotels and gardens of residential properties
1-hr mean	all locations where the annual mean, 24-hour and 8-hour means apply; also kerbside sites, parts of car parks, bus stations and railway stations which are not fully enclosed and any outdoor locations where members of the public might reasonably be expected to spend 1 hour or longer.
15-min mean	all locations where members of the public may be reasonably exposed for a period of 15 minutes

Note: the AQOs do not apply at building facades or other places of work where members of the public do not have regular access

2.2.6 Additional statutory and non-statutory ambient air quality standards (termed Critical Levels) are also provided by the UK Air Quality Strategy and NRW / EA guidance for the protection of vegetation and ecosystems to be applied at nature conservation sites. Applicable standards for this assessment are detailed below:

Table 2.3: Additional Non-Statutory Critical Levels for Protection of Vegetation and Ecosystems

Pollutant	Concentration (µg/m^3)	Measured as
nitrogen oxides (as NO_2)	30	annual mean
	75	daily mean

2.2.7 In addition, Critical Loads are provided for nitrogen nutrient and acidity deposition; these are dependent on the specific habitat and location.

Deposition Dust

2.2.8 Disamenity dust as such is not regulated as a pollutant under the above requirements and there are no European or UK statutory or recommended levels that define the point when deposited dust causes annoyance or disamenity. Public concerns in relation to dust accumulation and soiling may be related to a range of factors including the nature of a site and locality and baseline levels.

2.2.9 Controls of soiling and annoyance impacts are typically achieved through conditions within planning permissions and / or environmental permits requiring the implementation of a dust management plan to prevent amenity impacts. Deposited dust may also give rise to 'nuisance', as Statutory, private and public nuisance as defined in environmental law and in so far as nuisance relates to unacceptable effects of emissions. It is recognised however that a significant loss of amenity may occur at lower levels of emission than would constitute a statutory nuisance.

2.3 Pollution Control - Environmental Permits

2.3.1 A wide range of industrial, waste and agricultural installations require an Environment Permit to operate under the Environmental Permitting (England and Wales) Regulations 2010 (EPR), and subsequent amendments. The aim of the permitting system is to prevent, and where that is not practicable reduce, emissions to air, water and land by potentially polluting and other installations.

2.3.2 Premises that are operated under a Permit are required to operate in such a way that a) all the appropriate preventative measures are taken against pollution, in particular through the application of the best available technique; and b) no significant pollution is caused. Permits are issued by either NRW or the Local Authority dependant on the nature and size of the facility. The applicability of Environmental Permitting to the current and proposed operations is discussed below in Section 4.

2.4 National Planning Policy and Guidance

2.4.1 Planning Policy Wales (PPW, Edition 9, November 2016) sets out the Welsh Government's land use planning policies and how these are expected to be applied. Chapter 13 of PPW deals with minimising and managing environmental risks and pollution, including air quality issues. Section 13.1.1 of PPW states that:

'Planning and environmental management are separate but complementary. By controlling where development can take place and what operations may be carried out, the planning system has an important role in avoiding or minimising the adverse effects of any environmental risks on present or future land use."

2.4.2 The Framework provides guidance to local authorities on taking air pollution into account in planning policies and decisions. Section 13.10.1 states:

'The planning system should determine whether a development is an acceptable use of land and should control other development in proximity to potential sources of pollution rather than seeking to control the processes or substances used in any particular development.'

2.4.3 Of note, the different roles of a planning authority and a pollution control authority are addressed by PPW in section 13.10.2:

'Planning authorities should operate on the basis that the relevant pollutant control regimes will be properly applied and enforced by other agencies. They should not seek to control through planning measures, matters that are the proper concern of the pollution control authority. These

regimes are set out in the Environment Act 1995, the Environmental Protection Act 1990, the Water Resources Act 1991 and the regulatory regimes introduced by the Pollution Prevention and Control Act 1999. Each of these may have a bearing on the environmental controls imposed on the development in respect of environmental and health concerns and planning authorities will need to ensure that planning conditions do not duplicate or contradict measures more appropriately controlled under these regimes.

2.4.4 PPW sets out the position for development management in relation to air (and water) quality in section 13.12.1 as follows:

The potential for pollution affecting the use of land will be a material consideration in deciding whether to grant planning permission. Material considerations in determining applications for potentially polluting development are likely to include:

- *location, taking into account such considerations as the reasons for selecting the chosen site itself;*
- *impact on health and amenity;*
- *the risk and impact of potential pollution from the development, insofar as this might have an effect on the use of other land and the surrounding environment (the environmental regulatory regime may well have an interest in these issues, particularly if the development would impact on an Air Quality Management Area or a SAC);*
- *prevention of nuisance;*
- *impact on the road and other transport networks, and in particular on traffic generation; and*
- *the need, where relevant, and feasibility of restoring the land (and water resources) to standards sufficient for an appropriate after use. (Powers under the Pollution Prevention and Control Act 1999 require an operator to return a site to a satisfactory state on surrender of an Integrated Pollution Prevention and Control Permit).*

2.5 National Best Practice and Guidance

LAQM Policy Guidance LAQM.PG(W)[4]

2.1.1 LAQM.PG(W) provides policy guidance to Local Authorities in Wales in carrying out their air quality management (LAQM) duties under Part IV of the Environment Act 1995 to achieve implementation of the AQS. The policy guidance outlines the LAQM process including the process for designating AQMAs. The guidance requires that local authorities integrate air quality considerations into the planning process at the earliest stage.

LAQM Technical Guidance LAQM.TG16[3]

2.1.2 LAQM.TG16 provides detailed technical guidance to Local Authorities in carrying out their LAQM duties and sets out the process to be used in reviewing and assessing air quality in their areas. LAQM.TG16 provides detailed guidance in undertaking updating and screening assessments, and detailed assessments, and how to undertake monitoring and modelling in support of these assessments.

IAQM: Planning for Air Quality[4]

2.1.3 The IAQM document provides specific non-statutory guidance on air quality and the planning system for new development. The guidance clarifies when an air quality assessment is required, what it should contain and how impacts should be described and assessed. In addition, the guidance sets out suggested approaches to reducing emissions and impacts.

2.1.4 IAQM also produces a series of additional non-statutory guidance documents in relation to the assessment of construction dust[5] in relation to the planning regime, and which have been referred to in the course on this assessment.

EA: Air emissions risk assessment for your environmental permit[6]

2.1.5 The EA guidance provides an air emissions risk assessment methodology in support of environmental permit applications.

[3] Defra: Local Air Quality Management, Technical Guidance (TG 16), February 2018
[4] Institute of Air Quality Management (IAQM): Land Use Planning and Development Control: Planning for Air; January 2017 (v1.2)
[5] Institute of Air Quality Management (IAQM), Guidance on the assessment of dust from construction and demolition, February 2014
[6] Environment Agency (EA) and Defra: Air Emissions Risk Assessment for Your Environmental Permit, last updated 2 August 2016

3 Assessment Methodology

3.1 Methodology

3.1.1 In undertaking the air quality assessment SGP has carried out the following activities:

- site visit to view the site and surrounding area;
- review of development proposals, including current and proposed operations;
- review of baseline air quality, DCC air quality reports and monitoring data;
- review of appropriate meteorological data including local wind speed and direction statistics;
- review of technical information relating to existing and proposed process emissions, specifically NO_x / NO_2 and PM_{10} / $PM_{2.5}$;
- modelling of stack emissions, specifically NO_x / NO_2 and PM_{10} / $PM_{2.5}$ using the ADMS atmospheric dispersion model;
- qualitative assessment of stack emission impacts on human health receptors;
- provision of recommendations for mitigation where necessary.

3.1.2 The baseline data has mainly been gathered through a desk top study and a site visit. No additional survey or field work has been undertaken as part of this assessment. In undertaking the assessment reference has been made to the following principal sources of information:

Table 3.1: Information Sources

Reference and Data	Author and Source	Purpose and Information Content
background and topographical information		
Promap, accessed May-June 2018	Ordnance Survey (OS)	general mapping information including topography, ground features, rights of way, communications etc
Google Earth (imagery date 2015 & 2016)	aerial photography	site setting
www.environment.data.gov.uk; accessed May-June 2018	Environment Agency	general information on industrial pollution sources
www.magic.gov.uk; accessed May-June 2018	multi-agency	web-based interactive map containing information on nature conservation areas
air quality information		
North Wales Combined Authority Annual Progress Report 2017, September 2017 *(and earlier reports)*	Bureau Veritas	update of local authority air quality monitoring and assessment
www.aqma.defra.gov.uk	Defra	details and maps of AQMAs throughout UK
www.defra.gov.uk	Defra	Local Authority air quality management support; background pollutant mapping

3.1.3 In addition, reference has been made to the current and proposed layout plans and existing emissions monitoring data (provided in Appendix A) for the existing CHP and dryer stacks.

3.1.4 A site visit was undertaken by K. Hawkins, Partner and D. Lloyd, Associate on 9th June 2018 to obtain overview information on the current site operations.

3.1.5 Technical details of the processes and combustion emissions were provided by Axis, NEL and the technology providers, Uniconfort and Stela, and have been incorporated as necessary in the description of the proposed development.

3.2 Scoped Out Matters

3.2.1 The additional development is predicted to generate about 12 2-way daily HGV movements (8 in / 8 out) on a 24 / 7 basis. The number of HGV movements therefore fall substantially below the screening criteria provided by IAQM[1] as indicating the need for an air quality assessment (100 AADT (annual average daily traffic) for HGVs (for areas outside an Air Quality Management Area).

3.2.2 Considering the absence of any known areas of air quality concern in the locality, as discussed below in Section 5, and that the additional vehicle movements fall below the IAQM screening thresholds, further consideration of potential impacts of emissions from the additional vehicles on local air quality is not considered necessary.

3.2.3 The additional proposals do not include for any different activities to those currently undertaken at the Site; purely an increase in quantities handled and processed. The specific processes associated with the additional drying and CHP capacity would be limited to the handling, drying and storage of material; not shredding or any other similar processing. The new dryers are to be located internally, and the proposals involve the relocation of the existing dryers to internally. Accordingly, the potential for significant fugitive emissions of dust that may result in loss of amenity or pose a nuisance is considered to be low and further assessment is not considered necessary.

3.2.4 Similarly, given the nature of the material to be handled and combusted at the facility, i.e. clean wood, the additional capacity on site is not expected to result in the generation of a significantly greater risk of odours to currently. Accordingly, the potential for significant emissions of odour that may result in loss of amenity or pose a nuisance is considered to be low and further assessment is not considered necessary.

3.3 Identification of Receptors

3.1.1 The assessment has predicted air quality impacts upon a range of representative receptors. In identifying potential receptors to be considered in the assessment reference has been made to IAQM and EA guidance. Potential receptors have been considered on the followed basis:

Table 3.2: Receptor Selection Principles

Human Health Receptors	
Houses / groups of houses Schools, hospitals, shops, factories Public rights of way, recreational areas Allotments	identified based on distance from site boundaries, operational areas and haulage distances, sensitivity and likely duration of exposure
Conservation sites	
SPAs, SACs and RAMSAR sites	within 5km of site boundaries
SSSIs	within 2km of site boundaries
National Nature Reserves and Local Nature Reserves	

1: EA guidance for Environmental Permit applications requires consideration of internationally designated sites within 10km of an installation; given the nature of the development significant impacts are not anticipated beyond 2km

3.4 Significance Evaluation Methodology

3.4.1 The severity of impacts and significance of potential air quality effects on human health receptors have been assessed primarily through reference to IAQM guidance with regards to air quality and planning. Where relevant, reference has also been made to the EA guidance for air quality and environmental permitting. The IAQM recommended approach is to initially assess the potential air quality impacts at selected individual receptors before assigning overall significance.

3.4.2 The severity of an impact of a pollutant at a receptor is based on the change in concentrations at a receptor brought about by the scheme (as a percentage of the AQAL) and the resulting average concentration at the receptor as summarised below (see IAQM guidance for full table and explanations):

Table 3.3: Impact Descriptors for individual receptors – long-term concentrations

Long term average concentration at receptor in assessment year	**% Change in Concentration relative to Air Quality Assessment Level (AQAL)**				
	0	**1**	**2-5**	**6-10**	**>10**
75% of less of AQAL	negligible	negligible	negligible	slight	moderate
79-94% of AQAL	negligible	negligible	slight	moderate	moderate
95-102% of AQAL	negligible	slight	moderate	moderate	substantial
103-109% of AQAL	negligible	moderate	moderate	substantial	substantial
110% or more of AQAL	negligible	moderate	substantial	substantial	substantial

Note: Refer to Table 6.3 of IAQM guidance for detail and explanatory notes

3.4.3 The change in concentration relative to the AQAL (the process contribution) is rounded to the nearest whole number. For example, where the % change is less than 0.5%, the %change is 0% and impact descriptor is *negligible*; where between 0.5% and 1.5% the change is 1%.

3.4.4 This approach is only applicable to long-term average concentrations (annual means). In considering short-term peak concentrations (i.e. those averaged over periods of an hour or less) the following impact descriptors are referred to:

Table 3.4: Impact Descriptors for individual receptors – short-term concentrations

% of relevant short-term ES[1]	impact descriptor
10% or less	negligible
10-20%	slight
21-50%	moderate
51% or above	substantial

1: rounded to whole numbers

3.4.5 Where process related contributions are less than 1% of the relevant long-term standard and 10% of the short-term standard then the severity of impacts is *negligible* irrespective of the background concentrations. This is consistent with the screening thresholds provided in the EA guidance for environmental permitting applications.

3.4.6 The IAQM guidance is not applicable to the assessment of air quality impacts on ecological / nature conservation receptors. The ecological assessment is therefore undertaken in accordance with the EA guidance for environmental permitting applications; although NRW (Natural Resources Wales) is the permitting authority for Wales, NRW has not published any specific guidance in relation to environmental permitting and aerial emissions and therefore the EA guidance is deemed most appropriate.

3.2 Overall Assessment

3.2.1 Where negligible impacts are predicted the overall effects will be not significant. In general, where slight impacts at receptors are predicted the resulting effects would be considered to be not significant and moderate and substantial impacts could result in significant effects. However, the judgement of the overall significance of air quality effects takes into account a number of additional factors, including but not limited to:

- the existing and predicted future air quality in the absence of the proposed development;
- the extent of current and future population exposure to the predicted impacts and the severity of those impacts;
- whether the predicted impacts potentially result in failure to achieve compliance, or enhance compliance, with EU AAD values and / or UK AQOs and national and / or local air quality action plans;

- whether the predicted impacts potentially result in the need for declaration of a new or extended AQMA, or removal of an existing AQMA
- whether the predicted impacts potentially result in permanent or temporary damage, or improvements, to nature conservation sites of local, national or international importance and the geographical extent of those impacts;
- the influence and validity of any assumptions adopted when undertaking the prediction of impacts.

4 Existing and Proposed Development

4.1 Full details of the proposed development are included within the planning application and supporting documentation and only those aspects of relevance to the air quality assessment are detailed below.

4.2 Existing Development

4.2.1 The existing plant on site includes a solid biomass CHP plant (a Uniconfort Boiler) and a woodchip dryer (Stela Dryer). The CHP plant was installed in 2017 and replaces the previous boiler used on site. The CHP plant is served by a single main stack of 20m, which replaces the previously utilised stack, and the Stela dryers by 2 stacks of 8m. The buildings are served by a number of other small emergency vent chimneys as marked on the As Existing Site Plan (R. Arwel Davies, 2018/02/AE1/e, 18th March 2018). The Stela dryers are currently located externally to the main building, as the proposed extension permitted under planning reference 02/2015/1095/PF has only been partially built out to date.

4.3 Proposed Development

4.3.1 The proposals are for the installation of additional wood drying equipment and CHP plant to augment the existing operations. The details are as follows:

- relocation of the existing Stela dryer to original woodchip storage area (the southwest corner of the existing building) including the relocation of the two associated stacks to a height of 12m above ground level;
- installation of a new (second) Stela dryer in the original woodchip storage area (the southwest corner of the existing building) including two new stacks to a height of 12m above ground level;
- increase in size (by 18.75%) and height (by 1.58m) of extension building to accommodate an additional CHP plant;
- installation of additional CHP plant with one main stack to a height of 20m above ground level and two emergency stacks;
- a second Organic Rankine Cycle (ORC) unit, which would be introduced next to the existing ORC unit;
- installation of ancillary plant and equipment to support operation of the CHP plant, comprising a water tank and pump house, air-cooler, oil storage tank, transformer and emergency diesel generator;
- removal of two previous chimneys which are no longer in use.

4.3.2 The additional facility would be the same as the CHP plant and Stela dryers installed in 2017. The additions would have a thermal input capacity of $5.2MW_{th}$ and electrical output of 1 MW_e; all the thermal energy will be utilised within the manufacturing process along with ~300KW of electrical energy. The remainder will be available for export to the grid. The total thermal input capacity of the plant would therefore be 10.4MW_{th} and electrical output of 2MW_e.

4.4 Existing and Future Environmental Legislative Control

4.4.1 Since the process utilises virgin woodchip as a fuel and a raw material for the production of a wood-based product, the wood chip is not classified as waste and the biomass CHP plant is not therefore a waste related operation[7]. As the existing thermal input capacity is less than 20MW_{th} the plant falls below the threshold that would currently require an Environmental Permit to operate a combustion process under the Environmental Permitting Regulations 2010 (as amended). The combined plant with the proposed development would similarly remain below the 20MW_{th} capacity.

4.4.2 Existing environmental controls of the facility are through the Clean Air Act (CAA) 1993 which targets smoke emissions from chimneys and industrial plant and smoke emissions from residential and non-residential furnaces and is primarily concerned with the supervision of smaller combustion activities (<20MW_{th}). The key CAA measures are applied and supervised by Local Authorities and include the control (prohibition) of 'grit and dust' emissions and approval of chimney heights. The Local Authority must be satisfied that the height of a chimney is sufficient '*to prevent, so far as practicable, the smoke, grit, dust or gases from becoming prejudicial to health or a nuisance'*.

4.4.3 The existing facility does however fall under the requirements of the EU Medium Combustion Plant Directive (MCPD) which has recently been transposed into UK legislation and which will require future permitting of medium combustion plant (MCP) of between 1MW_{th} – 50MW_{th}[8]. Guidance is currently in the process of being drafted and released by Defra and the EA regarding the requirements of the MCPD.

4.4.4 Under the MCPD from the 20th December 2018 all new plant will be required to obtain a permit to operate; all plant that is existing by December 2018 will need to obtain a permit by 2024 or 2029 depending on size. The MCPD also establishes the requirement for combustion plant to meet specified emission limit values (ELVs); the values are dependent on the fuel and rated thermal input of an installation and whether a plant is 'existing' i.e. has been put into operation (fired with its design fuel up to its full load) by 20th December 2018.

4.4.5 It is anticipated that the regulator will be Natural Resources Wales (NRW); however further guidance and clarification is awaited.

[7] Environment Agency (EA), Regulatory Position Statement, On the environmental regulation of wood
[8] Defra, *Consultation on reducing emissions from medium combustion plant and generators to improve air quality*, November 2016 and subsequent supporting information

5 Baseline Conditions

5.1 General Site Setting

5.1.1 The site is located in a mixed-use area on the northwestern outskirts of Ruthin and consists of the existing wood drying facility of Blazer's Fuels Ltd. The site location is shown in Drawing D01. Access to the facility is gained via Lon Cae Brics / Brickfields Lane to the north off the A525 Lon Gwernydd 260m to the west. Ruthin North Link Road is located 155m to the south.

5.1.2 The adjacent commercial premises to the east are used by Clifford Jones Timber Ltd. Further commercial / industrial premises are located on land to the north and northeast. The surrounds to the west and south consist of undeveloped land. An area of recent residential development is located 175m to the southeast beyond the Ruthin North Link Road, adjacent to which is a recently constructed school. The premises of the Ruthin Livestock Market are located 110m to the southwest

5.1.3 Site boundaries and immediate environs are:

Table 5.1: Site Boundaries and Environs

Direction	Boundary	Neighbouring Land
north	fencing	Brickfields Lane
east	fencing / Trees	Clifford Jones Timber Ltd
south	fencing	timber storage
west	fencing / Hedgerow	field

5.1.4 The closest residential properties are located about 175m to the southeast off Stryd Yr Wennol and Stryd Yr Alarch at the edge of a residential development that extends further to the southeast and south. Golf Links Farm is located 405m to the west.

5.1.5 The buildings of the recently completed Glasdir shared school development are located about 385m to the south of the site, with a pedestrian access off the Ruthin North Link Road 310m to the south and vehicular access off the Ruthin North Link Road 275m to the south.

5.1.6 A public footpath lies 270m to the east of the site.

5.2 Nature Conservation Sites

5.2.1 EA guidance for environmental permitting requires consideration of any international statutory designated sites (such as SPAs, SACs and Ramsar sites) within 10km of an installation and national or local statutory designated sites (such as SSSIs and local nature sites (ancient woods, local wildlife sites, and national and local nature reserves)) within 2km. Given the nature and size of the site however a search radius of 5km is considered appropriate for international designated sites.

5.2.2 The Clwydian Range Area of Outstanding Natural Beauty (AONB) is located approximately 2.7km to the east of the site at its closest point. No other statutory designated sites have been identified within 5km of the site.

5.2.3 No information on locally designated nature conservation sites e.g. County Wildlife Sites has been obtained as part of this assessment.

5.3 Topography

5.3.1 The site is mapped at approximately 50m AOD on OS mapping located within the broad base of the north-south trending valley of the Afon Clwyd. Immediate surrounding land is at a similar elevation. Ground rises steeply on the valley side to the west beyond the A525 285m distant. The valley side to the east beyond the river is initially less steep before rising to the Clwydian Range.

5.4 Air Quality Review

5.4.1 DCC is one of the six local authorities in the North Wales Combined Authority Area. Reference has been made to the Annual Progress Report (APR) 2017, September 2017, prepared by Bureau Veritas for the North Wales Combined Authority in fulfilment of the LAQM reporting requirements.

5.4.2 To date, DCC has not declared any Air Quality Management Areas (AQMAs) within Denbighshire. DCC has not identified any areas of potential poor air quality within the vicinity of the site.

5.5 Background Airborne Pollutant Concentrations

5.5.1 Predicted background air quality data for NO_2, NO_x, PM_{10} and $PM_{2.5}$ were obtained from the Defra LAQM website for the 1km x 1km grid square in which the application site and nearby receptors are located.

5.5.2 The predicted data is based on 2015 ambient monitoring and meteorological data and incorporate revised information on the age and distribution of vehicles and emission factors. Predicted data is provided by Defra for each year from 2015 to 2030.

5.5.3 Predicted background concentrations for the current year (2018) are summarised in the following tables.

Table 5.2: Predicted Background Air Quality Data – 2018

Grid Square	Location	Annual Mean Concentrations (µg/m³)			
		NO_2	NO_x	PM_{10}	$PM_{2.5}$
311500, 359500	Site	6.28	8.54	10.93	7.55
311500, 358500	Site, receptors to south	5.07	6.48	10.80	7.52
	objective (annual mean)	**40**	**30**	**40**	**25**

data downloaded from Defra website on 8th May 2018; data provided on Defra website on 13th November 2017

5.5.4 The average background annual mean NO_2 and PM_{10} concentrations for the grid square in which the assessment site and receptors is located are predicted to be substantially below the AQS objective, at 12.7% and 27% respectively of the objectives in 2018.

5.5.5 It should be noted that the data are effectively an average concentration across each 1 km square. The pollutant concentrations will therefore be higher close to any significant source, such as main roads, junctions and concentrated habitation, such as within the Ruthin town centre.

5.6 Local Authority Monitored Air Quality

Continuous Monitoring

5.6.1 DCC did not operate any automatic monitoring stations within in the borough in 2017.

Diffusion Tube Monitoring

5.6.2 DCC operates a network of diffusion tubes for monitoring NO_2 concentrations across the Council area; in 2015 14 locations were monitored. Four of the monitored locations are within Ruthin and are detailed in the table below and shown on Drawing D02:

Table 5.3: Non-automatic Monitoring Sites

Site ID	Location	Type[1]	Grid reference	Distance and Orientation from Site
DBR20	25 Park Road, Ruthin.	Roadside	312106, 358306	840m SE
DBR37	Haul Fryn Depot, Ruthin	Roadside	312789, 358231	1.37km SE
DBR38	Adj 62 Rhos Street, Ruthin	Roadside	312913, 358273	1.45km SE
DBR54	Adj. 2 Market Street, Ruthin	Suburban	312502, 358376	1.05km SE

1: Defra definitions

5.6.3 None of these locations are within the immediate vicinity of the site, but they do provide data on local air quality within the Ruthin town centre. Recorded concentrations of NO_2 from the diffusion tubes for the period 2012-2016 are as follows:

Table 5.4: Measured Annual Mean Nitrogen Dioxide Concentrations

Site ID	Annual Mean Concentration (µg/m^3) (bias adjusted)				
	2012	2013	2014	2015	2016
DBR20	24.4	24	21.3	21.2	19.8
DBR37	29.9	29.4	28.5	28.0	26.6
DBR38	21	19.9	17.9	16.5	16.8
DBR54	n/a	n/a	16.1	13.2	13.7

5.6.4 The annual mean NO_2 concentrations are all well below the UK annual objective of 40µg/m^3, but as would be expected are above the Defra background concentrations due to proximity to roads.

5.7 Industrial Emissions and Other Emission Sources

5.7.1 Clifford Jones Timber operates on the neighbouring premises to the east. Activities at this facility are not likely to have significant impacts on local air quality with regards to the pollutants under consideration, as discussed later in section 7.0.

5.7.2 No other local facilities have been identified within 2km of the site that may significantly impact local air quality. No installations operating under an Environmental Permit that may significantly impact local air quality have been identified within 3km of the application site.

5.8 Wind speed and direction

5.8.1 The most important meteorological parameters governing the atmospheric dispersion of pollutants are:

- wind direction: determines the broad direction of the transport of the emission;
- wind speed: affects the ground levels concentrations by determining the initial dilution of pollutants emitted;
- atmospheric stability: a measure of atmospheric turbulence and hence dispersion of pollutants.

5.8.2 The two closest meteorological stations to the Site are located at Rhyl No 2 (NGR: 299448 374652; 77m aod), about 19.7km to the northwest, and at Bala (NGR: 293549, 335636; 163m aod), about 29.5km to the southwest. Although referred to as Rhyl No 2, the Rhyl station is located inland away from the town of Rhyl.

5.8.3 The annual windroses for Bala and Rhyl for the years 2006-2015 and 2007-2016 are provided in Appendix A. The Rhyl No 2 windrose shows the prevailing wind direction to be broadly south-easterly to north-easterly, consistent with typical UK conditions. The Bala windrose is very different with a prominent south-westerly wind direction, atypical for the UK, and thought to be heavily influenced by the valley of Llyn Tegid / Bala Lake to the southwest.

5.8.4 Meteorological conditions at the Site itself will be influenced by the location of the Afon Clwyd valley and presence of the Clwydian Range to the east and northeast of the Site. Given the uncertainties in the applicability of the available monitored meteorological data to conditions at the Site the assessment has referred to NWP (Numerical Weather Prediction) meteorological data obtained from the Met Office for the Site for the years 2012-2016 and provided in Appendix A.

5.8.5 The windroses show prevailing winds to be east-southeasterly through to south-southeasterly consistent with the influences of the Clwydian Range.

6 Assessment – Model Setup

6.1 Introduction

6.1.1 The ADMS atmospheric dispersion model (ADMS 5) was used to model potential ground-level pollutant concentrations arising from the current and proposed stack emissions.

6.2 Sources of Emissions

6.2.1 The model set-up included both the existing CHP boiler and Stela dryers, the proposed additional CHP boiler and Stela dryer and the relocated existing dryer.

6.2.2 The pre-installation information on the existing and proposed stack characteristics, based on the information provided by NEL, Axis and the supplier (OEM: Original Equipment Manufacturer), are summarised in Table 6.1 and 6.2:

Table 6.1: Current Stack Characteristics

	Biomass boiler No 1	Stela Dryer No1 & 2
stack heights	20m	8m
effective internal diameter	0.9m	2.0m
volumetric flow rate (reference conditions)	12,202 (11% O_2; dry gas) Nm^3/h	2 x 77,000 Nm^3/h
volumetric flow rate (actual conditions)	20,328 Am^3/h	2 x 89,500 Am^3/h
exhaust velocity	8.88 m/s	7.9 m/s
flue gas temperature	181°C	40°C

Notes:
1: based on pre-installation data provided by Axis, NEL and Uniconfort for the proposed new installation; understood to be the same equipment
2: drawing ref: 2018/02/AE1/I, dated 18th March 2018, produced by R Arwel Davies & Co

Table 6.2: Proposed Stack Characteristics

	Biomass boilers		Stela Dryers	
	No 1 (existing)	No 2 (new)	No 1 & 2 (relocated)	No 3 & 4 (new)
stack heights	20m	20m	12m	12m
effective internal diameter	0.9m		2.0m	
volumetric flow rate (reference conditions)	12,202 (11% O_2; dry gas) Nm^3/h		4 x 77,000 Nm^3/h	
volumetric flow rate (actual conditions)	20,328 Am^3/h		4 x 89,500 Am^3/h	
exhaust velocity	8.88 m/s		7.9 m/s	
flue gas temperature	181°C		40°C	

Notes:
1: based on pre-installation data provided by Axis, NEL and Uniconfort for the equipment
2: drawing ref: 2018/02/AP1/a, dated 12th April 2018 produced by R Arwel Davies & Co

6.2.3 The proposals include for the re-location of the existing Stela dryer stacks, which will be increased in height, and removal of the existing, but now disused, former main chimney. The proposed new CHP plant boiler and Stela dryers are understood to be the same specification as the recently installed boiler and dryers.

6.2.4 The pollutant emission concentrations and emission rates for each stack based on the above OEM data are detailed in the following table.

Table 6.3: Summary Emission Rates: based on OEM Data

Pollutant	Emission concentration[1] (mg/m^3)	Emission rate[1] ($g\ s^{-1}$)
Biomass Boiler (per stack)		
NO_x	350	1.18
PM	Dust = 10	0.34
Stela Dryer (per stack)		
NO_x	none	n/a
PM	Dust = <10 mg/Nm^3	Dust = 0.427 g/s (combined)

1: Emission concentrations and / or emission rates provided by NEL and Uniconfort
2: Dust = Total Particulate Matter of which PM_{10} and $PM_{2.5}$ will be a proportion

6.2.5 NEL has also provided SGP with monitoring results for the existing biomass CHP boiler stack exhaust and the two Stela dryer stacks. The monitoring was undertaken by Exova Catalyst in October 2017 and June 2018 for total particulate matter (PM) and oxides of nitrogen. The results of these monitoring exercises are summarised below in Table 6.4 and 6.5:

Table 6.4: CHP Stack Exhaust Monitoring Results: October 2017 and June 2018

Parameter	June 2018[1]		October 2017[2]	
	Conc. (mg/m^3)	Rate (g/s)	Conc. (mg/m^3)	Rate (g/s)
NO_x (as NO_2)	155	0.38	82.1	0.20
total particulate matter (PM)	8.6	0.02	6.4	0.02
PM_{10}	not undertaken		0.29	0.0007
$PM_{2.5}$	not undertaken		0.21	0.0005
Other Parameters				
temperature	198ºC		160 ºC	
exit velocity	6.8 m/s		6.1 m/s	
volumetric flow (actual)	14,630 m^3/hr		14,061 m^3/hr	
volumetric flow (reference)	8,757 m^3/hr		8,827 m^3/hr	
oxygen content (dry)	9.6% v/v		11.6% v/v	
water vapour	10.8% v/v		11.6%	

1: Monitoring undertaken by Exova Catalyst on 13th June 2018; report ref: CAT-4237; reference conditions were 273K, 101.3kPa, dry gas, 11% oxygen; data used for model inputs

2: Monitoring undertaken by Exova Catalyst on 5th October 2017; report ref: CAT-3701; reference conditions were 273K, 101.3kPa, without correction for water vapour

Table 6.5: Stale Dryer Stack Exhaust Monitoring Results: June 2018

Parameter	Belt Dryer 1[1]		Belt Dryer 2[2]	
	Conc. (mg/m^3)	Rate (g/s)	Conc. (mg/m^3)	Rate (g/s)
NO_x (as NO_2)	n/a	n/a	n/a	n/a
total particulate matter (PM)	3.4	0.073	7.5	0.494
PM_{10}	0.94	0.02	0.24	0.016
$PM_{2.5}$	0.68	0.01	0.29	0.019
Other Parameters				
temperature	30.0ºC		30.0ºC	
exit velocity	7.6 m/s		23.1 m/s	
volumetric flow (actual)	85,720 m^3/hr		261,631 m^3/hr	
volumetric flow (actual)	77,450 m^3/hr		237,738 m^3/hr	
oxygen content (dry)	21.0% v/v		20.9% v/v	
water vapour	3.7% v/v		4.1% v/v	

2: Monitoring undertaken by Exova Catalyst on 13th-14th June 2018; report ref: CAT-4238; reference conditions were 273K, 101.3kPa, dry gas, without correction for water vapour content; data used for model inputs

3: Monitoring undertaken by Exova Catalyst on 14th June 2018; report ref: CAT-4238; reference conditions were 273K, 101.3kPa, dry gas, without correction for water vapour content

6.2.6 There are variations between the 2 sets of data for the CHP stack as would be expected. The later June 2018 monitored data results in higher pollutant emission rates and this has therefore been used in the modelling exercise.

6.2.7 The data for the Stela Dryer No 2 reports an unusually high flow. It also appears that the concentrations of PM_{10} and $PM_{2.5}$ reported are actually the limit of detection (LOD). These results have not therefore been referred to further in the assessment. The earlier October 2017 monitoring did not include the Stela dryers. The June 2018 data has therefore primarily been used in the assessment. The October data has however been referred to provide data on the PM_{10} and $PM_{2.5}$ emissions from the Biomass boiler as a % of the total PM emissions.

6.2.8 The emission concentration data in Tables 6.3, 6.4 and 6.5 are not directly comparable as adjustments are required for temperature, water content and moisture content. However, the resulting NO_x and PM mass emission rates for both the boiler stack and dryer stacks are substantially lower than the OEM data.

6.2.9 The model was run for the following scenarios:

Table 6.5: Model Scenarios

Scenario	Comment
A1	Existing stacks and layout; OEM emissions data
A2	Existing stacks and layout; monitored emissions data
B1	Proposed future stacks and layout (including retained existing); OEM emissions data
B2	Proposed future stacks and layout (including retained existing); monitored emissions data

6.2.10 The scheme also includes two emergency stacks which are to be provided for the biomass boiler. NEL has advised that these stacks will vent for a 20-minute period in the event of an emergency shut-down; the likelihood of such an event is considered to be extremely low. The controlled shut-down of the plant will take place twice a year and will vent from the main stack. Given the unlikely occurrence of emissions from these stacks, and the short-term nature of any such emissions if they do occur, further assessment is not considered necessary.

6.3 General Model Input Parameters

Meteorological Data

6.3.1 The dispersion modelling has been undertaken using 5 years of hourly sequential NWP modelled data (years 2013-2017) provided by the Met Office; the use of 5 years' data is recommended by the EA[9].

Building Wake Effects

6.3.2 Buildings in the vicinity of a stack are known to affect the dispersion of flue gases. In practice, the significance of building effects depends on their proximity to the stack and their height in relation to height of the stack. In this case the main site building and adjoining building have been included within the model.

Terrain

6.3.3 The presence of hills and valleys can modify the dispersion of emissions and the resulting pollutant concentrations. CERC, the provider of the ADMS modelling software, advise that terrain effects should be considered if the slope of the terrain exceeds 1 in 10. The area immediately surrounding the Site is relatively level with the ground starting to rise towards the Clwydian Range about 1km to the east. On this basis terrain effects were not considered important in this instance.

[9] Environment Agency (EA) / Department for Environmental, Food and Rural Affairs (Defra), www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports, published 1st November 2014

Surface Roughness

6.3.4 Surface roughness plays an important part in determining the mechanical turbulence generated in the atmosphere as wind passes and generates turbulence which can modify the dispersion of gases and needs to be considered in the modelling process. The area surrounding the works is mixed with light industrial to the east and north, fields to the west and built development to the south. A surface roughness length of 0.5m has therefore been used in the model.

Operational Hours

6.3.5 The assessment has considered 365/24/7 operational hours.

Modelled Domain and Receptors

6.3.6 A variable grid spacing was used within the modelled domain based on a 15m spacing across a 400m x 400m area centred on the Site and a 50m spacing across a wider 2km by 2km area centred on the site.

6.3.7 In addition to the area assessment, individual receptors in the locality have been identified for consideration as detailed in the following table and in Drawing D03. These have been selected to represent a range of potentially sensitive locations within 1km of the site and include the closest centres of public occupation and use.

Table 6.6: Individual Receptors – relevant receptors

ref	name	type	X (m)	Y (m)	distance & orientation
Human Health Receptors					
R1	Glasdir shared school access	school	311576	358668	310m S
R2	Glasdir shared school access	school	311673	358718	275m S
R3	Stryd Yr Ehedydd	residential (community)	311731	358743	275m SSE
R4	Stryd Yr Wennol	residential (community)	311741	358816	210m SSE
R5	Stryd Yr Wennol	residential (community)	311799	358892	175m SE
R6	Stryd Yr Alarch	residential (community)	311886	358937	215m SE
R7	Golf Links Farm	residential (isolated)	311195	358842	395m W
R9	Granary, Tyddan Isaf	residential (assumed)	311112	359186	405m NW
R10	Footpath	leisure	311904	359136	270m E
R11	Ruthin Livestock Market	leisure / commercial	311543	358868	115m SW
R12	Bodlondeb	residential (community)	311221	359538	530m NW
R13	Bodlondeb	residential (community)	311221	359577	560m NW
R14	A525	residential (community)	311148	359589	610m NW
R15	Cae Seren	residential (community)	311921	358456	615m SE
R16	Y Parc	residential (community)	311804	358473	545m SE
R17	Y Parc	residential (community)	311582	358503	470m S
R18	Canol-Y-Dre	residential (community)	312326	358695	735m SE
R19	Min Yr Afon	residential (community)	312219	358440	815m SE

1: Distance from wider site boundary to nearest 5m; orientation from site

2: R1 & R2 represent leisure use at new school; R11, the livestock market has been included as it may represent a location where members of the public may spend 1 hour or more

3. R8 not used as represents former farm buildings now demolished as part of school development

6.3.8 All represent locations where members of the public may be exposed to ambient air (residential properties, schools, footpaths etc) with R3-R9 and R12-R19 representing those locations where long-term and short-term AQALs are relevant, and receptors R1-R2 and R10-R11 representing areas of open leisure use where exposure is short-term.

6.3.9 The nearest identified nature conservation site is over 2km distant. Given the size of the facility and nature of the proposed operations detailed assessment of potential impacts on this site is not considered necessary.

Summary Model Conditions

6.3.10 The general model conditions are summarised below:

Table 6.7: ADMS Model Input Parameters

Variables	Model Input
emissions	NO_x, PM_{10} and $PM_{2.5}$ (based on CHP June 2018 data and Stala Dryer No1 June 2018 data)
emission profiles	average throughout 24 hours; 8,760 hours per annum operation
surface roughness at source	0.5m
terrain	not included
meteorological data	5 years (2013-2017) hourly sequential NWP data centred on the site
surface roughness at meteorological data location	0.5m
grid spacing	15m: 400m x 400m 50m: 2km x 2km
model output	modelled pollutant concentrations for different averaging periods within modelled domain and at modelled receptors
receptor location	x, y coordinates, z = 0m (see Table 6.7 and Figure 6.1)

7 Assessment – Human Health

7.1 Introduction

7.1.1 The monitored emissions data is considered to be more representative than the OEM data. The assessment has primarily been undertaken on this data. To provide a robust and transparent assessment however, reference has also been made to the results of the modelling using the OEM data.

7.1.2 The maximum predicted Process Contributions (PCs) for each pollutant from the stack emissions for the existing and proposed scenarios within the modelled domain and at each modelled receptor for each year are provided in Appendix C. The differences in the PCs between the two scenarios (i.e. Scenario B-Scenario A) within the modelled domain and at each relevant receptor have been calculated. This enables assessment of the potential impacts of the additional emission sources and alterations to existing sources associated with the proposals. In accordance with the IAQM guidance the results are assessed against relevant AQALs as detailed in Section 2.

7.1.3 Where the modelling predicts potential PCs from the proposals within the modelled domain are below the screening thresholds (short term PC <10% of relevant AQAL; long term PC <1% of AQAL), the severity of the impacts of the PCs can be seen to be *negligible* and no further assessment is required. Where the PCs within the modelled domain are in excess of the screening thresholds further assessment is undertaken considering the predicted PCs at relevant receptors. Where screening thresholds are exceeded at these receptors account is taken of the background concentrations to determine the severity of impacts at affected receptors with reference to IAQM guidance, and where necessary EA guidance.

7.1.4 The Predicted Environmental Concentrations (PECs) for long-term concentrations are calculated as follows:

$PEC_{(long\ term)}$ = BC (background concentration) + PC (Process Contribution)

7.1.5 To provide a robust assessment the background concentration at an individual receptor has been taken as the predicted Defra background pollutant concentration for the gird square in which a receptor in located plus the modelled PC at that receptor arising from the existing scenario.

7.1.6 For short term impacts IAQM guidance is that background concentrations are less important in determining severity of impacts, particularly as the peak concentrations attributable to a source and the background are not additive.

7.1.7 A proportion of the emissions of NO_x are likely to be nitric oxide (NO) for which no air quality objective or limit exists rather than NO_2. The emitted NO will be converted in part to NO_2 at a rate dependent upon several factors including ozone concentrations and solar radiation levels. In accordance with EA guidance therefore[10] the assessment is undertaken using 35% and 70% conversion of the modelled NO_x to NO_2 values for short-term and long-term average concentrations respectively.

7.2 Predicted PCs with Monitored Data (Scenario B2-Scenrio A2)

7.2.1 The maximum predicted ground-level PCs within the modelled domain associated with the proposals, across the 5 years, with respect to human health and the proposed development are summarised below in Table 7.1.

Table 7.1: Maximum Predicted PCs due to the Proposed Alterations within the Modelled Domain: Monitored Data Human Health

Pollutant	Averaging Period	AQAL	PC[1]	Year	PC % AQAL	Comment
Long-term concentrations						
NO_2[2]	annual mean (1 hr)	40	1.71	2013	4	≥1% AQAL; further assessment
PM_{10}[4]	annual mean (1 hr)	40	0.57	2013	1	≥1% AQAL; further assessment
$PM_{2.5}$[5]	annual mean (1 hr)	25	0.43	2013	2	≥1% AQAL; further assessment
Short-term concentrations						
NO_2[3]	1-hour (99.79^{th} %ile)	200	10.64	2013	5	<10% AQAL; no further assessment required
PM_{10}	daily mean (90.4^{th} %ile)	50	1.67	2015	3	

Notes: No further assessment required when maximum predicted process contributions within the modelled domain are less than the screening thresholds (i.e. <1% of AQAL for long-term and <10% of AQAL for short-term)
1: PC = PC Scenario B – PC Scenario A
2: assumes 70% conversion modelled NO_x to NO_2
3: assumes 35% conversion modelled NO_x to NO_2
4: assumes CHP stack PM10 and PM2.5 each emitted as 100% PM
All concentrations µg/m^3 unless stated otherwise

7.2.2 The maximum long-term NO_2, PM_{10} and $PM_{2.5}$ concentrations within the modelled domain are above the screening thresholds referred to and further assessment has therefore been undertaken of predicted PCs at the modelled receptors.

7.2.3 The maximum short-term NO_2 and PM_{10} concentrations within the modelled domain are all less than the screening criteria and no further assessment is required. To provide a comprehensive assessment however the maximum modelled short-term concentrations at receptors are reported below.

7.2.4 The maximum predicted ground level concentrations at the most affected relevant receptors, with respect to human health and long-term AQALs are summarised below in Table 7.2. For locations

[10] EA AQMAU FAQs: Conversion Ratios for NO_x and NO_2, www.environment-agency.gov.uk

where the long-term AQALs are relevant the maximum process contributions are experienced at R4, representing housing on Stryd Yr Wennol to the southeast.

Table 7.2: Maximum Predicted PCs at a Relevant Receptor due to the Proposed Alterations: Monitored Data Long-term AQALs

Pollutant	Averaging period	AQAL	PC	Receptor	PC %AQAL[2]	BC[3]	PEC	PEC %AQAL[2]
NO_2[1]	annual mean (1hr)	40	0.63	R5	2	5.82	6.45	16
PM_{10}[4]	annual mean (1hr)	40	0.19	R5	0	*PC negligible*		
$PM_{2.5}$[4]	annual mean (1hr)	25	0.15	R5	1	7.68	7.81	31

All concentrations µg/m³ unless stated otherwise

1: assumes 70% conversion of modelled NO_x to NO_2

2: rounded to nearest whole figure in accordance with IAQM guidance; severity of impacts of PC are negligible when <1% of AQAL

3: BC = Defra predicted background NO_2 concentration for 2018 for relevant grid square + modelled existing scenario process contribution (70% modelled NO_2) at receptor

4: assumes CHP stack PM10 and PM2.5 each emitted as 100% PM

7.2.5 For assessment against the short-term AQALs consideration is also made to additional locations where these AQALs may potentially be relevant. In this regard the maximum process contributions are experienced at R11, which represents the livestock market to the southwest, and R4-R5, representing residential housing on Stryd Yr Wennol to the southeast.

Table 7.3: Maximum Predicted PCs at a Relevant Receptor due to the Proposed Alterations: Monitored Data Short-term AQALs

Pollutant	Averaging period	AQAL	PC	Receptor	PC %AQAL[2]	Comment[3]
Residential, schools etc						
NO_2[1]	1-hour (99.79th %ile)	200	4.08	R4	2	*PC negligible*
PM_{10}[3]	daily mean (90.4th %ile)	50	0.68	R4	1	*PC negligible*
Leisure						
NO_2[1]	1-hour (99.79th %ile)	200	3.82	R10	2	*PC negligible*
PM_{10}[3]	daily mean (90.4th %ile)	50	0.35	R11	1	*PC negligible*

All concentrations µg/m³ unless stated otherwise

1: assumes 35% conversion of modelled NO_x to NO_2

2: rounded to nearest whole number in accordance with IAQM guidance

3: where severity of impacts of PC is negligible when ≤10% of AQAL

4: assumes CHP stack PM10 and PM2.5 each emitted as 100% PM

Nitrogen Dioxide - Long-Term Assessment

7.2.6 Contour plots for the annual mean NO_2 PCs (assuming 70% conversion) are provided in Appendix C for each of the 5 modelled years. The 0.2 µg/m^3 contour, which represents 1% of the AQAL (when taking account of rounding e.g. 0.5% (0.2 µg/m^3) rounds up to 1%), extends across the residential development area to the southeast and area to the northwest.

7.2.7 The predicted long-term PC from the stacks at relevant receptors peaks at 0.63 µg/m^3 (assuming 70% NO_x conversion) at the properties on Stryd Yr Wennol (R5). This is at the screening threshold of 1% of the AQAL, at 2%, indicating the need for further assessment through consideration of background concentrations.

7.2.8 The resulting PEC, at 5.82 µg/m^3, is substantially below the AQAL at 16%. With reference to the IAQM guidance the severity of impacts at this receptor are *negligible* (% change in concentration relative to AQAL is in the 2-5% range and long-term average concentration at receptor is <75% of AQAL).

7.2.9 Predicted PCs at some other modelled residential receptors are similarly at 1% to 2% of the AQAL; resulting PECS are similarly substantially below 75% of the AQAL and the severity of impacts are all *negligible*. The results for receptors where the PCs are 1% or above are summarised below.

Table 7.4: Summary of Long-term NO_2 Impacts at Modelled Relevant Receptors due to Proposed Alterations: Monitored Data

Receptor	PC NO_2[1] annual mean (1hr)	PC %AQAL[2]	BC[3]	PEC	PEC %AQAL[2]	Impact descriptor
R2	0.33	1	5.36	5.69	14	*PC negligible*
R3	0.47	1	5.55	6.03	15	*PC negligible*
R4	**0.63**	2	5.81	6.44	16	*PC negligible*
R5	0.63	2	5.82	6.45	16	*PC negligible*
R6	0.43	1	5.57	6.00	15	*PC negligible*
R9	0.28	1	6.86	7.14	18	*PC negligible*

All concentrations µg/m^3 unless stated otherwise

1: long-term NO_2 = 70% modelled NO_2

2: rounded to nearest whole number in accordance with IAQM guidance

3: BC = Defra predicted background concentration for 2018 for grid square in which receptor located + modelled long-term existing scenario Process Contribution (70% NO_2 modelled) at receptor

7.2.10 Predicted PCs at all other modelled residential receptors are less than 0.5% of the AQAL (i.e. 0%) and the severity of impacts are all *negligible* regardless of background concentrations.

Nitrogen Dioxide - Short-Term Assessment

7.2.11 The predicted short-term NO_2 PC peaks at relevant receptors at 4.08 µg/m^3 (assuming 35% of modelled values) at receptor R4, a residential property on Stryd Yr Wennol. At 2% of the AQAL this is well below the IAQM screening threshold of 10% of the AQAL. The PC therefore has a *negligible* severity of impact and no further assessment of short-term impacts is required.

Nitrogen Dioxide – Additional Considerations

7.2.12 The long-term assessment above uses the Defra predicted background concentrations for the grid square in which a receptor is located with the addition of the PC from the existing Site stack emissions. Background concentrations may however be higher where a receptor is located close to an existing source of NO_2 emissions such as a busy road etc, as indicated by the diffusion tube monitoring within the town centre. All the relevant receptors above are however located away from busy roads and other potential significant pollutants sources and the background concentrations referred to are considered appropriate for the assessment.

PM_{10} - Long-Term Assessment

7.2.13 The predicted long-term PM_{10} PC peaks at relevant receptors at 0.19 µg/m^3 at the properties on Stryd Yr Wennol Park (R5). At 0.4% the PC is below the screening threshold of 1% of the relevant AQAL (<0.5%) and the severity of impacts at all modelled receptors is therefore *negligible* irrespective of background concentrations and no further assessment is required.

7.2.14 This is highly conservative as the modelling has assumed PM_{10} emissions from the CHP stacks are emitted as 100% PM. With reference to the October 2017 monitoring data for the CHP and Table 7.6 below the PM_{10} emissions only form a small proportion (<5% of the emitted PM from the CHP boiler stack. This would result in a significant reduction in the predicted PCs from the CHP stacks within the modelled domain and at receptors.

PM10 - Short-Term Assessment

7.2.15 The predicted short-term PM_{10} PC peaks relevant receptors at 0.68 µg/m^3 at the properties on Stryd Yr Wennol Park (R4). At 1% of the relevant short-term AQAL this is well below the IAQM screening threshold of 10%; the severity of impacts at all modelled receptors is therefore *negligible*.

7.2.16 The above comments with regards to PM10 emissions from the CHP stack apply.

$PM_{2.5}$ - Long-Term Assessment

7.2.17 The IAQM guidance also recommends consideration of $PM_{2.5}$ for assessment of combustion emissions. The predicted long-term $PM_{2.5}$ PC peaks at 0.15 µg/m^3 at the properties on Stryd Yr Wennol (R5). At 1% of the AQAL this is at the IAQM screening threshold (allowing for rounding) indicating the need for further assessment considering background concentrations.

7.2.18 The resulting PEC of 7.68 µg/m³ is substantially below the AQAL at 31% of the AQAL. The resulting severity of impacts at the worst affected receptor is *negligible*.

7.2.19 Predicted PCs at some other modelled residential receptors are at 1% of the AQAL; resulting PECs are similarly substantially below 75% of the AQAL and the severity of impacts are all *negligible*. The results for the receptors where the PCs are 1% or above are summarised below.

Table 7.5: Summary of Long-term $PM_{2.5}$ Impacts at Modelled Relevant Receptors due to Proposed Alterations: Monitored Data

Receptor	PC PM2.5 annual mean (1hr)	PC %AQAL[1]	BC[2]	PEC	PEC %AQAL[1]	Impact descriptor
R3	0.14	1	7.67	7.75	31	*negligible*
R4	0.15	1	7.67	7.82	31	*negligible*
R5	0.14	1	7.67	7.81	31	*negligible*

All concentrations µg/m³ unless stated otherwise

1: rounded to nearest whole number in accordance with IAQM guidance

2: BC = Defra predicted background concentration for 2018 for grid square in which receptor located + modelled long-term existing scenario Process Contribution at receptor

7.2.20 Predicted PCs at all other modelled residential receptors are less than 0.5% of the AQAL and the severity of impacts are all *negligible* regardless of background concentrations.

7.2.21 This assessment is highly conservative as the modelling has assumed PM_{10} emissions from the CHP stacks are emitted as 100% PM. With reference to the October 2017 monitoring data for the CHP and Table 7.6 below the PM_{10} emissions only form a small proportion (<5% of the emitted PM from the CHP boiler stack. This would result in a significant reduction in the predicted PCs from the CHP stacks within the modelled domain and at receptors.

7.3 Predicted PCs with OEM Data (Scenario B1 – Scenario A1)

7.3.1 The above assessment is based on the recent monitored data as discussed in Section 6. To provide a fully transparent assessment consideration has also been made of the potential impacts associated the emissions data as provided by the OEM.

7.3.2 The OEM data includes for total particulate matter emissions (PM) from the boiler and dryer stacks, but not the PM_{10} or $PM_{2.5}$ components. The June 2018 monitoring data shows the PM_{10} and $PM_{2.5}$ emissions concentrations and rates to comprise the following % of total PM:

Table 7.6: PM10 and PM2.5 as %of total PM[1]

	Boiler[1]	Dryer 1[2]
PM10	4.5%	27.6%
PM2.5	3.3%	20%

1: Based on Catalyst Exova monitoring data of October 2017

2: Based on Catalyst Exova monitoring data of June 2018

7.3.3 For the purposes of the assessment it has initially been assumed that PM_{10} concentrations are 50% of total PM emissions and $PM_{2.5}$ are 25% of total PM emissions and the modelled PCs at receptors pro-rated accordingly. This is highly conservative as the above data indicates PM_{10} and $PM_{2.5}$ will be much lower proportions.

7.3.4 The resulting maximum predicted ground level concentrations at the most affected relevant receptors, with respect to human health and long-term AQALs are summarised below in Table 7.7. For locations where the long-term AQALs are relevant the maximum process contributions are experienced at R4 and R5, representing housing on Stryd Yr Wennol to the southeast.

Table 7.7: Maximum Predicted PCs at a Relevant Receptor due to the Proposed Alterations: OEM Data Long-term AQALs

Pollutant	Averaging period	AQAL	PC	Receptor	PC %AQAL[3]	BC[4]	PEC	PEC %AQAL[3]
NO_2[1]	annual mean (1hr)	40	1.80	R5	5	7.25	9.05	23
PM_{10}[2]	annual mean (1hr)	40	1.35	R4	3	12.2	14.9	37
$PM_{2.5}$[2]	annual mean (1hr)	25	0.67	R4	3	8.9	11.6	29

All concentrations µg/m^3 unless stated otherwise

1: assumes 70% conversion of modelled NO_x to NO_2

2: assumes PM_{10} = 50% total PM and $PM_{2.5}$ = 25% total PM

3: rounded to nearest whole figure in accordance with IAQM guidance; severity of impacts of PC are negligible when <1% of AQAL

4: BC = Defra predicted background NO_2 concentration for 2018 for relevant grid square + modelled existing scenario process contribution at receptor

7.3.5 For assessment against the short-term AQALs consideration is also made to additional locations where these AQALs may potentially be relevant. The maximum process contributions remain experienced at R4-R5, representing residential housing on Stryd Yr Wennol to the southeast.

Table 7.8: Maximum Predicted PCs at a Relevant Receptor due to the Proposed Alterations: OEM Data Short-term AQALs

Pollutant	Averaging period	AQAL	PC	Receptor	PC %AQAL[2]	Comment[3]
Residential, schools etc						
NO_2[1]	1-hour (99.79th %ile)	200	11.86	R4	6	*PC negligible*
PM_{10}[2]	daily mean (90.4th %ile)	50	4.91	R4	10	*PC negligible*
Leisure						
NO_2[1]	1-hour (99.79th %ile)	200	10.75	R10	5	*PC negligible*
PM_{10}[2]	daily mean (90.4th %ile)	50	2.75	R11	5	*PC negligible*

All concentrations µg/m^3 unless stated otherwise

1: assumes 35% conversion of modelled NO_x to NO_2

2: assumes PM_{10} = 50% total PM

3: rounded to nearest whole number in accordance with IAQM guidance

4: where severity of impacts of PC is negligible when ≤10% of AQAL

NO_2 - Long-Term Assessment

7.3.6 The predicted long-term PC from the stacks assuming the OEM predicted emissions at relevant receptors peaks at 1.8 µg/m^3 (assuming 70% NO_x conversion) at the properties on Stryd Yr Wennol (R4). This is above the screening threshold of 1% of the AQAL, at 5%, indicating the need for further assessment through consideration of background concentrations.

7.3.7 The resulting PEC, at 9.05 µg/m^3, is substantially below the AQAL at 23%. With reference to the IAQM guidance the severity of impacts at this receptor are *negligible*.

7.3.8 Predicted PCs at some other modelled residential receptors are >1% of the AQAL; resulting PECS are similarly substantially below 75% of the AQAL and the severity of impacts are all *negligible*. The results for receptors where the PCs are 1% or above are summarised below.

Table 7.9: Summary of Long-term NO_2 Impacts at Modelled Relevant Receptors due to Proposed Alterations: OEM Data

Receptor	PC NO_2[1] annual mean (1hr)	PC %AQAL[2]	BC[3]	PEC	PEC %AQAL[2]	Impact descriptor
R1	0.32	1	5.33	5.65	14	*PC negligible*
R2	0.96	2	5.91	6.86	18	*PC negligible*
R3	1.37	3	6.47	7.85	20	*PC negligible*
R4	1.80	4	7.19	8.99	22	*PC negligible*
R5	**1.80**	**5**	**7.25**	**9.05**	**23**	***PC negligible***
R6	1.26	3	6.55	7.81	20	*PC negligible*
R9	0.76	2	7.32	8.08	20	*PC negligible*
R12	0.53	1	7.11	7.64	19	*PC negligible*
R13	0.50	1	7.09	7.58	19	*PC negligible*
R14	0.48	1	7.05	7.53	19	*PC negligible*
R15	0.49	1	5.59	6.08	15	*PC negligible*
R16	0.50	1	5.56	6.07	15	*PC negligible*
R18	0.29	1	6.33	6.62	17	*PC negligible*
R19	0.30	1	6.33	6.63	17	*PC negligible*

All concentrations µg/m^3 unless stated otherwise

1: long-term NO_2 = 70% modelled NO_2

2: rounded to nearest whole number in accordance with IAQM guidance

3: BC = Defra predicted background concentration for 2018 for grid square in which receptor located + modelled long-term existing scenario Process Contribution (70% NO_2 modelled) at receptor

7.3.9 Predicted PCs at all other modelled residential receptors are less than 0.5% of the AQAL (i.e. 0%) and the severity of impacts are all *negligible* regardless of background concentrations.

NO_2 - Short-Term Assessment

7.3.10 The predicted short-term NO_2 PC peaks at relevant receptors at 11.86 µg/m^3 assuming the OEM predicted emissions (assuming 35% of modelled values) at receptor R5, a residential property on Stryd Yr Wennol. At 6% of the AQAL this is below the IAQM screening threshold of >10% of the AQAL. The PC therefore has a *negligible* severity of impact and no further assessment of short-term impacts is required.

PM_{10} - Long-Term Assessment

7.3.11 The predicted long-term PM_{10} PC assuming the OEM emissions peaks at relevant receptors at 1.35 µg/m^3 at the properties on Stryd Yr Wennol Park (R4). At 3% the PC is above the screening threshold of 1% of the relevant AQAL (<0.5%) indicating the need for further assessment considering the background concentrations. The resulting PEC is 14.9 µg/m^3, 37% of the AQAL, with resulting *negligible* severity of impacts.

7.3.12 Predicted PCs at some other modelled residential receptors are >1% of the AQAL; resulting PECS are similarly substantially below 75% of the AQAL and the severity of impacts are all *negligible*. The results for receptors where the PCs are 1% or above are summarised below.

Table 7.10: Summary of Long-term PM_{10} Impacts at Modelled Relevant Receptors due to Proposed Alterations: OEM Data

Receptor	PC PM_{10}[1] annual mean (1hr)	PC %AQAL[2]	BC[3]	PEC	PEC %AQAL[2]	Impact descriptor
R1	0.28	1	11.0	11.3	28	*PC negligible*
R2	0.89	2	11.5	13.3	33	*PC negligible*
R3	1.12	3	11.8	14.0	35	*PC negligible*
R4	**1.35**	**3**	**12.2**	**14.9**	**37**	***PC negligible***
R5	1.26	3	12.2	14.7	37	*PC negligible*
R6	0.84	2	11.7	13.4	34	*PC negligible*
R9	0.57	1	11.7	12.8	32	*PC negligible*
R12	0.35	1	11.5	12.2	31	*PC negligible*
R13	0.34	1	11.5	12.2	30	*PC negligible*
R14	0.31	1	11.4	12.0	30	*PC negligible*
R15	0.35	1	11.1	11.8	30	*PC negligible*
R16	0.39	1	11.1	11.9	30	*PC negligible*
R19	0.21	1	11.4	11.8	30	*PC negligible*

All concentrations µg/m^3 unless stated otherwise

1: assumes PM10 = 50% total emitted PM

2: rounded to nearest whole number in accordance with IAQM guidance

3: BC = Defra predicted background concentration for 2018 for grid square in which receptor located + modelled long-term existing scenario Process Contribution at receptor

7.3.13 Predicted PCs at all other modelled residential receptors are less than 0.5% of the AQAL (i.e. 0%) and the severity of impacts are all *negligible* regardless of background concentrations.

PM_{10} - Short-Term Assessment

7.3.14 The predicted short-term PM_{10} PC peaks relevant receptors at 4.91 µg/m^3 at the properties on Stryd Yr Wennol Park (R5). At 10% of the relevant short-term AQAL this is below the IAQM screening threshold of >10%; the severity of impacts at all modelled receptors is therefore *negligible*.

$PM_{2.5}$ - Long-Term Assessment

7.3.15 The predicted long-term $PM_{2.5}$ PC peaks at 0.67 µg/m^3 at the properties on Stryd Yr Wennol (R5). At 3% of the AQAL this is at the IAQM screening threshold (allowing for rounding) indicating the need for further assessment considering background concentrations.

7.3.16 The resulting PEC of 11.6 µg/m^3 is substantially below the AQAL at 31%. The resulting severity of impacts at the worst affected receptor is *negligibl*e.

7.3.17 Predicted PCs at some other modelled residential receptors are at 1% of the AQAL; resulting PECS are similarly substantially below 75% of the AQAL and the severity of impacts are all *negligible*. The results for the receptors where the PCs are 1% or above are summarised below.

Table 7.11: Summary of Long-term PM2.5 Impacts at Modelled Relevant Receptors due to Proposed Alterations: OEM Data

Receptor	PC PM2.5[1] annual mean (1hr)	PC %AQAL[2]	BC[3]	PEC	PEC %AQAL[2]	Impact descriptor
R1	0.14	1	7.58	7.72	30.87	*PC negligible*
R2	0.45	2	7.69	8.14	32.55	*PC negligible*
R3	0.56	2	7.76	8.32	33.28	*PC negligible*
R4	**0.67**	**3**	**7.86**	**8.54**	**34.15**	***PC negligible***
R5	0.63	3	7.87	8.50	34.02	*PC negligible*
R6	0.42	2	7.75	8.17	32.66	*PC negligible*
R9	0.28	1	7.72	8.01	32.03	*PC negligible*
R12	0.17	1	7.69	7.86	31.44	*PC negligible*
R13	0.17	1	7.68	7.85	31.40	*PC negligible*
R14	0.16	1	7.66	7.82	31.27	*PC negligible*
R15	0.18	1	7.60	7.78	31.11	*PC negligible*
R16	0.19	1	7.60	7.80	31.18	*PC negligible*

All concentrations µg/m^3 unless stated otherwise

1: assumes PM2.5 = 25% emitted total PM2.5

2: rounded to nearest whole number in accordance with IAQM guidance

3: BC = Defra predicted background concentration for 2018 for grid square in which receptor located + modelled long-term existing scenario Process Contribution at receptor

7.3.18 Predicted PCs at all other modelled residential receptors are less than 0.5% of the AQAL and the severity of impacts are all *negligible* regardless of background concentrations.

7.4 Plume Visibility

7.4.1 Visible plumes arise from gas flows to air which are above ambient temperature, and which, as the gases are cooled to ambient temperature, result in the condensation of water vapour. This results in a white plume. However, the water vapour in the gases mixes with the ambient air as the plume disperses, so that the plume ceases to be visible once the water content is low enough. The extent of a visible plume will depend on the flow rate of the gases, the amount of water vapour present, the relative humidity of the atmosphere and the dispersion of the plume. The presence of a visible plume has no health effects but may cause nuisance due to overshadowing effects at local receptors if the plume extends over a property.

7.4.2 With an exit temperature of 181°C and monitored moisture content of 10.8 v/v a visible plume is not predicted to occur from the biomass plant stack. The exit temperature of the dryer stacks is however much lower at 30ºC-40°C. The OEM data indicates a potential moisture content of 70% v/v and this would be expected to give rise to a visible plume. The monitored data however shows a much lower moisture content at about 4%, which would not be expected to give rise to a visible plume. The potential plume visibility has been further assessed using the ADMS model which models the dispersion and cooling of water vapour and predicts whether the plume will be visible based on the water content of the plume. The model does not predict the presence of any visible plumes. This is consistent with observations of the site visit in June 2018.

7.5 Other Considerations

7.5.1 The proximity of the Clifford Jones Timber facility is noted. SGP is not aware of any specific aerial emission sources from this facility other than potential fugitive dust from the handling and processing of wood and a small biomass boiler of less than 1MW. The proposed additional capacity at the Site is not expected to give rise to a greater risk of fugitive dust emissions than currently, with the existing Stela dryer operations being relocated internally.

7.5.2 The small biomass boiler will give rise to some NO_x and particulate matter emissions but is below a size that requires an Environmental Permit, either now or in the future under the MCPD, and hence these are unlikely to be significant. Given the expected relatively short height of the Clifford Jones boiler stack (actual height unknown) the pollutant footprint would be expected to be concentrated within the vicinity of the stack with substantially reduced concentrations away from the stack. These would be expected to be negligible at the nearest receptors. Also of note the Defra predicted background data takes into account existing sources of pollution with an area; the predicted background pollutant concentrations are all well below the relevant AQALs.

7.5.3 Due to the spatial separation of the stack to those on the application site the maximum ground-level PCs from all the stacks will not coincide. With reference to the assessment of the application site proposals the resulting short-term and long-term PECs due to NO_2, PM_{10} and $PM_{2.5}$ at the most affected modelled receptors are all well below the relevant AQALs as summarised below:

Table 7.12: Predicted PECs at Receptors Due to Proposed Development

Pollutant	Averaging Period	AQAL	Max PC[1]	BC[2, 3]	Max PEC	% AQAL
Monitored Data						
NO_2	annual mean (1 hr)	40	0.63	5.82	6.45	16
	1-hour (99.79%ile)	200	4.08	14.87	98.96	9
PM_{10}[4]	annual mean (1 hr)	40	0.19	10.98	11.16	28
	daily mean (90.4th %ile)	50	0.68	22.22	22.9	46
$PM_{2.5}$[4]	annual mean (1 hr)	25	0.15	7.68	7.81	31
OEM Data						
NO_2	annual mean (1 hr)	40	1.80	7.25	9.05	23
	1-hour (99.79%ile)	200	11.86	19.07	30.93	15
PM_{10}	annual mean (1 hr)	40	1.35	12.2	14.9	37
	daily mean (90.4th %ile)	50	4.91	25.53	30.44	61
$PM_{2.5}$	annual mean (1 hr)	25	0.67	8.9	11.6	29

1: see Tables 7.2, 7.3, 7.7 and 7.8

2: Defra background concentration for grid square where site located + predicted PC for existing scenario

3: where short-term background = 2 x long-term background

4: conservative as assumes PM10 and PM2.5 each emitted as 100% PM

7.5.4 On this basis, the cumulative emissions from the proposed development and the existing nearby small biomass boiler, are not predicted to result in any exceedances of an AQAL at any relevant receptor.

7.5.5 Hence, no particular issues have been identified with the cumulative impacts with the adjoining operations.

7.6 Assumptions and Limitations

7.6.1 The modelling has been undertaken based on both monitoring data provided by NEL and original OEM data provided by the technology provider and is therefore considered robust.

7.6.2 The meteorological data has been undertaken using NWP data for the specific location provided by the Met Office. The use of this data is therefore considered robust and appropriate for this site location and assessment.

7.6.3 Background data has been taken from Defra provided modelled data for the locality for 2018 (NO_x / NO_2, PM_{10} and $PM_{2.5}$). It is acknowledged that there is some current uncertainty in future

NO_x / NO_2 concentrations due to a number of factors, such as higher real-world vehicle emission factors and variances in the UK fleet from expectations. However, the data is based on the most recent issued data by Defra, issued in 2017, and incorporates the latest vehicle emission factors and fleet composition. The assessment has also considered the contributions of the facility's existing emissions to the background pollutant concentrations at relevant receptors. The use of the resulting background concentrations is considered robust and appropriate.

7.7 <u>Summary of Potential Impacts and Assessment of Significance</u>

7.7.1 The modelling has been undertaken using both the latest emissions monitoring data and the original OEM data. The latest monitoring data shows the emissions to be much lower than predicted by the original manufacturers. The monitoring data is expected to be more representative of the expected emissions. However, due to the potential fluctuations in emissions, and to provide a robust conservative and assessment reference has also been made to the OEM data.

7.7.2 The OEM emissions data results in higher predicted PCs at receptors than the monitored data. However, in both instances the assessment predicts the potential severity impacts due to increases in long-term and short-term concentrations of NO_2, PM_{10} and $PM_{2.5}$ at residential and leisure receptors to be *negligible* as summarised below*:*

Table 7.5: Summary of Predicted Impacts (Human Health)

Pollutant	**Impact Descriptor at Most Affected Receptor(s)**	**Comments**
Long-Term PCs		
NO_2	negligible	assumes NO_2 as 70% modelled NO_x
PM_{10}	negligible	OEM data assessment assumes PM_{10} comprises 50% of total PM
$PM_{2.5}$	negligible	OEM data assessment assumes $PM_{2.5}$ comprises 25% of total PM
Short-Term PCs		
NO_2 (1 hr)	negligible	assumes NO_2 as 35% modelled NO_x,
PM_{10} (24 hr)	negligible	OEM data assessment assumes PM_{10} comprises 50% of total PM

7.7.3 The overall significance of potential effects with respect to human health receptors takes into account a range of factors including the potential impacts at individual receptors discussed above. All predicted impacts at residential and leisure receptors are *negligible.* The overall effect with regards to air emissions and human health receptors is therefore considered to be **'not significant'**.

8 Conclusions

8.1 Proposals are for the installation of additional equipment comprising a CHP biomass boiler and a Stela dryer at the existing wood drying facility operated by Blazer's Fuels / Newbridge Energy Ltd in Ruthin. The new plant would supplement the existing CHP plant and Stela dryer installed in 2017 at the facility. The additional facility will be served by a main flue associated with the biomass boiler (and two emergency stacks) and two stacks associated with the dryer. The proposals also include for the re-location of the two stacks associated with the existing Stela dryer.

8.2 The development proposals would result in effectively doubling the existing aerial emissions of NO_x / NO_2 and PM_{10} / $PM_{2.5}$ that arise from the activities.

8.3 The proposed development lies within an industrial / commercial use area on the northwestern outskirts of Ruthin. The closest residential properties are located 175m to the southeast off Stryd Yr Wennol. The buildings of the recently completed Glasdir shared school site are located 385m to the south of the site, with accesses off the Ruthin North Link Road 310m and 275m from the site boundary.

8.4 Background air quality in the general area is good with annual mean concentrations of NO_2 and PM_{10} predicted to be well below the relevant Air Quality Assessment Levels. Existing concentrations at the nearest receptors are similarly expected to remain well below the AQALs (AQALs) with the existing operations.

8.5 The air quality assessment has considered the potential impacts of aerial emissions from the stacks associated with the plant through detailed dispersion modelling. The assessment has been undertaken through reference to both recently monitored data for the existing stacks (which is the same as the proposed additional equipment) and the original suppliers data.

8.6 Potential impacts due to NO_2, PM_{10} and $PM_{2.5}$ are predicted to be negligible at all receptors with regards to both long-term and short-term air quality objectives. Resulting total pollutant concentrations are predicted to remain well below the relevant objectives.

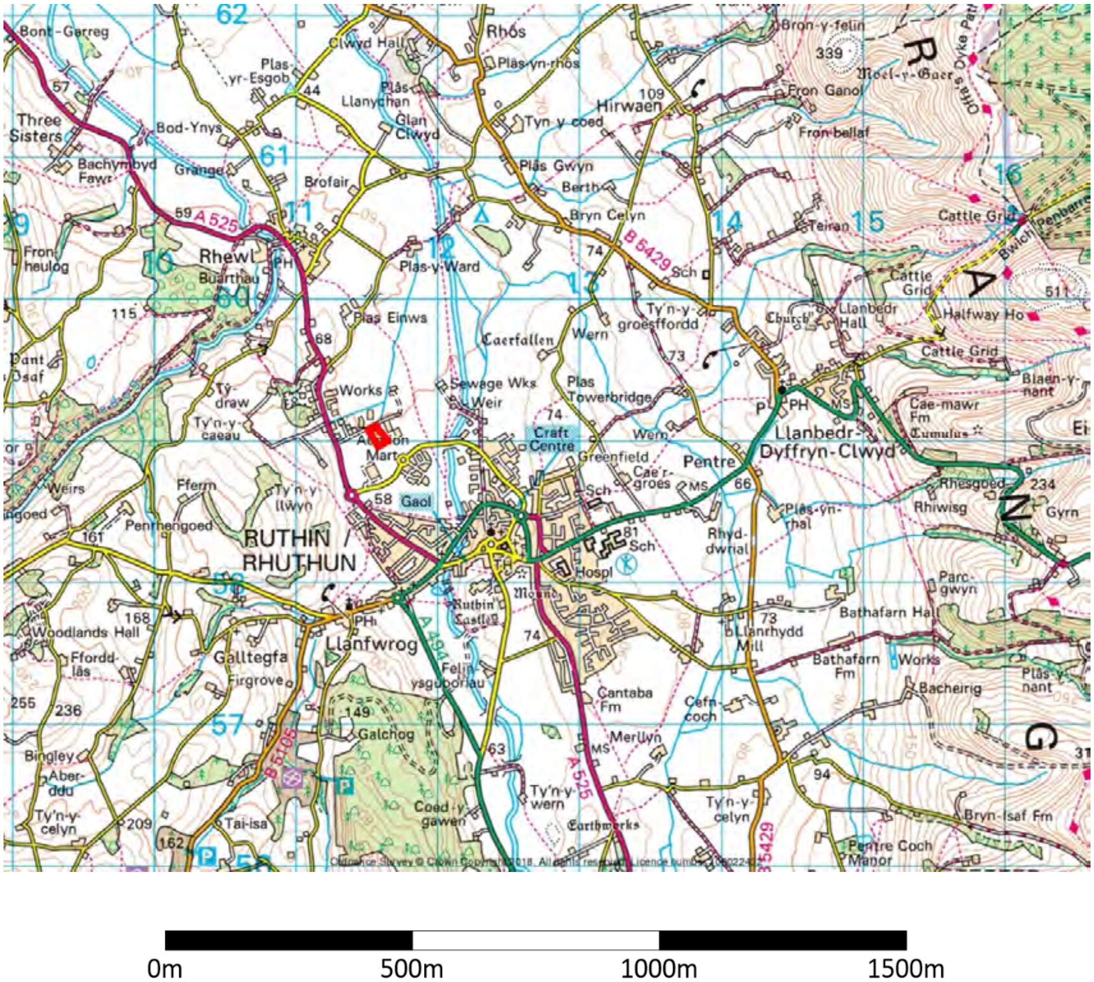
8.7 IAQM guidance advises that the overall significance of potential impacts should take into account a range of factors including the existing and future air quality and extent of population exposure to the impacts. Taking the above comments into account it is unlikely that significant adverse effects on local relevant human health receptors would occur and the site is considered suitable for the proposed use.

8.8 Under recently introduced UK legislation the biomass CHP plant is expected to require a future Environmental Permit to operate under the requirements of the Medium Combustion Plant

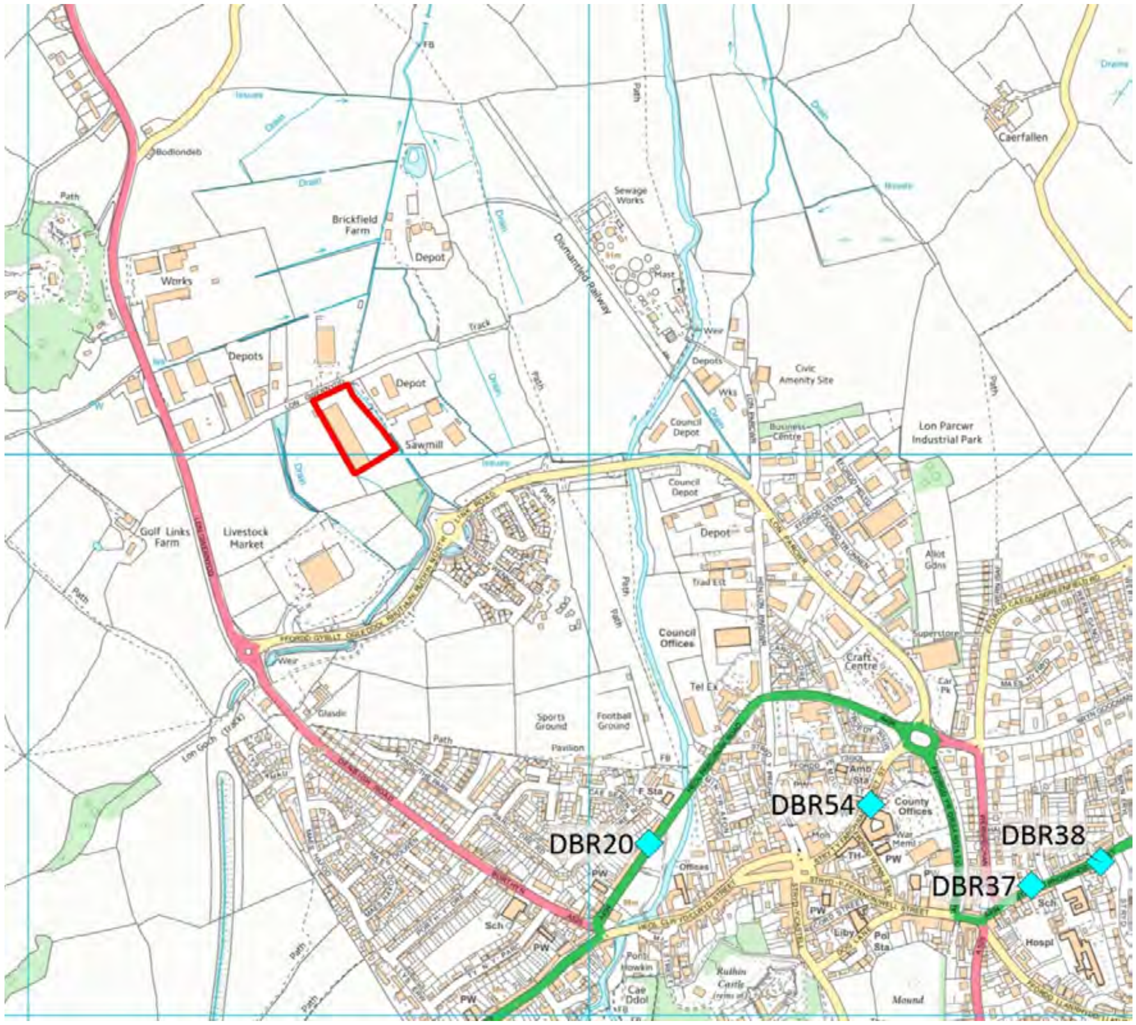
Directive (MCPD). This would be required for any existing plant by 2024 or 2029 and for any new plant from December 2018. The Permit would specify limits for emissions of NO_x / NO_2, and dust / PM_{10}.

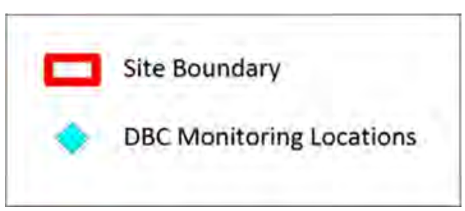
8.9 The majority of handling of materials is to be undertaken internally other than some storage of raw wood. Given the nature of the locality potential risks associated with fugitive emissions of dust are therefore expected to be low. Based on the latest monitoring information the biomass boiler and dryer stacks are not indicated as likely to give rise to a visible plume of water vapour.

DRAWINGS

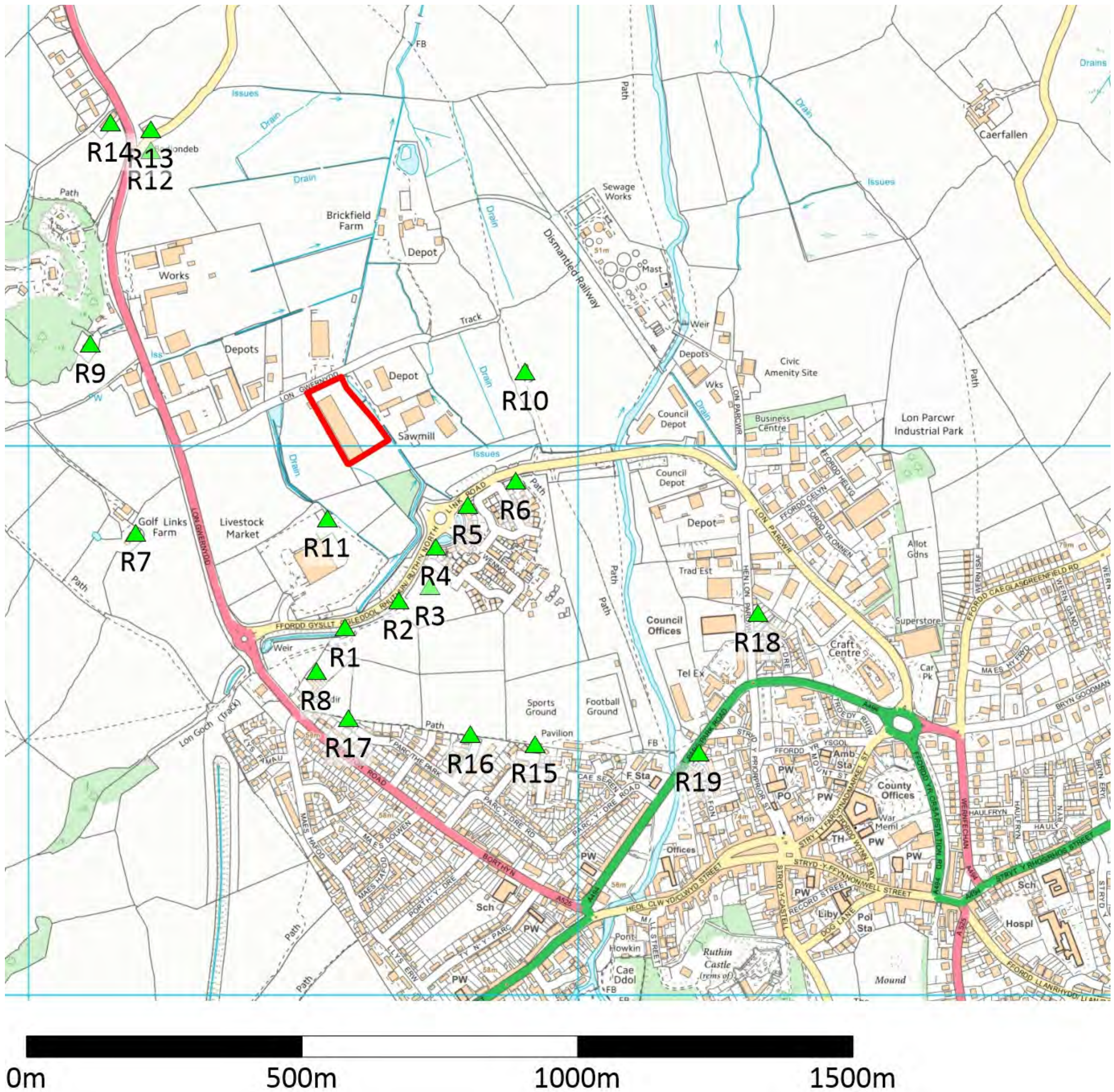


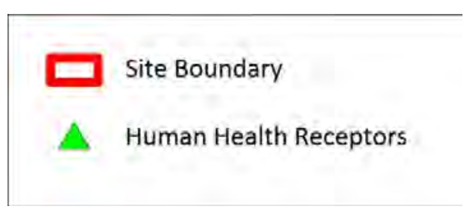
Drawing D01: Site Location





Drawing D02: Air Quality Monitoring Locations

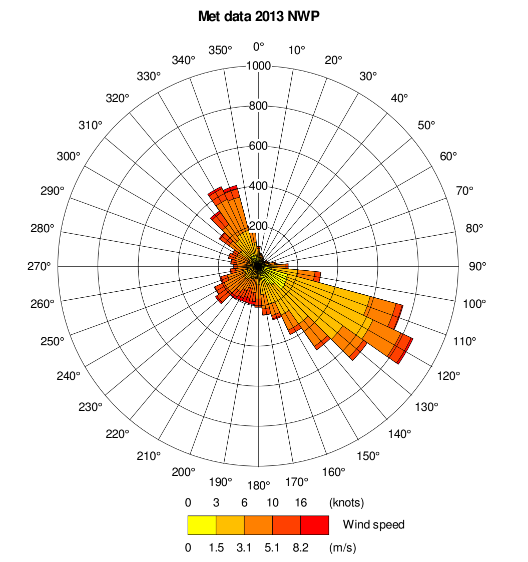


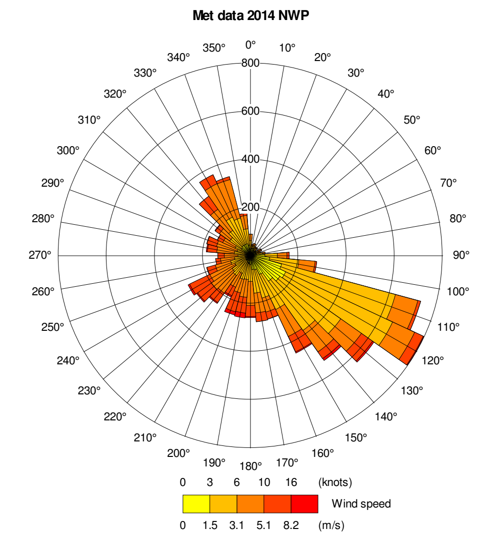


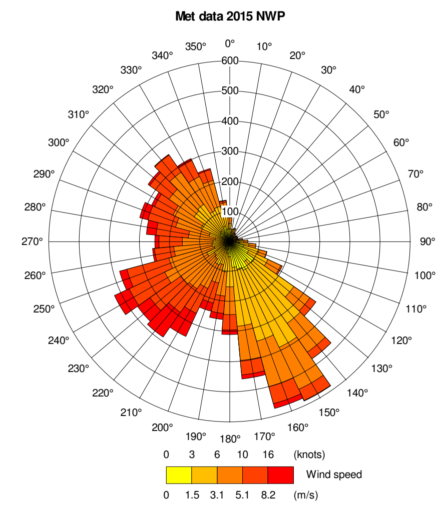
Drawing D03: Site Location and Modelled Receptor Locations

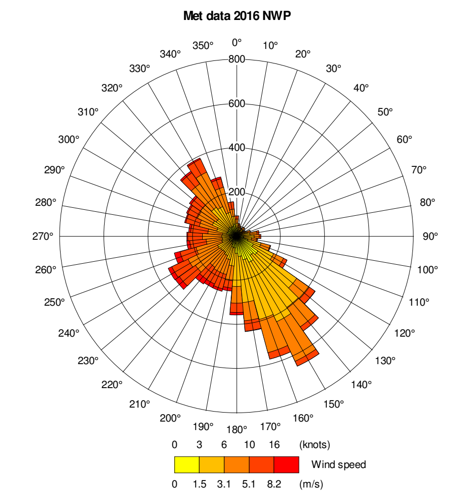
Appendix A

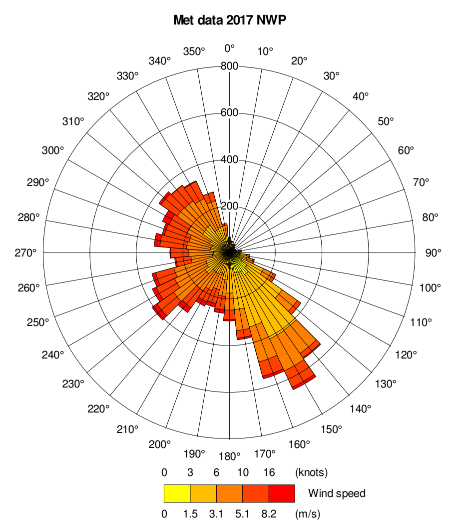
Site-Specific NWP, Bala and Rhyl No.2 Windroses











Appendix Ai: NWP Windroses:2012-2017

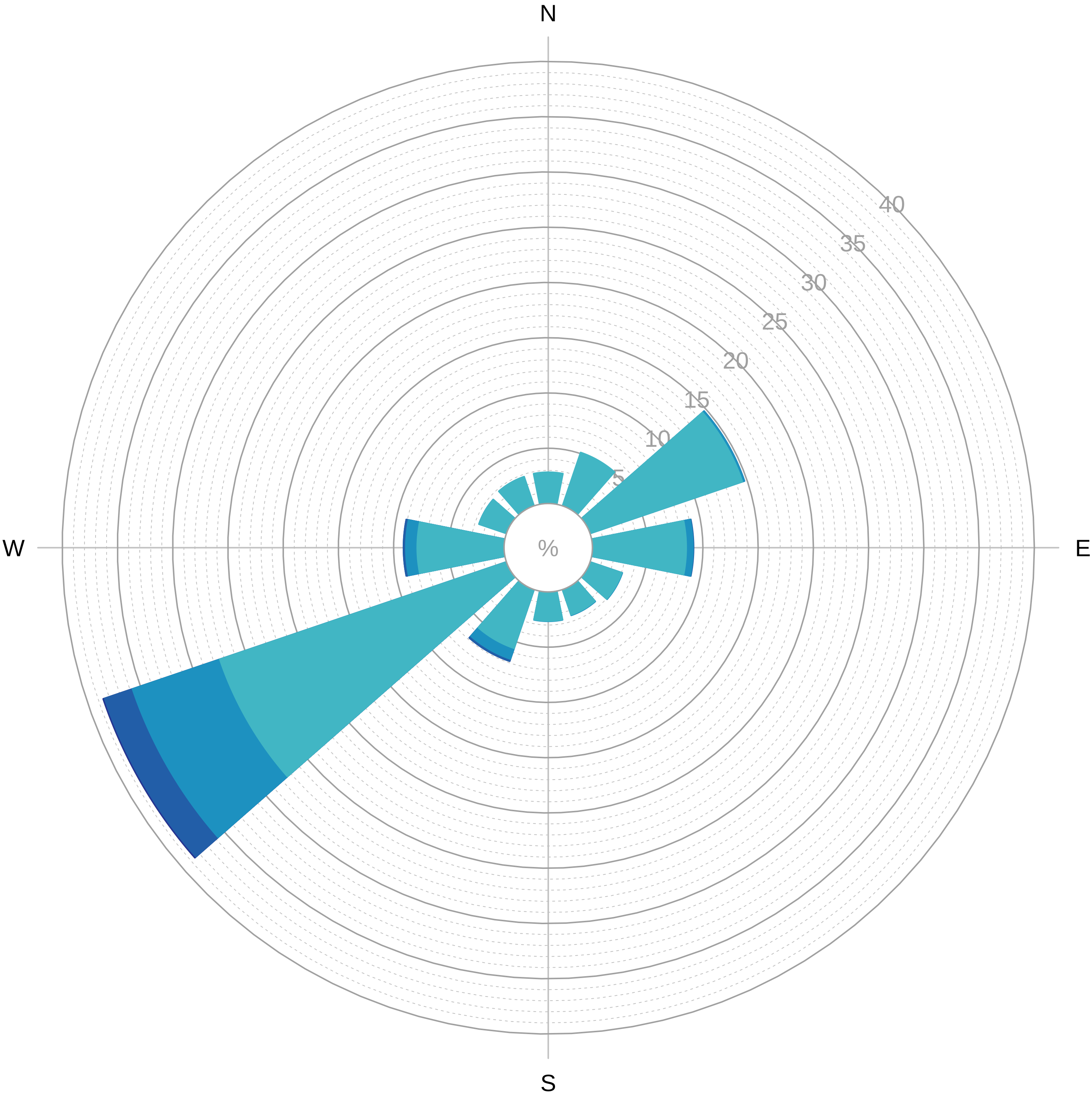
HOURLY MEAN WIND ROSE FOR BALA

NGR: 2935 E 3356 N

SEASON: ANNUAL

ALTITUDE: 163 metres AMSL

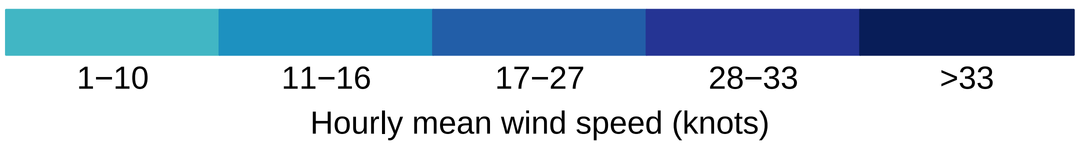
Period of data: Jan 2007 − Dec 2016



87,064 OBSERVATIONS

6.8% CALM

0.0% VARIABLE



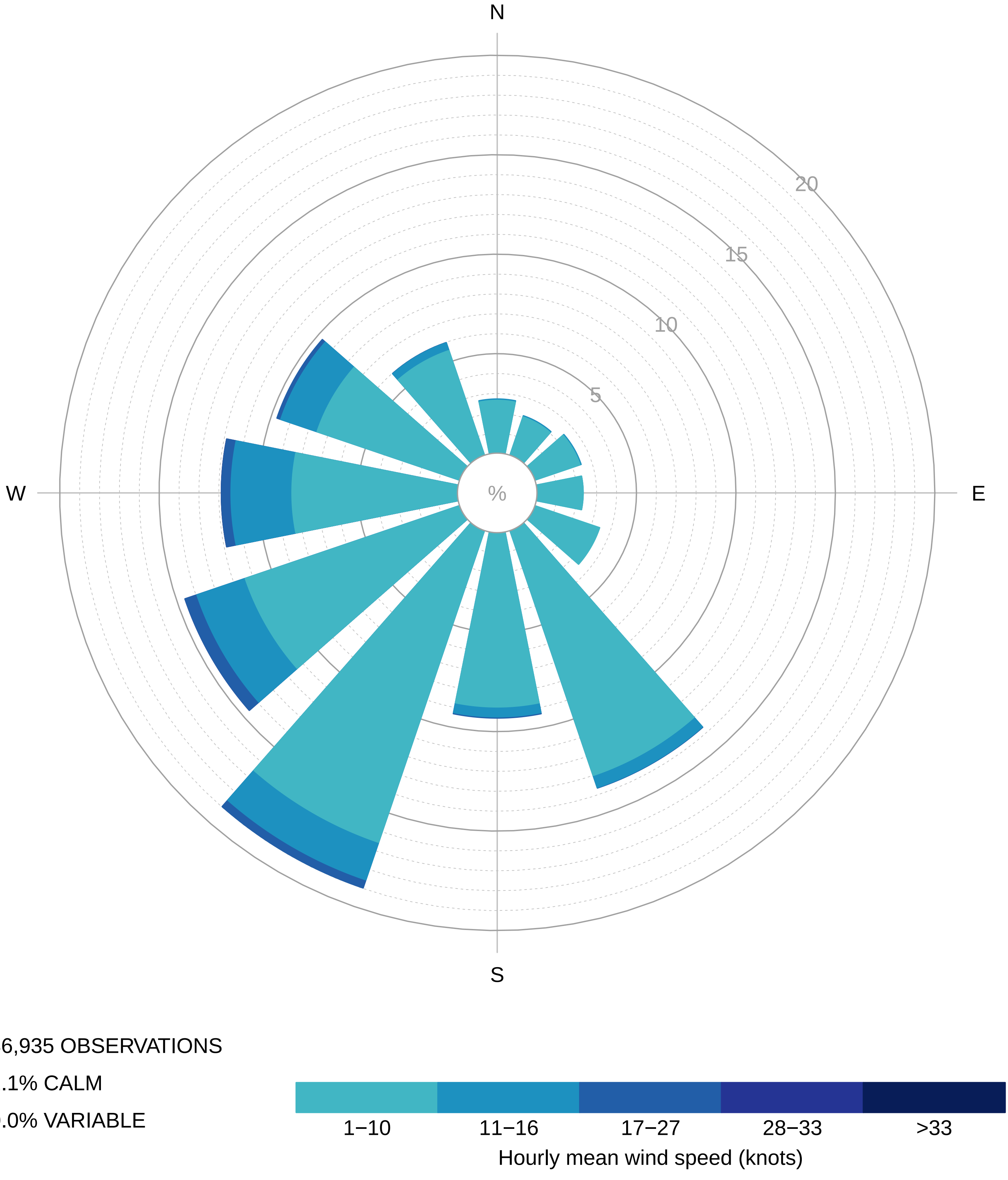
HOURLY MEAN WIND ROSE FOR RHYL NO 2

NGR: 2994 E 3747 N

SEASON: ANNUAL

ALTITUDE: 77 metres AMSL

Period of data: Jan 2006 − Dec 2015



86,935 OBSERVATIONS

2.1% CALM

0.0% VARIABLE

Appendix B

Monitoring Data

Exova Catalyst, Unit C6, Emery Court, The Embankment Business Park, Heaton Mersey, Stockport, SK4 3GL
E: toby.campbell@exova.com
Your Exova Catalyst Contact: Toby Campbell (07825 130 074)

Stack Emissions Testing Report Commissioned by
Newbridge Energy Ltd

Installation Name & Address
Blazers Fuels Ltd
Brickfield Lane
Ruthin
Denbighshire
North Wales
LL15 2TN

Stack Reference
Biomass CHP Plant Exhaust

Dates of the Monitoring Campaign
13th June 2018

Job Reference Number
CAT-4237

Report Written by
Brian Jacob Team Leader MCERTS Level 2 MM 06 693 TE1 TE2 TE3 TE4

Report Approved by
Michelle Edwards Team Leader MCERTS Level 2 MM 05 659 TE1 TE2 TE3 TE4

Report Date
18th June 2018

Version
Version 1

Signature of Report Approver
MEdwards

CONTENTS

Opinions and interpretations expressed herein are outside the scope of Exova Catalyst's ISO 17025 accreditation.

MONITORING OBJECTIVES

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust
13th June 2018

Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by Newbridge Energy Ltd to carry out stack emissions testing for Blazers Fuels Ltd on the Biomass CHP Plant Exhaust at Ruthin.

The aim of the monitoring campaign was to perform testing, as requested by the customer, for a number of prescribed pollutants, as part of a RHI assessment.

Special Requirements

There were no special requirements.

Target Parameters

Total Particulate Matter, Oxides of Nitrogen (as NO_2)

MONITORING RESULTS

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust
13th June 2018

where MU = Measurement Uncertainty associated with the Result

	Concentration				Mass Emission			
Parameter	**Units**	**Result**	**MU +/-**	**Limit**	**Units**	**Result**	**MU +/-**	**Limit**
Total Particulate Matter [1]	mg/m^3	8.6	1.5	-	g/hr	74.9	14.1	-
Oxides of Nitrogen (as NO_2) [1]	mg/m^3	155	7.3	-	g/hr	1361	95.3	-
Oxygen	% v/v	**Dry** 9.6	0.34					
Water Vapour	% v/v	10.8	0.54					
Stack Gas Temperature	°C	198						
Stack Gas Velocity	m/s	6.8	0.17					
Volumetric Flow Rate (ACTUAL)	m^3/hr	14630	757					
Volumetric Flow Rate (REF) [1]	m^3/hr	8757	453					

NOTE: VOLUMETRIC FLOW RATE & VELOCITY DATA TAKEN FROM AN AVERAGE OF ALL OF THE ISOKINETIC RUNS.

[1] Reference Conditions (REF) are: 273K, 101.3kPa, dry gas, 11% oxygen.

RHI (RENEWABLE HEAT INCENTIVE) RESULTS

Parameter	**Units**	**Result (NET)**
Total Particulate Matter	g/GJ	4.5
Oxides of Nitrogen (as NO_2)	g/GJ	82.6

Reference Document: DEFRA Conversion of biomass boiler emission concentration data for comparison with Renewable Heat Incentive emission criteria, Issue 1

MONITORING DATE(S) & TIMES

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust
13th June 2018

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m³	4.2	g/hr	36.5	13/06/2018	10:48 - 11:04, 11:05 - 11:21	32
Total Particulate Matter	R2	mg/m³	17.6	g/hr	154	13/06/2018	11:33 - 11:49, 11:50 - 12:06	32
Total Particulate Matter	R3	mg/m³	3.9	g/hr	34.6	13/06/2018	12:16 - 12:32, 12:33 - 12:49	32
Oxides of Nitrogen (as NO_2)	R1	mg/m³	147	g/hr	1286	13/06/2018	10:48 - 11:21	33
Oxides of Nitrogen (as NO_2)	R2	mg/m³	136	g/hr	1193	13/06/2018	11:33 - 12:06	33
Oxides of Nitrogen (as NO_2)	R3	mg/m³	183	g/hr	1604	13/06/2018	12:16 - 12:49	33
Oxygen	R1	% v/v	9.1			13/06/2018	10:48 - 11:21	33
Oxygen	R2	% v/v	10.2			13/06/2018	11:33 - 12:06	33
Oxygen	R3	% v/v	9.4			13/06/2018	12:16 - 12:49	33
Velocity Traverse	R1					13/06/2018	10:02 - 10:12	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust
13th June 2018

Standard Operating Conditions

Parameter	**Value**
Process Status	Normal Operation
Capacity (of 100%) and Tonnes / Hour	Full Load (Burnt power capacity 6366 kW)
Continuous or Batch Process	Continuous
Feedstock (if applicable)	Wood Chips
Abatement System	Bag Filter & Cyclone
Abatement System Running Status	On
Fuel	Wood Chips
Plume Appearance	None Visible

MONITORING & ANALYTICAL METHODS

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust
13th June 2018

Parameter	Monitoring				Analysis				MCERTS Testing	LOD (Average)
	Standard	Technical Procedure	ISO 17025 Testing	Testing Lab	Analytical Procedure	Analytical Technique	ISO 17025 Analysis	Analysis Lab		
Total Particulate Matter	EN 13284-1	CAT-TP-01	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.4 mg/m³
Water Vapour	EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.10 % v/v
Oxides of Nitrogen (as NO_2)	EN 14792	CAT-TP-21	Yes	CAT	Chemiluminescence by Horiba PG-250				Yes	0.41 mg/m³
Oxygen	EN 14789	CAT-TP-21	Yes	CAT	Dry Zirconia Cell by Horiba PG-250				Yes	0.1 %
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41	Yes	CAT	Pitot Tube and Thermocouple				Yes	1.2 m/s

ANALYSIS LABORATORIES

(with short name reference as appears in the table above)

Exova Catalyst (CAT)	ISO 17025 Accreditation Number: 4279

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
All Parameters	All Runs	There are no deviations associated with the sampling employed.

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.87
Width	m	-
Area	m²	0.59
Port Depth	cm	30
Orientation of Duct	-	Vertical
Number of Ports	-	2
Sample Port Size	-	5" Flange

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	Permanent
Inside / Outside	Inside

Platform Details

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	Yes
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	Yes
Platform has vertical base boards (approx. 0.25m high)	Yes
Platform has chains / self closing gates at top of ladders	No
There are no obstructions present which hamper insertion of sampling equipment	Yes
Safe Access Available	Yes
Easy Access Available	Yes

Sampling Location / Platform Improvement Recommendations

In the interest of improved Health and Safety, it would be advantageous to install some form of chain or self closing gate at the top of the sampling platform ladder.

EN 15259 Homogeneity Test Requirements

There is no requirement to perform a EN 15259 Homogeneity Test on this Stack.

Sampling Plane Validation Criteria (from EN 15259)

Criteria in EN 15259	Units	Traverse 1		Required	Compliant
Lowest Differential Pressure	Pa	23.0		> 5 Pa	Yes
Mean Velocity	m/s	6.47		-	-
Lowest Gas Velocity	m/s	6.30		-	-
Highest Gas Velocity	m/s	6.70		-	-
Ratio of Above	: 1	1.06		< 3 : 1	Yes
Maximum Angle of Swirl	°	14		< 15°	Yes
No Local Negative Flow	-	Yes		-	Yes

Executive Summary

PLANT PHOTOS

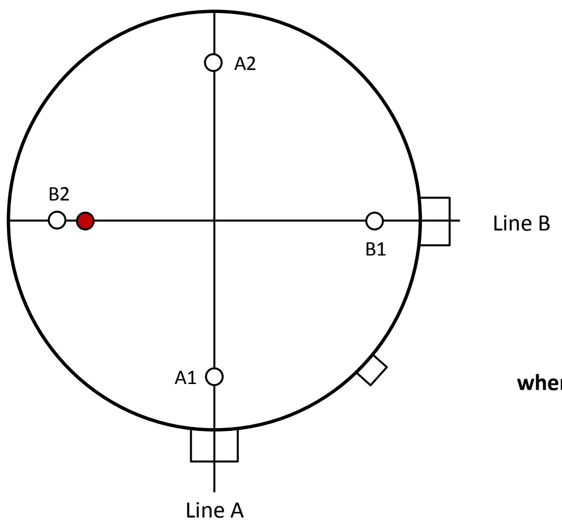
Photo 1

Photo 2

Photo 3

Photo 4

SAMPLE POINTS



where ○ = isokinetic point sampled at

● = isokinetic point not sampled at

● = combustion gases sample point

○ = non-isokinetic sample point

APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Brian Jacob	MCERTS Level 2	MM 06 693	TE1 TE2 TE3 TE4
Trainee	Danny Williams	MCERTS Trainee	Pending	None

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	CAT 7.39
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.10
Box Thermocouples (2)	-
Umbilical (1)	CAT 3.10
Umbilical (2)	-
Oven Box (1)	-
Oven Box (2)	-
Heated Probe (1)	CAT 5.7
Heated Probe (2)	-
Heated Probe (3)	-
S-Pitot (1)	CAT 21p.43
S-Pitot (2)	-
L-Pitot	-
Site Balance	CAT 17.13
500g / 1Kg Check Weights	CAT 17.13
Last Impinger Arm	-
Callipers	CAT 23.10
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-250	CAT 9.11
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Testo 350 XL	-
JCT JCC P1 Cooler	CAT 4.135
Gasmet DX4000	-
Gasmet Sampling System	-
Bernath 3006 FID	-
M&C PSS	CAT 12.93
Mass Flow Controller (1)	CAT 6.3
Mass Flow Controller (2)	CAT 6.4
Mass View (1)	-
Mass View (2)	-
Easylogger EN-EL-12 Bit	-
Easylogger EN-EL-12 Bit	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer (1)	CAT 3.25
Digital Manometer (2)	-
Digital Temperature Meter	CAT 3.25
Stopwatch	CAT 14.53
Barometer	CAT 13.20
Stack Thermocouple (1)	CAT 4.1040
Stack Thermocouple (2)	-
Stack Thermocouple (3)	-
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	-
20m Heated Line (1)	CAT 20.69
20m Heated Line (2)	-
Dual Channel Heater Controller	-
Single Channel Heater Controller	-
Laboratory Balance	CAT 1.18 / 1.18a
Tape Measure	CAT 16.14

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	EN 13284-1	CAT-TP-01
Water Vapour	EN 14790	CAT-TP-05
Oxides of Nitrogen (as NO_2)	EN 14792	CAT-TP-21
Oxygen	EN 14789	CAT-TP-21
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41

PRELIMINARY STACK SURVEY: CALCULATIONS

General Stack Details

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	0.87
Stack Width, W	m	-
Stack Area, A	m²	0.59
Average Stack Gas Temperature, T_a	°C	157.8
Average Stack Gas Pressure	Pa	24.3
Average Stack Static Pressure, P_{static}	kPa	0.017
Average Barometric Pressure, P_b	kPa	101.6
Average Pitot Tube Calibration Coefficient, C_p	-	0.84

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m³ p	Conc kg/m³ p_i
CO_2 (Estimated)	-	10.00	8.92	0.1000	44.01	1.9635	0.19635
O_2	-	9.57	8.54	0.0957	32.00	1.4277	0.13669
N_2	-	80.43	71.76	0.8043	28.01	1.2498	1.00520
Moisture (H_2O)	-	-	10.77	0.1077	18.02	0.8037	0.08657

Where: p = M / 22.41

p_i = r x p

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m³	1.338
Wet Density (STP), P_{STW}	kg/m³	1.281
Dry Density (Actual), P_{Actual}	kg/m³	0.851
Average Wet Density (Actual), $P_{ActualW}$	kg/m³	0.814

Where: P_{STD} = sum of component concentrations, kg/m³ (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m³ (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (at each sampling point) $= P_{STW} \times (T_s / P_s) \times (P_a / T_a)$

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF [1]
Temperature	°C	157.8	0.0
Total Pressure	kPa	101.6	101.3
Moisture	%	10.77	0.00
Oxygen (Dry)	%	9.6	11.0

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m³/hr	13845
Gas Volumetric Flowrate (STP, Wet)	m³/hr	8802
Gas Volumetric Flowrate (STP, Dry)	m³/hr	7854
Gas Volumetric Flowrate REF [1]	m³/hr	8974

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID)

(1 of 1)

Parameter	Units	Value
Date of Survey	-	13/06/2018
Time of Survey	-	10:02 - 10:12
Atmospheric Pressure	kPa	101.6
Average Stack Static Pressure	Pa	17
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 200 (500Pa)	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C_p	-	0.84
Number of Lines Available	-	2
Number of Lines Used	-	2

		Sampling Line A					Sampling Line B				
Traverse Point	**Depth m**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**
STATIC (Units: Pa)		*18.0*					*16.0*				
Mean		**25.0**	**158.0**	**0.814**	**6.57**		**23.5**	**157.5**	**0.815**	**6.37**	
1	0.13	24.0	158.0	0.814	6.44	12.0	24.0	158.0	0.814	6.44	10.0
2	0.74	26.0	158.0	0.814	6.70	11.0	23.0	157.0	0.816	6.30	14.0

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID) - MEASUREMENT UNCERTAINTY

(1 of 1)

Performance characteristics (Uncertainty Components)	Uncertainty	Value	Units
Standard Uncertainty on the coefficient of the Pitot Tube	u(k)	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	u(Δpi)	1.074	Pa
- Resolution	u(res)	0.00087	
- Calibration	u(cal)	0.061	
- Drift	u(drift)	0.083	
- Lack of Fit	u(fit)	0.007	
- Overall corrections to dynamic measurements	u(Cf)	0.153	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00007	-
- φO_2,w	-	8.543	
- φCO_2,w	-	8.923	
- Oxygen, dry	u(ϕO_2,d)	0.293	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.306	
- Water Vapour	u(ϕH_2O)	0.550	
- Oxygen, wet	u(ϕO_2,w)	0.267	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.279	
Standard uncertainty associated with the stack temperature	u(Tc)	2.198	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.694	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	0.759	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00439	-
Standard uncertainty associated with the local velocities	u(vi)	0.149	Pa
Standard uncertainty associated with the mean velocity	u(v)	0.083	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	0.163	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	2.51	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	716.8	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00070	
- $u^2(qV,w)$	-	133762	
- u(qV,w)	-	365.7	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	5.18	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

Parameter	Units	Run 1	Run 2	Run 3		Mean
Concentration	mg/m³	4.2	17.6	3.9		8.6
Uncertainty	±mg/m³	1.4	1.7	1.4		1.5
Mass Emission	g/hr	36.5	154	34.6		74.9
Uncertainty	±g/hr	12.5	17.0	12.8		14.1

Parameter	Units	Run 1	Run 2	Run 3		Mean
Water Vapour	% v/v	9.9	10.1	12.3		10.8
Uncertainty	±% v/v	0.52	0.51	0.61		0.54

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.98		0.98

General Sampling Information

Parameter	Value	
Standard	EN 13284-1	
Technical Procedure	CAT-TP-01	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Glass Fibre	
Number of Sampling Lines Used	2 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	4 / 4	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1, A2, B1 & B2	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 11% oxygen.

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	Run 2	Run 3	
Absolute pressure of stack gas, P_s					
Barometric pressure, P_b	mmHg	762.0	762.0	769.5	
Stack static pressure, P_{static}	mmH_2O	1.8	1.8	2.5	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	762.1	762.1	769.7	
Volume of water vapour collected, V_{wstd}					
Total mass collected in impingers (liquid trap)	g	35.0	39.2	46.6	
Total mass collected in impingers (silica trap)	g	0.0	0.2	1.0	
Total mass of liquid collected, V_{lc}	g	35.0	39.4	47.6	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0436	0.0491	0.0593	
Volume of gas metered dry, V_{mstd}					
Volume of gas sample through gas meter, V_m	m^3	0.4300	0.4340	0.4280	
Gas meter correction factor, Y_d	-	1.0180	1.1080	1.1018	
Average dry gas meter temperature, T_m	°C	29.4	30.1	35.3	
Average pressure drop across orifice, ΔH	mmH_2O	21.5	22.9	19.5	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.3970	0.4353	0.4236	
Moisture content, B_{wo} & R_{wv}					
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0990	0.1014	0.1228	
B_{wo} as a percentage	% v/v	9.90	10.14	12.28	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	9.90	10.14	12.28	
Volume of gas metered wet, V_{mstw}					
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	0.4406	0.4844	0.4830	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$					
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	No	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	8.16	8.37	9.10	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	9.15	9.38	10.19	
% oxygen reference condition, $REF\%O_2$	% v/v	11.00	11.00	11.00	
O_2 Reference Factor wet (O_{2REFw}) = $(21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	0.78	0.79	0.84	
O_2 Reference Factor dry (O_{2REFd}) = $(21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	0.84	0.86	0.93	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	0.5656	0.6118	0.5749	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	0.4705	0.5058	0.4578	
Molecular weight of dry gas stream, M_d					
CO_2 (Estimated)	% v/v	10.00	6.00	6.00	
O_2	% v/v	9.15	9.38	10.19	
Total	% v/v	19.15	15.38	16.19	
N_2	% v/v	80.85	84.62	83.81	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	29.97	29.34	29.37	
Molecular weight of stack gas (wet), M_s					
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.78	28.19	27.97	
Velocity of stack gas, V_s					
Pitot tube velocity constant, K_p	-	34.97	34.97	34.97	
Velocity pressure coefficient, C_p	-	0.84	0.84	0.84	
Average of velocity heads, ΔP_{avg}	mmH_2O	2.35	2.23	2.98	
Average square root of velocity heads, $\sqrt{\Delta P}$	$\sqrt{mmH_2O}$	1.53	1.49	1.72	
Average stack gas temperature, T_s	°C	281.6	146.0	164.9	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s + 273})) / (\sqrt{(M_s)(P_s)})$	m/s	7.16	6.12	7.23	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})					
Area of stack, A_s	m^2	0.59	0.59	0.59	
$Q_a = (60)(A_s)(V_s)$	m^3/min	255.4	218.3	257.8	
Conversion factor (K/mm.Hg), C_f	-	0.3592	0.3592	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	126.1	142.6	162.7	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	113.6	128.2	142.8	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	161.9	180.1	193.7	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	134.6	148.9	154.3	
Percent isokinetic, %I					
Nozzle diameter, D_n	mm	9.02	9.02	8.11	
Nozzle area, A_n	mm^2	63.96	63.96	51.71	
Total sampling time, q	min	32	32	32	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	101.5	98.7	106.6	

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	Run 2	Run 3	
Sampling Times	-	10:48 - 11:04, 11:05 - 11:21	11:33 - 11:49, 11:50 - 12:06	12:16 - 12:32, 12:33 - 12:49	
Sampling Dates	-	13/06/2018	13/06/2018	13/06/2018	
Sampling Device	-	ISO	ISO	ISO	
Volume Sampled (REF)	m^3	0.4705	0.5058	0.4578	
Filter I.D. Number	-	47-51009	47-51011	47-51010	
Start Filter Mass	g	0.14791	0.14920	0.14805	
End Filter Mass	g	0.14861	0.15797	0.14909	
Total Mass on Filter	g	0.00070	0.00877	0.00104	
Probe Rinse I.D. Number	-	PR-47-51009	PR-47-51011	PR-47-51010	
Start Probe Rinse Mass	g	2.55829	2.54230	2.88641	
End Probe Rinse Mass	g	2.55955	2.54241	2.88717	
Total Mass in Probe Rinse	g	0.00126	0.00011	0.00076	
Total Mass Collected	mg	1.96	8.88	1.81	
Calculated Concentration	mg/m^3	4.17	17.56	3.95	
Balance Uncertainty / LOD	mg/m^3	0.40	0.38	0.42	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	13/06/2018	
Average Volume Sampled (REF)	m^3	0.4780	
Filter I.D. Number	-	47-51012	
Start Filter Mass	g	0.14914	
End Filter Mass	g	0.14952	
Total Mass on Filter	g	0.00038	
Probe Rinse I.D. Number	-	PR-47-51012	
Start Probe Rinse Mass	g	2.72771	
End Probe Rinse Mass	g	2.72780	
Total Mass in Probe Rinse	g	0.00009	
Total Mass Collected	mg	0.47	
Calculated Concentration	mg/m^3	0.98	
Balance Uncertainty / LOD	mg/m^3	0.40	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1	Run 2	Run 3
Mean Sampling Rate	l/min	13.68	15.03	14.74
Pre-Sampling Leak Rate	l/min	0.14	0.15	0.13
Post-Sampling Leak Rate	l/min	0.14	0.16	0.13
Allowable Leak Rate	l/min	0.27	0.30	0.29
Leak Test Acceptable	-	Yes	Yes	Yes

Water Droplets	Units	Run 1	Run 2	Run 3
Are Water Droplets Present	-	No	No	No

MU (Concurrent Water Vapour)	Units	Run 1	Run 2	Run 3
Measurement Uncertainty (MU)	%	5.3	5.0	4.9
Allowable MU	%	20	20	20
MU Acceptable	%	Yes	Yes	Yes

Silica Gel (Concurrent Water Vapour)	Units	Run 1	Run 2	Run 3
Less than 50% Faded	%	Yes	Yes	Yes

Isokinetic Criterion Compliance	Units	Run 1	Run 2	Run 3
Isokinetic Variation	%	101.5	98.7	106.6
Allowable Isokinetic Range	%	95 - 115	95 - 115	95 - 115
Isokineticity Acceptable	-	Yes	Yes	Yes

Weighing Uncertainty Criteria	Units	Run 1	Run 2	Run 3
Overall Weighing Uncertainty	± mg	0.33	0.33	0.33
Overall Weighing Uncertainty	± mg/m^3	0.69	0.64	0.71
ELV [Daily ELV for IED]	mg/m^3	N/A	N/A	N/A
Allowable Weighing Uncertainty	mg/m^3	N/A	N/A	N/A
Weighing Uncertainty Acceptable	-	N/A	N/A	N/A

Filter Temperatures	Units	Run 1	Run 2	Run 3
Pre-Conditioning Temperature	°C	180	180	180
Post-Conditioning Temperature	°C	160	160	160
Maximum Filter Temperature	°C	1156	147	170

Test Conditions	Units	Run 1	Run 2	Run 3
Ambient Temperature Recorded?	-	Yes	Yes	Yes

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	15.00
Pre-Sampling Leak Rate	l/min	0.10
Post-Sampling Leak Rate	l/min	0.12
Allowable Leak Rate	l/min	0.30
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m^3	N/A
Blank Acceptable	-	N/A

Acetone / Water Rinse Blank	Units	Blank
Acetone / Water Rinse Value	mg/l	2.7
Allowable Blank	mg/l	10
Blank Acceptable	-	Yes

Method Deviations

Nature of Deviation	Run Number		
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	1	2	3
There are no deviations associated with the sampling employed.	wx	wx	wx

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value: Symbol	Run 1	Run 2	Run 3		Standard uncertainty: Symbol	Units	Run 1	Run 2	Run 3	
Sampled Volume (Actual)	V_m	0.4300	0.4340	0.4280		uV_m	m³	0.0086	0.0087	0.0086	
Sampled Gas Temperature	T_m	302.4	303.1	308.3		uT_m	K	2.0	2.0	2.0	
Sampled Gas Pressure	ρ_m	101.6	101.6	102.6		$u\rho_m$	kPa	0.5	0.5	0.5	
Sampled Gas Humidity	H_m	0.0	0.0	0.0		uH_m	% v/v	1.0	1.0	1.0	
Leak	L	1.02	1.06	0.88		uL	%	-	-	-	
Mass of Particulate	m	1.96	8.88	1.81		um	mg	0.19	0.19	0.19	
Uncollected Mass	UCM	0.47	0.47	0.47		uUCM	mg	-	-	-	

Measured Quantities	Uncertainty as a Percentage: Units	Run 1	Run 2	Run 3		Requirement of Standard
Sampled Volume (Actual)	%	2.00	2.00	2.00		≤2%
Sampled Gas Temperature	%	0.66	0.66	0.65		≤1%
Sampled Gas Pressure	%	0.49	0.49	0.49		≤1%
Sampled Gas Humidity	%	1.00	1.00	1.00		≤1%
Leak	%	1.02	1.06	0.88		≤2%
Mass of Particulate	%	-	-	-		<5% of ELV
Uncollected Mass	%	-	-	-		-

Measured Quantities	Uncertainty in Measurement Units: Symbol	Units	Run 1	Run 2	Run 3		Sensitivity Coefficient: Run 1	Run 2	Run 3	
Sampled Volume (STP)	V_m	m³	0.3970	0.4353	0.4236		10.49	40.35	9.32	
Leak	L	mg/m³	0.025	0.108	0.020		1.00	1.00	1.00	
Mass of Particulate	L_r	mg	1.960	8.883	1.807		2.13	1.98	2.18	
Uncollected Mass	UCM	mg	0.27	0.27	0.27		2.13	1.98	2.18	

Measured Quantities	Uncertainty in Result: Units	Run 1	Run 2	Run 3	
Sampled Volume (STP)	mg/m³	0.105	0.418	0.095	
Leak	mg/m³	0.0246	0.1080	0.0201	
Mass of Particulate	mg/m³	0.4038	0.3756	0.4151	
Uncollected Mass	mg/m³	0.5767	0.5365	0.5928	

Measured Quantities	Oxygen Correction Part of MU Budget: Units	Run 1	Run 2	Run 3	
O_2 Correction Factor	-	0.84	0.86	0.93	
Stack Gas O_2 Content	% v/v	9.15	9.38	10.19	
MU for O_2 Correction	-	0.04	0.04	0.04	
Overall MU For O_2 Measurement	%	4.22	4.30	4.63	

Parameter	Units	Run 1	Run 2	Run 3	
Combined uncertainty	mg/m³	0.71	0.78	0.73	
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m³	1.40	1.54	1.43	
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m³	1.41	1.71	1.44	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m³	1.41	1.71	1.44	
Reported Uncertainty	mg/m³	1.41	1.71	1.44	
Expanded uncertainty (95% confidence), without Oxygen Correction	%	33.5	8.8	36.3	
Expanded uncertainty (95% confidence), with Oxygen Correction	%	33.8	9.8	36.6	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	33.8	9.8	36.6	
Reported Uncertainty	%	33.8	9.8	36.6	

OXIDES OF NITROGEN (as NO_2): RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

Parameter	Units	Run 1	Run 2	Run 3	Mean
Concentration	mg/m³	147	136	183	155
Uncertainty	±mg/m³	7.0	6.4	8.5	7.3
Mass Emission	g/hr	1286	1193	1604	1361
Uncertainty	±g/hr	90.7	83.7	111	95.3

General Sampling Information

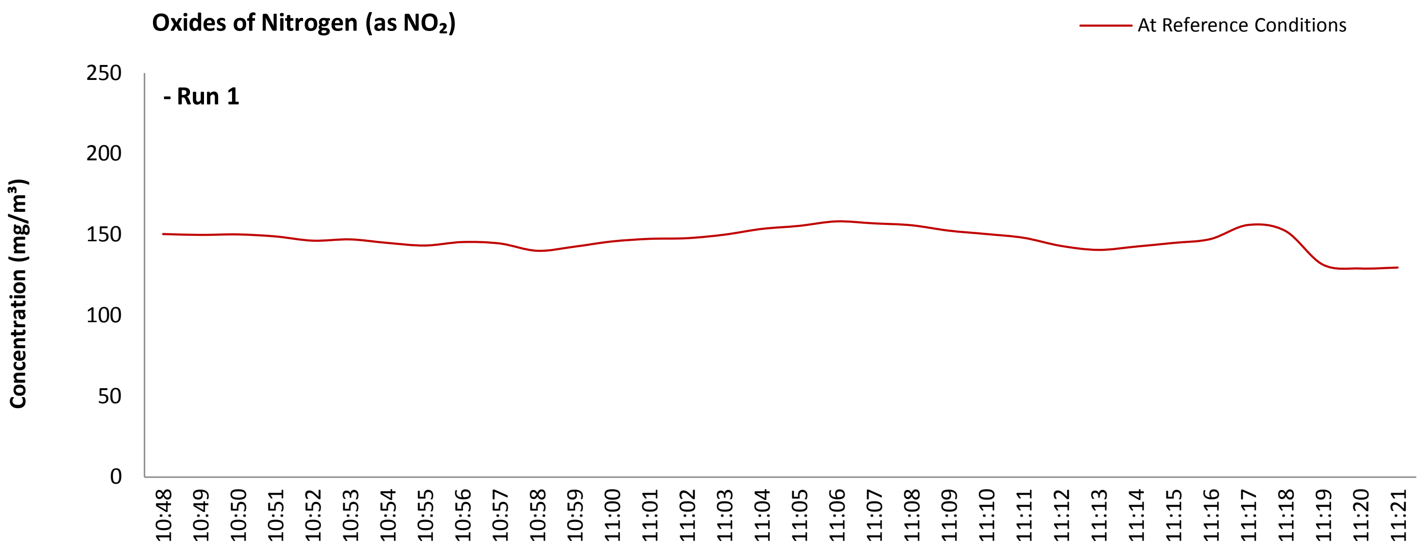
Parameter	Value	
Standard	EN 14792	
Technical Procedure	CAT-TP-21	
Probe Material	Titanium	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Date & Result of Last Converter Check	15/05/2018 - 95.3%	
Span Gas Type	Nitrogen Monoxide	
Span Gas Reference Number	CYL 12.0136	
Span Gas Expiry Date	100	
Span Gas Start Pressure (bar)	120	
Gas Cylinder Concentration (ppm)	413.6	NOTE: Dilution performed to achieve correct span value
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	B2	

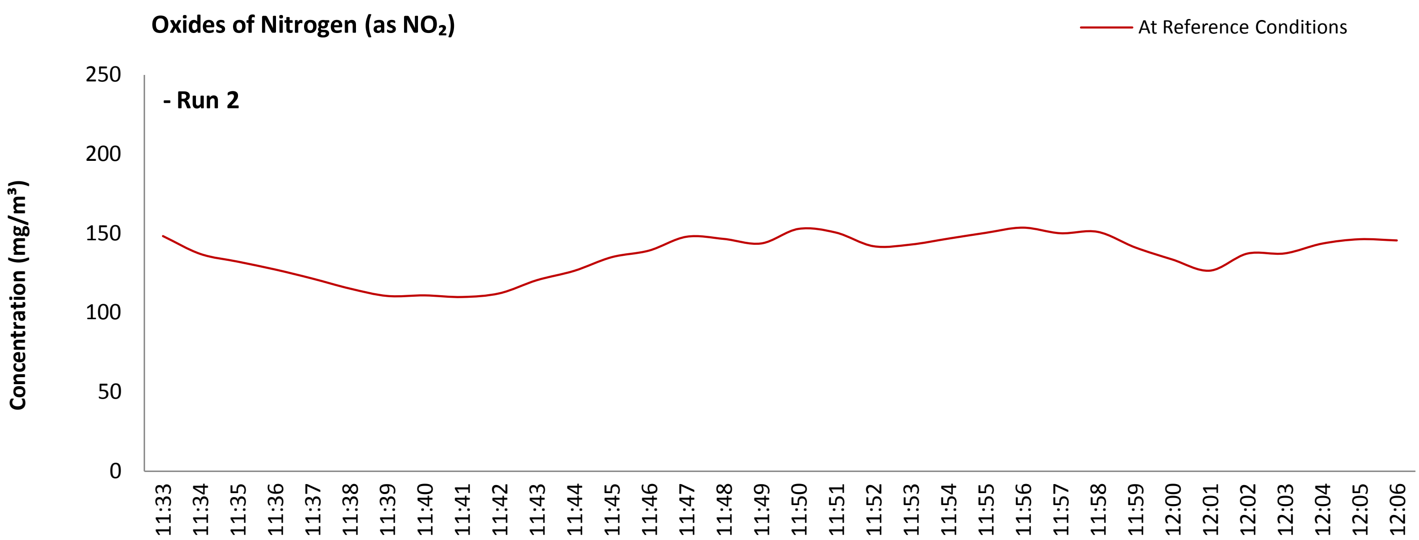
Reference Conditions

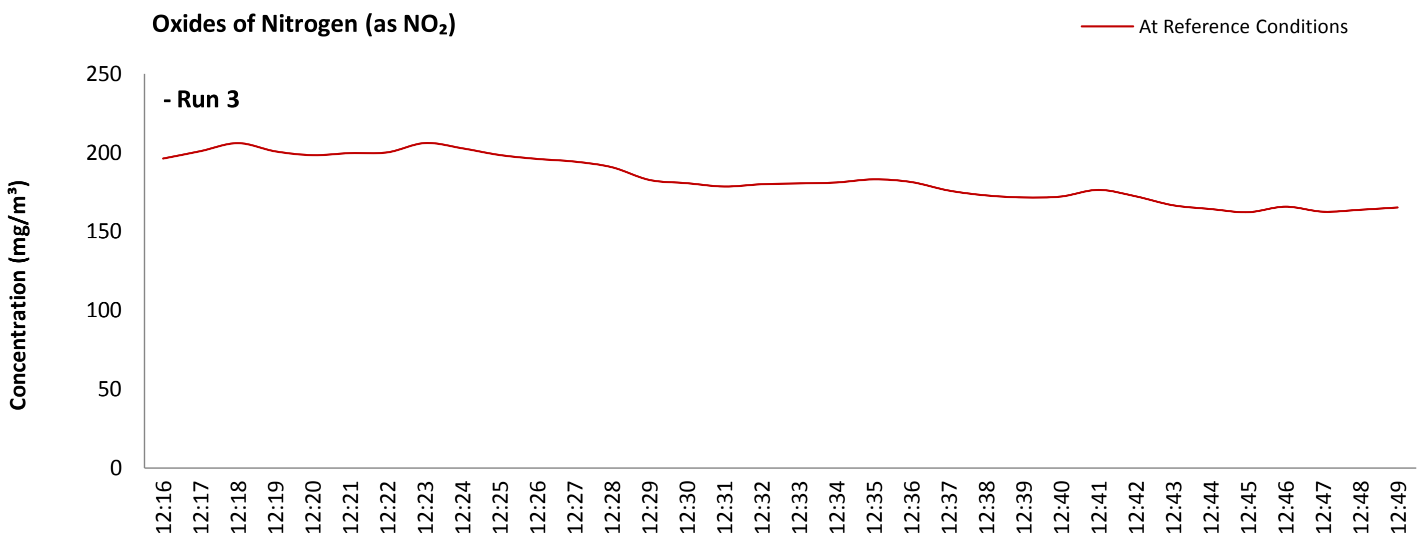
Reference Conditions are: 273K, 101.3kPa, dry gas, 11% oxygen.

OXIDES OF NITROGEN (as NO_2): DATA TREND

Graphical Trend of Data







OXIDES OF NITROGEN (as NO_2): SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	Run 2	Run 3
Sampling Times	-	10:48 - 11:21	11:33 - 12:06	12:16 - 12:49
Sampling Dates	-	13/06/2018	13/06/2018	13/06/2018
Instrument Range	ppm	500	500	500
Span Gas Value	ppm	413.6	413.6	413.6

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	Run 2	Run 3
Average Temperature	°C	2.3	2.3	2.3
Allowable Temperature	< °C	4.0	4.0	4.0
Temperature Acceptable	-	Yes	Yes	Yes

	Zero Drift	Units	Run 1	Run 2	Run 3
CAL 1	Zero at Analyser (Pre)	ppm	0.00	0.00	0.00
CAL 1	Zero at Analyser (Post)	ppm	0.60	0.60	0.60
CAL 1	Zero Drift	ppm	0.60	0.60	0.60
	Allowable Zero Drift	± ppm	20.68	20.68	20.68
	Zero Drift Acceptable	-	Yes	Yes	Yes

	Span Drift	Units	Run 1	Run 2	Run 3
CAL 1	Span at Analyser (Pre)	ppm	413.60	413.60	413.60
CAL 1	Span at Analyser (Post)	ppm	406.00	406.00	406.00
CAL 1	Span Drift	ppm	-7.60	-7.60	-7.60
	Allowable Span Drift	± ppm	20.68	20.68	20.68
	Span Drift Acceptable	-	Yes	Yes	Yes

Test Conditions	Units	Run 1	Run 2	Run 3
Run Ambient Temperature Range	°C	22 - 23	22 - 23	22 - 23

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	2	3
There are no deviations associated with the sampling employed.	x	x	x

OXIDES OF NITROGEN (as NO_2): MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	RUN 2	RUN 3	Units
Limit value	-	-	-	mg/m³ (REF)
TGN M2 Allowable MU	10.0	10.0	10.0	%
Measured concentration	174.10	158.37	197.98	mg/m³ (STP, dry)
Ration NO / NO_2	5	5	5	%
Range Used	500.0	500.0	500.0	ppm
Range Used [A]	1026.1	1026.1	1026.1	mg/m³
Cal gas conc.	413.6	413.6	413.6	ppm
Conversion	2.05	2.05	2.05	ppm to mg/m³
MCERTS Range [B]	125.0	125.0	125.0	mg/m³
Lower of [A] or [B]	125.0	125.0	125.0	mg/m³
Cal gas conc.	848.8	848.8	848.8	mg/m³

Performance characteristics	RUN 1	RUN 2	RUN 3	Units
Response time	60	60	60	seconds
Number of readings in measurement	33	33	33	-
Repeatability at zero	0.40	0.40	0.40	% full scale
Repeatability at span level	0.40	0.40	0.40	% full scale
Deviation from linearity	0.19	0.19	0.19	% of value
Zero drift	0.15	0.15	0.15	% full scale
Span drift	-1.84	-1.84	-1.84	% full scale
Volume or pressure flow dependence	0.40	0.40	0.40	% of full scale
Atmospheric pressure dependence	0.30	0.30	0.30	% of value/kPa
Ambient temperature dependence	0.18	0.18	0.18	% full scale/10K
Combined interference	0.60	0.60	0.60	% range
Dependence on voltage	0.40	0.40	0.40	% full scale/10V
Converter efficiency	95.3	95.3	95.3	%
Losses in the line (leak)	0.24	0.24	0.24	% of value
Uncertainty of calibration gas blending	1.40	1.40	1.40	% of value
Uncertainty of calibration gas	2.00	2.00	2.00	% of value

Performance characteristic	RUN 1	RUN 2	RUN 3	Units
Standard deviation of repeatability at zero	use rep at span	use rep at span	use rep at span	mg/m³
Standard deviation of repeatability at span level	0.07	0.07	0.07	mg/m³
Lack of fit	0.14	0.14	0.14	mg/m³
Drift	-1.14	-0.97	-1.39	mg/m³
Volume or pressure flow dependence	0.00	0.00	0.00	mg/m³
Atmospheric pressure dependence	0.11	0.11	0.11	mg/m³
Ambient temperature dependence	0.03	0.03	0.03	mg/m³
Combined interference (from MCERTS Certificate)	0.43	0.43	0.43	mg/m³
Dependence on voltage	0.05	0.05	0.05	mg/m³
Converter efficiency	0.24	0.21	0.27	mg/m³
Losses in the line (leak)	0.24	0.22	0.28	mg/m³
Uncertainty of calibration gas blending	1.41	1.28	1.60	mg/m³
Uncertainty of calibration gas	2.01	1.83	2.29	mg/m³

			RUN 1	RUN 2	RUN 3	Units
Measurement uncertainty		**Result**	174.10	158.37	197.98	mg/m³
Combined uncertainty			2.80	2.54	3.21	mg/m³
Expanded uncertainty	k =	1.96	5.49	4.97	6.28	mg/m³
Uncertainty corrected to std conds. (O_2)			4.63	4.28	5.82	mg/m³ (REF)

	RUN 1	RUN 2	RUN 3	Units
Expanded uncertainty (no O_2) - at 95% Confidence	3.15	3.14	3.17	% of Value
Expanded uncertainty (no O_2) - at 95% Confidence	N/A	N/A	N/A	% at ELV
Overall Allowable uncertainty (no O_2) - at 95% Confidence	N/A	N/A	N/A	% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**	**N/A**	**N/A**	-

	RUN 1	RUN 2	RUN 3	Units
Expanded uncertainty (with O_2) - at 95% Confidence	4.78	4.73	4.63	% of Value
Expanded uncertainty (with O_2) - at 95% Confidence	N/A	N/A	N/A	% at ELV
Overall Allowable uncertainty (with O_2) - at 95% Confidence	N/A	N/A	N/A	% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**	**N/A**	**N/A**	-

Requirement for SRM is that Uncertainty should be <10% of the value at the ELV, on a dry gas basis, or if O_2 correction is applied less than 10% + the uncertainty associated with the O_2 correction (using sqrt of sum squares to add uncertainty components). Ref EA TGN M2.

OXYGEN: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

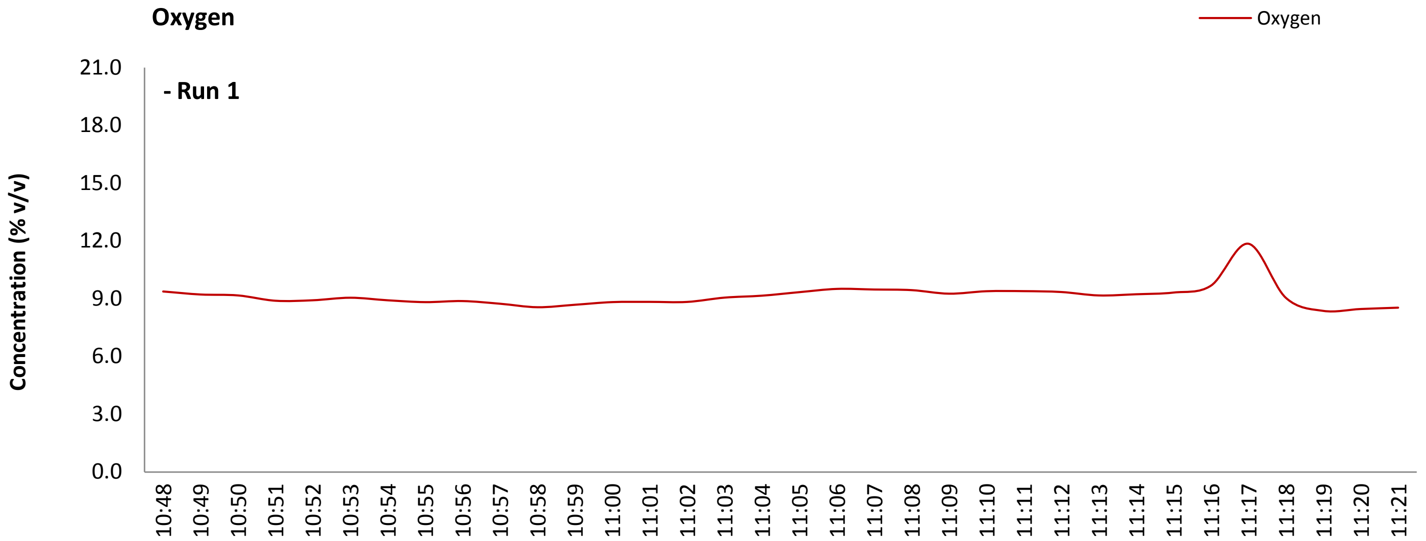
Parameter	Units	Run 1	Run 2	Run 3	Mean
Concentration	% v/v	9.1	9.4	10.2	9.6
Uncertainty	±% v/v	0.33	0.33	0.34	0.33

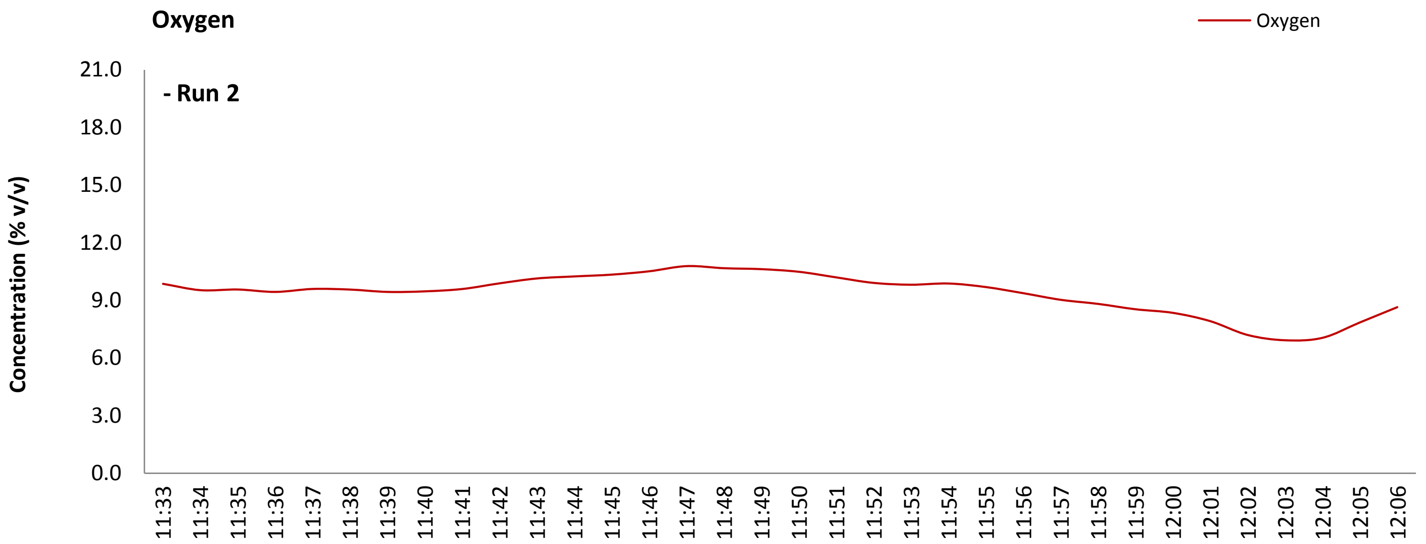
General Sampling Information

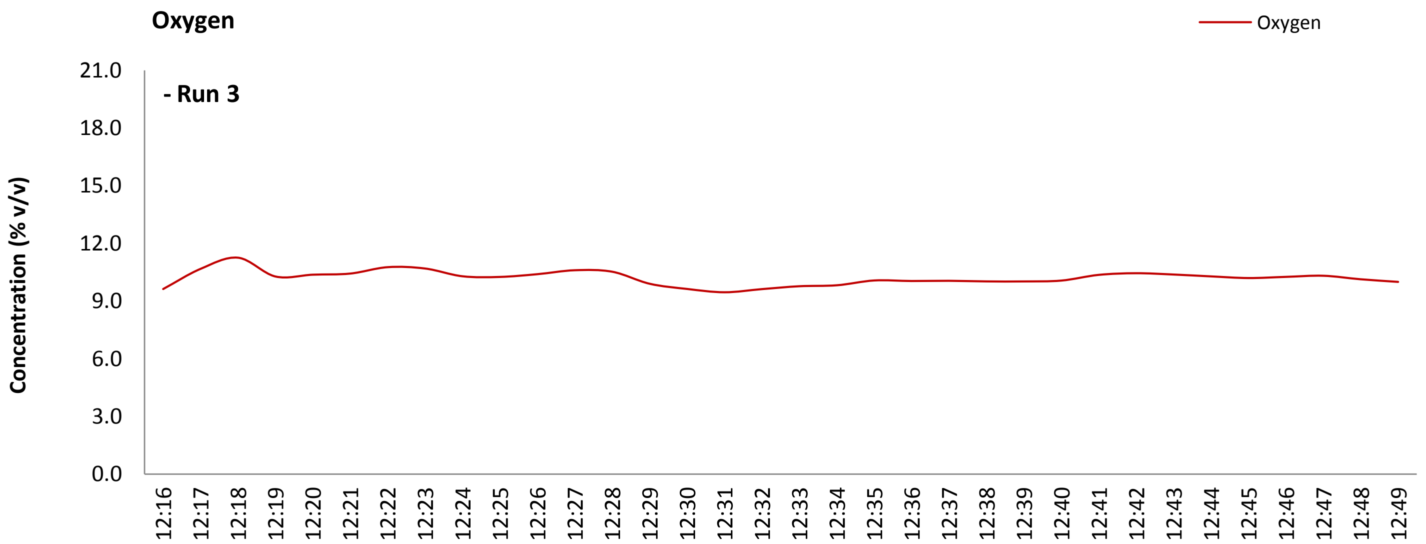
Parameter	Value	
Standard	EN 14789	
Technical Procedure	CAT-TP-21	
Probe Material	Titanium	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Synthetic Air (5 Grade)	
Span Gas Reference Number	CYL 11.0307	
Span Gas Expiry Date	11/10/2022	
Span Gas Start Pressure (bar)	50	
Gas Cylinder Concentration (% v/v)	21.62	NOTE: Dilution performed to achieve correct span value
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	B2	

OXYGEN: DATA TREND

Graphical Trend of Data







OXYGEN: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	Run 2	Run 3
Sampling Times	-	10:48 - 11:21	11:33 - 12:06	12:16 - 12:49
Sampling Dates	-	13/06/2018	13/06/2018	13/06/2018
Instrument Range	% v/v	25	25	25
Span Gas Value	% v/v	11.00	11.00	11.00

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	Run 2	Run 3
Average Temperature	°C	2.3	2.3	2.3
Allowable Temperature	< °C	4.0	4.0	4.0
Temperature Acceptable	-	Yes	Yes	Yes

	Zero Drift	Units	Run 1	Run 2	Run 3
CAL 1	Zero at Analyser (Pre)	% v/v	0.00	0.00	0.00
CAL 1	Zero at Analyser (Post)	% v/v	0.06	0.06	0.06
CAL 1	Zero Drift	% v/v	0.06	0.06	0.06
	Allowable Zero Drift	± % v/v	0.55	0.55	0.55
	Zero Drift Acceptable	-	Yes	Yes	Yes

	Span Drift	Units	Run 1	Run 2	Run 3
CAL 1	Span at Analyser (Pre)	% v/v	10.85	10.83	10.85
CAL 1	Span at Analyser (Post)	% v/v	10.82	10.82	10.82
CAL 1	Span Drift	% v/v	-0.03	-0.03	-0.03
	Allowable Span Drift	± % v/v	0.55	0.55	0.55
	Span Drift Acceptable	-	Yes	Yes	Yes

Test Conditions	Units	Run 1	Run 2	Run 3
Run Ambient Temperature Range	°C	22 - 23	22 - 23	22 - 23

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	2	3
There are no deviations associated with the sampling employed.	x	x	x

OXYGEN: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	RUN 2	RUN 3	Units
Limit value	N/A	N/A	N/A	%vol
TGN M2 Allowable MU	6.0	6.0	6.0	%
Measured concentration	9.15	9.38	10.19	%vol
Range Used	25.0	25.0	25.0	%vol
Cal gas conc.	21.6	21.6	21.6	%vol

Performance characteristics	RUN 1	RUN 2	RUN 3	Units
Response time	60	60	60	seconds
Number of readings in measurement	33	33	33	-
Repeatability at zero	0.04	0.04	0.04	% full scale
Repeatability at span level	0.04	0.04	0.04	% full scale
Deviation from linearity	0.11	0.11	0.11	% of value
Zero drift	0.55	0.55	0.55	% full scale
Span drift	-0.28	-0.28	-0.28	% full scale
Volume or pressure flow dependence	0.20	0.20	0.20	% of full scale
Atmospheric pressure dependence	0.30	0.30	0.30	% of value/kPa
Ambient temperature dependence	-0.07	-0.07	-0.07	% full scale/10K
Combined interference	0.56	0.56	0.56	% range
Dependence on voltage	0.02	0.02	0.02	% full scale/10V
Losses in the line (leak)	0.18	0.18	0.18	% of value
Uncertainty of calibration gas	2.00	2.00	2.00	% of value

Performance characteristic	RUN 1	RUN 2	RUN 3	Units
Standard deviation of repeatability at zero	use rep at span	use rep at span	use rep at span	%vol
Standard deviation of repeatability at span level	0.01	0.01	0.01	%vol
Lack of fit	0.02	0.02	0.02	%vol
Drift	0.05	0.05	0.05	%vol
Volume or pressure flow dependence	0.00	0.00	0.00	%vol
Atmospheric pressure dependence	0.02	0.02	0.02	%vol
Ambient temperature dependence	-0.01	-0.01	-0.01	%vol
Combined interference (from MCERTS Certificate)	0.08	0.08	0.08	%vol
Dependence on voltage	0.00	0.00	0.00	%vol
Losses in the line (leak)	0.01	0.01	0.01	%vol
Uncertainty of calibration gas	0.11	0.11	0.12	%vol

			RUN 1	RUN 2	RUN 3	Units
Measurement uncertainty		**Result**	9.15	9.38	10.19	%vol
Combined uncertainty			0.17	0.17	0.18	%vol
Expanded uncertainty	k =	1.96	0.33	0.33	0.34	%vol

	RUN 1	RUN 2	RUN 3	Units
Expanded uncertainty (no O_2) - at 95% Confidence	3.60	3.54	3.37	% of Value
Result of Compliance with Uncertainty Requirement in M2	**COMPLIANT**	**COMPLIANT**	**COMPLIANT**	-

Requirement for SRM is that Uncertainty should be 0.5%vol absolute or 6% relative whichever is the lower, on a dry gas basis. Ref EA TGN M2.

Exova Catalyst, Unit C6, Emery Court, The Embankment Business Park, Heaton Mersey, Stockport, SK4 3GL
E: toby.campbell@exova.com
Your Exova Catalyst Contact: Toby Campbell (07825 130 074)

Stack Emissions Testing Report Commissioned by
Newbridge Energy Ltd

Installation Name & Address
Blazers Fuels Ltd
Brickfield Lane
Ruthin
Denbighshire
North Wales
LL15 2TN

Stack Reference
Belt Dryer No.1

Dates of the Monitoring Campaign
13th - 14th June 2018

Job Reference Number
CAT-4238

Report Written by
Brian Jacob Team Leader MCERTS Level 2 MM 06 693 TE1 TE2 TE3 TE4

Report Approved by
Michelle Edwards Team Leader MCERTS Level 2 MM 05 659 TE1 TE2 TE3 TE4

Report Date
19th June 2018

Version
Version 1

Signature of Report Approver
MEdwards

CONTENTS

Opinions and interpretations expressed herein are outside the scope of Exova Catalyst's ISO 17025 accreditation.

MONITORING OBJECTIVES

Blazers Fuels Ltd, Ruthin
Belt Dryer No.1
13th - 14th June 2018

Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by Newbridge Energy Ltd to carry out stack emissions testing for Blazers Fuels Ltd on the Belt Dryer No.1 at Ruthin.

The aim of the monitoring campaign was to perform testing, as requested by the customer, for a number of prescribed pollutants. There are no emission limits set for any of the pollutants at this time.

Special Requirements

There were no special requirements.

Target Parameters

Total Particulate Matter, PM_{10}, $PM_{2.5}$

MONITORING RESULTS

Blazers Fuels Ltd, Ruthin
Belt Dryer No.1
13th - 14th June 2018

where MU = Measurement Uncertainty associated with the Result

				Concentration				Mass Emission			
Parameter				**Units**	**Result**	**MU +/-**	**Limit**	**Units**	**Result**	**MU +/-**	**Limit**
Total Particulate Matter [1]				mg/m³	3.4	1.7	-	g/hr	261	131	-
PM_{10} [1]				mg/m³	0.94	0.60	-	g/hr	72.4	46.2	-
$PM_{2.5}$ [1]				mg/m³	0.68	0.69	-	g/hr	52.9	53.7	-
Oxygen	% v/v	**Wet**	20.25	% v/v	**Dry** 21.0	0.53					
Water Vapour				% v/v	3.7	0.20					
Stack Gas Temperature				°C	30.0						
Stack Gas Velocity				m/s	7.6	0.11					
Volumetric Flow Rate (ACTUAL)				m³/hr	85720	4080					
Volumetric Flow Rate (REF) [1]				m³/hr	77450	3686					

NOTE: VOLUMETRIC FLOW RATE & VELOCITY DATA TAKEN FROM AN AVERAGE OF ALL OF THE ISOKINETIC RUNS.

[1] Reference Conditions (REF) are: 273K, 101.3kPa, without correction for water vapour content.

MONITORING DATE(S) & TIMES

Blazers Fuels Ltd, Ruthin
Belt Dryer No.1
13th - 14th June 2018

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m³	4.0	g/hr	306	13/06/2018	14:53 - 15:23	30
Total Particulate Matter	R2	mg/m³	2.8	g/hr	215	13/06/2018	15:40 - 16:10	30
PM_{10}	R1	mg/m³	0.94	g/hr	72.4	14/06/2018	09:48 - 10:18	30
$PM_{2.5}$	R1	mg/m³	0.68	g/hr	52.9	14/06/2018	09:48 - 10:18	30
Oxygen	R1	% v/v	20.3			13/06/2018	14:53 - 15:23	30
Oxygen	R2	% v/v	20.3			13/06/2018	15:40 - 16:10	30
Oxygen	R3	% v/v	20.2			14/06/2018	09:48 - 10:18	30
Velocity Traverse	R1					13/06/2018	14:30 - 14:45	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Blazers Fuels Ltd, Ruthin
Belt Dryer No.1
13th - 14th June 2018

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operation
Capacity (of 100%) and Tonnes / Hour	4 - 5 Tonne / Hour
Continuous or Batch Process	Continuous
Feedstock (if applicable)	Wood Chips
Abatement System	None
Abatement System Running Status	N/A
Fuel	Waste Heat From CHP
Plume Appearance	None Visible

MONITORING & ANALYTICAL METHODS

Blazers Fuels Ltd, Ruthin
Belt Dryer No.1
13th - 14th June 2018

Parameter	Monitoring				Analysis				MCERTS Testing	LOD (Average)
	Standard	Technical Procedure	ISO 17025 Testing	Testing Lab	Analytical Procedure	Analytical Technique	ISO 17025 Analysis	Analysis Lab		
Total Particulate Matter	EN 13284-1	CAT-TP-01	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.42 mg/m³
PM_{10}	BS EN ISO 23210	CAT-TP-18	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.28 mg/m³
$PM_{2.5}$	BS EN ISO 23210	CAT-TP-18	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.35 mg/m³
Water Vapour	EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.10 % v/v
Oxygen	EN 14789	CAT-TP-21	Yes	CAT	Dry Zirconia Cell by Horiba PG-250				Yes	0.1 %
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41	Yes	CAT	Pitot Tube and Thermocouple				Yes	1.2 m/s

ANALYSIS LABORATORIES

(with short name reference as appears in the table above)

Exova Catalyst (CAT)	ISO 17025 Accreditation Number: 4279

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
Total Particulate Matter	All Runs	Due to the restricted access, it was not possible to sample at all of the sample points on the available sampling lines.

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	2.00
Width	m	-
Area	m²	3.14
Port Depth	cm	15
Orientation of Duct	-	Vertical
Number of Ports	-	2
Sample Port Size	-	4" BSP

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	MEWP
Inside / Outside	Outside

Platform Details

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	No
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	Yes
Platform has vertical base boards (approx. 0.25m high)	Yes
Platform has chains / self closing gates at top of ladders	Yes
There are no obstructions present which hamper insertion of sampling equipment	No
Safe Access Available	Yes
Easy Access Available	Yes

Sampling Location / Platform Improvement Recommendations

All platforms should be designed in accordance with the requirements in the Environment Agency's Technical Guidance Note M1 and EN 15259.

EN 15259 Homogeneity Test Requirements

There is no requirement to perform a EN 15259 Homogeneity Test on this Stack.

Sampling Plane Validation Criteria (from EN 15259)

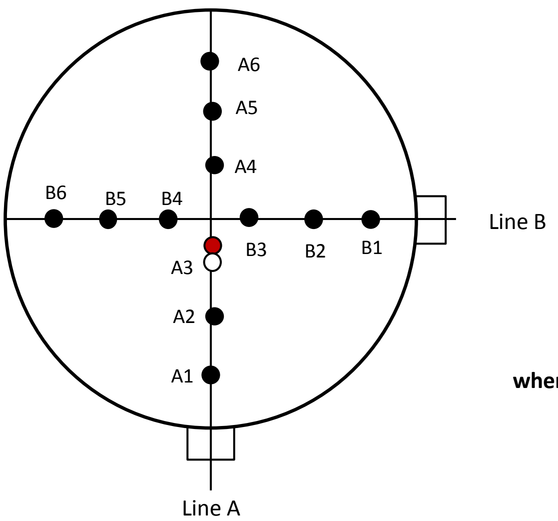
Criteria in EN 15259	Units	Traverse 1		Required	Compliant
Lowest Differential Pressure	Pa	17.0		> 5 Pa	Yes
Mean Velocity	m/s	5.44		-	-
Lowest Gas Velocity	m/s	4.56		-	-
Highest Gas Velocity	m/s	6.36		-	-
Ratio of Above	: 1	1.39		< 3 : 1	Yes
Maximum Angle of Swirl	°	14		< 15°	Yes
No Local Negative Flow	-	Yes		-	Yes

PLANT PHOTOS

Photo 1

Photo 2

SAMPLE POINTS



where ○ = isokinetic point sampled at
● = isokinetic point <u>not</u> sampled at
● = combustion gases sample point
● = non-isokinetic sample point

APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Brian Jacob	MCERTS Level 2	MM 06 693	TE1 TE2 TE3 TE4
Trainee	Danny Williams	MCERTS Trainee	Pending	None

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	CAT 7.39
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.10
Box Thermocouples (2)	-
Umbilical (1)	CAT 3.10
Umbilical (2)	-
Oven Box (1)	-
Oven Box (2)	-
Heated Probe (1)	CAT 5.7
Heated Probe (2)	-
Heated Probe (3)	-
S-Pitot (1)	CAT 21p.43
S-Pitot (2)	-
L-Pitot	-
Site Balance	CAT 17.13
500g / 1Kg Check Weights	CAT 17.13
Last Impinger Arm	-
Callipers	CAT 23.10
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-250	CAT 9.11
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Testo 350 XL	-
JCT JCC P1 Cooler	CAT 4.135
Gasmet DX4000	-
Gasmet Sampling System	-
Bernath 3006 FID	-
M&C PSS	CAT 12.93
Mass Flow Controller (1)	CAT 6.3
Mass Flow Controller (2)	CAT 6.4
Mass View (1)	-
Mass View (2)	-
Easylogger EN-EL-12 Bit	-
Easylogger EN-EL-12 Bit	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer (1)	CAT 3.25
Digital Manometer (2)	-
Digital Temperature Meter	CAT 3.25
Stopwatch	CAT 14.53
Barometer	CAT 13.20
Stack Thermocouple (1)	CAT 4.140
Stack Thermocouple (2)	-
Stack Thermocouple (3)	-
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	-
20m Heated Line (1)	CAT 20.69
20m Heated Line (2)	-
Dual Channel Heater Controller	-
Single Channel Heater Controller	-
Laboratory Balance	CAT 1.18 / 1.18a
Tape Measure	CAT 16.14

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	EN 13284-1	CAT-TP-01
PM_{10}	BS EN ISO 23210	CAT-TP-18
$PM_{2.5}$	BS EN ISO 23210	CAT-TP-18
Water Vapour	EN 14790	CAT-TP-05
Oxygen	EN 14789	CAT-TP-21
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41

PRELIMINARY STACK SURVEY: CALCULATIONS

General Stack Details

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	2.00
Stack Width, W	m	-
Stack Area, A	m²	3.14
Average Stack Gas Temperature, T_a	°C	30.1
Average Stack Gas Pressure	Pa	24.3
Average Stack Static Pressure, P_{static}	kPa	0.021
Average Barometric Pressure, P_b	kPa	101.6
Average Pitot Tube Calibration Coefficient, C_p	-	0.84

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m³ p	Conc kg/m³ p_i
CO_2 (Estimated)	-	0.06	0.06	0.0006	44.01	1.9635	0.00118
O_2	-	21.03	20.25	0.2103	32.00	1.4277	0.30031
N_2	-	78.91	75.95	0.7891	28.01	1.2498	0.98619
Moisture (H_2O)	-	-	3.75	0.0375	18.02	0.8037	0.03013

Where: p = M / 22.41

p_i = r x p

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m³	1.288
Wet Density (STP), P_{STW}	kg/m³	1.270
Dry Density (Actual), P_{Actual}	kg/m³	1.164
Average Wet Density (Actual), $P_{ActualW}$	kg/m³	1.147

Where: P_{STD} = sum of component concentrations, kg/m³ (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m³ (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (at each sampling point) = $P_{STW} \times (T_s / P_s) \times (P_a / T_a)$

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF [1]
Temperature	°C	30.1	0.0
Total Pressure	kPa	101.6	101.3
Moisture	%	3.75	3.75

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m³/hr	61480
Gas Volumetric Flowrate (STP, Wet)	m³/hr	55553
Gas Volumetric Flowrate (STP, Dry)	m³/hr	53471
Gas Volumetric Flowrate REF [1]	m³/hr	55553

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID)

Parameter	Units	Value
Date of Survey	-	13/06/2018
Time of Survey	-	14:30 - 14:45
Atmospheric Pressure	kPa	101.6
Average Stack Static Pressure	Pa	21
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 200 (500Pa)	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C_p	-	0.84
Number of Lines Available	-	2
Number of Lines Used	-	2

		Sampling Line A					Sampling Line B				
Traverse Point	**Depth m**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**
STATIC (Units: Pa)		*20.0*					*22.0*				
Mean		**25.3**	**30.1**	**1.147**	**5.54**		**23.3**	**30.1**	**1.147**	**5.33**	
1	0.09	17.0	30.0	1.147	4.56	10.0	20.0	30.1	1.147	4.95	12.0
2	0.29	28.0	30.0	1.147	5.86	12.0	24.0	30.1	1.147	5.42	14.0
3	0.59	33.0	30.1	1.147	6.36	13.0	28.0	30.0	1.147	5.86	14.0
4	1.41	30.0	30.2	1.147	6.06	12.0	26.0	30.0	1.147	5.64	13.0
5	1.71	24.0	30.2	1.147	5.42	14.0	23.0	30.0	1.147	5.31	12.0
6	1.91	20.0	30.2	1.147	4.95	14.0	19.0	30.1	1.147	4.83	10.0

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID) - MEASUREMENT UNCERTAINTY

(1 of 1)

Performance characteristics (Uncertainty Components)	**Uncertainty**	**Value**	**Units**
Standard Uncertainty on the coefficient of the Pitot Tube	u(k)	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	u(Δpi)	1.074	Pa
- Resolution	u(res)	0.00087	
- Calibration	u(cal)	0.062	
- Drift	u(drift)	0.083	
- Lack of Fit	u(fit)	0.007	
- Overall corrections to dynamic measurements	u(Cf)	0.153	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00003	-
- φO_2,w	-	20.246	
- φCO_2,w	-	0.058	
- Oxygen, dry	u(ϕO_2,d)	0.644	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.002	
- Water Vapour	u(ϕH_2O)	0.191	
- Oxygen, wet	u(ϕO_2,w)	0.621	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.002	
Standard uncertainty associated with the stack temperature	u(Tc)	1.546	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.694	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	0.759	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00618	-
Standard uncertainty associated with the local velocities	u(vi)	0.124	Pa
Standard uncertainty associated with the mean velocity	u(v)	0.041	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	0.080	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	1.47	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	2926.0	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00059	
- $u^2(qV,w)$	-	2228549	
- u(qV,w)	-	1492.8	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	4.76	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Belt Dryer No.1

Sample Runs

Parameter	Units	Run 1	Run 2		Mean
Concentration	mg/m³	4.0	2.8		3.4
Uncertainty	±mg/m³	1.7	1.7		1.7
Mass Emission	g/hr	306	215		261
Uncertainty	±g/hr	133	129		131

Parameter	Units	Run 1	Run 2		Mean
Water Vapour	% v/v	3.8	4.4		4.1
Uncertainty	±% v/v	0.22	0.24		0.23

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	1.3		1.3

General Sampling Information

Parameter	Value	
Standard	EN 13284-1	
Technical Procedure	CAT-TP-01	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Glass Fibre	
Number of Sampling Lines Used	1 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 12	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A3	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	Run 2	
Absolute pressure of stack gas, P_s				
Barometric pressure, P_b	mmHg	762.0	762.0	
Stack static pressure, P_{static}	mmH_2O	2.0	2.0	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	762.2	762.2	
Volume of water vapour collected, V_{wstd}				
Total mass collected in impingers (liquid trap)	g	9.4	14.4	
Total mass collected in impingers (silica trap)	g	4.2	1.6	
Total mass of liquid collected, V_{lc}	g	13.6	16.0	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0169	0.0199	
Volume of gas metered dry, V_{mstd}				
Volume of gas sample through gas meter, V_m	m^3	0.4570	0.4650	
Gas meter correction factor, Y_d	-	1.0180	1.0180	
Average dry gas meter temperature, T_m	°C	26.0	25.1	
Average pressure drop across orifice, ΔH	mmH_2O	25.3	23.2	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.4269	0.4356	
Moisture content, B_{wo} & R_{wv}				
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0382	0.0438	
B_{wo} as a percentage	% v/v	3.82	4.38	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	3.82	4.38	
Volume of gas metered wet, V_{mstw}				
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	0.4439	0.4556	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$				
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	N/A	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	N/A	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	N/A	
Molecular weight of dry gas stream, M_d				
CO_2 (Estimated)	% v/v	0.06	0.06	
O_2	% v/v	21.07	21.10	
Total	% v/v	21.13	21.16	
N_2	% v/v	78.87	78.84	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.85	28.85	
Molecular weight of stack gas (wet), M_s				
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.44	28.38	
Velocity of stack gas, V_s				
Pitot tube velocity constant, K_p	-	34.97	34.97	
Velocity pressure coefficient, C_p	-	0.84	0.84	
Average of velocity heads, ΔP_{avg}	mmH_2O	8.27	7.60	
Average square root of velocity heads, $\sqrt{\Delta P}$	$\sqrt{mmH_2O}$	2.88	2.76	
Average stack gas temperature, T_s	°C	30.0	30.0	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s + 273})) / (\sqrt{(M_s)(P_s)})$	m/s	9.99	9.58	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})				
Area of stack, A_s	m^2	3.14	3.14	
$Q_a = (60)(A_s)(V_s)$	m^3/min	1882.6	1806.9	
Conversion factor (K/mm.Hg), C_f	-	0.3592	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	1700.9	1632.6	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	1636.0	1561.2	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	N/A	
Percent isokinetic, %I				
Nozzle diameter, D_n	mm	5.90	5.90	
Nozzle area, A_n	mm^2	27.34	27.34	
Total sampling time, q	min	30	30	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	100.0	106.9	

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	Run 2	
Sampling Times	-	14:53 - 15:23	15:40 - 16:10	
Sampling Dates	-	13/06/2018	13/06/2018	
Sampling Device	-	ISO	ISO	
Volume Sampled (REF)	m^3	0.4439	0.4556	
Filter I.D. Number	-	47-50224	47-51013	
Start Filter Mass	g	0.14805	0.14628	
End Filter Mass	g	0.14934	0.14675	
Total Mass on Filter	g	0.00129	0.00047	
Probe Rinse I.D. Number	-	PR-47-50224	PR-47-51013	
Start Probe Rinse Mass	g	2.74241	2.57773	
End Probe Rinse Mass	g	2.74287	2.57853	
Total Mass in Probe Rinse	g	0.00046	0.00080	
Total Mass Collected	mg	1.75	1.27	
Calculated Concentration	mg/m^3	3.95	2.78	
Balance Uncertainty / LOD	mg/m^3	0.43	0.42	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	13/06/2018	
Average Volume Sampled (REF)	m^3	0.4497	
Filter I.D. Number	-	47-51014	
Start Filter Mass	g	0.14939	
End Filter Mass	g	0.14977	
Total Mass on Filter	g	0.00038	
Probe Rinse I.D. Number	-	PR-47-51014	
Start Probe Rinse Mass	g	2.59436	
End Probe Rinse Mass	g	2.59456	
Total Mass in Probe Rinse	g	0.00020	
Total Mass Collected	mg	0.58	
Calculated Concentration	mg/m^3	1.29	
Balance Uncertainty / LOD	mg/m^3	0.42	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1	Run 2	
Mean Sampling Rate	l/min	15.51	15.78	
Pre-Sampling Leak Rate	l/min	0.13	0.14	
Post-Sampling Leak Rate	l/min	0.14	0.13	
Allowable Leak Rate	l/min	0.31	0.32	
Leak Test Acceptable	-	Yes	Yes	

Water Droplets	Units	Run 1	Run 2	
Are Water Droplets Present	-	No	No	

MU (Concurrent Water Vapour)	Units	Run 1	Run 2	
Measurement Uncertainty (MU)	%	5.7	5.5	
Allowable MU	%	20	20	
MU Acceptable	%	Yes	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	Run 2	
Less than 50% Faded	%	Yes	Yes	

Isokinetic Criterion Compliance	Units	Run 1	Run 2	
Isokinetic Variation	%	100.0	106.9	
Allowable Isokinetic Range	%	95 - 115	95 - 115	
Isokineticity Acceptable	-	Yes	Yes	

Weighing Uncertainty Criteria	Units	Run 1	Run 2	
Overall Weighing Uncertainty	± mg	0.33	0.33	
Overall Weighing Uncertainty	± mg/m³	0.73	0.71	
ELV [Daily ELV for IED]	mg/m³	N/A	N/A	
Allowable Weighing Uncertainty	mg/m³	N/A	N/A	
Weighing Uncertainty Acceptable	-	N/A	N/A	

Filter Temperatures	Units	Run 1	Run 2	
Pre-Conditioning Temperature	°C	180	180	
Post-Conditioning Temperature	°C	160	160	
Maximum Filter Temperature	°C	30	30	

Test Conditions	Units	Run 1	Run 2	
Ambient Temperature Recorded?	-	Yes	Yes	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	15.00
Pre-Sampling Leak Rate	l/min	0.11
Post-Sampling Leak Rate	l/min	0.14
Allowable Leak Rate	l/min	0.30
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m^3	N/A
Blank Acceptable	-	N/A

Acetone / Water Rinse Blank	Units	Blank
Acetone / Water Rinse Value	mg/l	2.7
Allowable Blank	mg/l	10
Blank Acceptable	-	Yes

Method Deviations

Nature of Deviation (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number 1	Run Number 2
Due to the restricted access, it was not possible to sample at all of the sample points on the available sampling lines.	x	x

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value				Standard uncertainty				
Measured Quantities	**Symbol**	**Run 1**	**Run 2**		**Symbol**	**Units**	**Run 1**	**Run 2**	
Sampled Volume (Actual)	V_m	0.4570	0.4650		uV_m	m³	0.0091	0.0093	
Sampled Gas Temperature	T_m	299.0	298.1		uT_m	K	2.0	2.0	
Sampled Gas Pressure	ρ_m	101.6	101.6		$u\rho_m$	kPa	0.5	0.5	
Sampled Gas Humidity	H_m	0.0	0.0		uH_m	% v/v	1.0	1.0	
Leak	L	0.90	0.82		uL	%	-	-	
Mass of Particulate	m	1.75	1.27		um	mg	0.19	0.19	
Uncollected Mass	UCM	0.58	0.58		uUCM	mg	-	-	

	Uncertainty as a Percentage				
Measured Quantities	**Units**	**Run 1**	**Run 2**		**Requirement of Standard**
Sampled Volume (Actual)	%	2.00	2.00		≤2%
Sampled Gas Temperature	%	0.67	0.67		≤1%
Sampled Gas Pressure	%	0.49	0.49		≤1%
Sampled Gas Humidity	%	1.00	1.00		≤1%
Leak	%	0.90	0.82		≤2%
Mass of Particulate	%	-	-		<5% of ELV
Uncollected Mass	%	-	-		-

	Uncertainty in Measurement Units					Sensitivity Coefficient		
Measured Quantities	**Symbol**	**Units**	**Run 1**	**Run 2**		**Run 1**	**Run 2**	
Sampled Volume (STP)	V_m	m³	0.4269	0.4356		9.25	6.38	
Leak	L	mg/m³	0.021	0.013		1.00	1.00	
Mass of Particulate	L_r	mg	1.753	1.267		2.25	2.20	
Uncollected Mass	UCM	mg	0.33	0.33		2.25	2.20	

	Uncertainty in Result			
Measured Quantities	**Units**	**Run 1**	**Run 2**	
Sampled Volume (STP)	mg/m³	0.099	0.070	
Leak	mg/m³	0.0206	0.0132	
Mass of Particulate	mg/m³	0.4281	0.4171	
Uncollected Mass	mg/m³	0.7544	0.7350	

	Oxygen Correction Part of MU Budget			
Measured Quantities	**Units**	**Run 1**	**Run 2**	
O_2 Correction Factor	-	N/A	N/A	
Stack Gas O_2 Content	% v/v	N/A	N/A	
MU for O_2 Correction	-	N/A	N/A	
Overall MU For O_2 Measurement	%	N/A	N/A	

Parameter	**Units**	**Run 1**	**Run 2**	
Combined uncertainty	mg/m³	0.87	0.85	
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m³	1.71	1.66	
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m³	N/A	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m³	1.71	1.66	
Reported Uncertainty	mg/m³	1.71	1.66	
Expanded uncertainty (95% confidence), without Oxygen Correction	%	43.3	59.8	
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	43.3	59.8	
Reported Uncertainty	%	43.3	59.8	

APPENDIX 2

PM_{10}: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Belt Dryer No.1

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.94		0.94
Uncertainty	±mg/m³	0.60		0.60
Mass Emission	g/hr	72.4		72.4
Uncertainty	±g/hr	46.2		46.2

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	3.6		3.6
Uncertainty	±% v/v	0.18		0.18

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.28		0.28

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	BS EN ISO 23210	
Technical Procedure	CAT-TP-18	
Sizing Device	TCR Tecora MSSI 3-Stage Cascade Impactor	
Sizing Device Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A3	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

PM_{10}: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	762.0	
Stack static pressure, P_{static}	mmH_2O	2.0	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	762.2	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	22.1	
Total mass collected in impingers (silica trap)	g	5.2	
Total mass of liquid collected, V_{lc}	g	27.3	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0340	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	0.9380	
Gas meter correction factor, Y_d	-	1.0180	
Average dry gas meter temperature, T_m	°C	17.1	
Average pressure drop across orifice, ΔH	mmH_2O	192.7	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.9176	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0357	
B_{wo} as a percentage	% v/v	3.57	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	3.57	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	0.9516	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet (O_{2REFw}) = (21 - $REF\%O_2$) / (21 - $ACT\%O_{2w}$)	-	N/A	
O_2 Reference Factor dry (O_{2REFd}) = (21 - $REF\%O_2$) / (21 - $ACT\%O_{2d}$)	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2 (Estimated)	% v/v	0.06	
O_2	% v/v	20.94	
Total	% v/v	21.00	
N_2	% v/v	79.00	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.85	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.46	
Velocity of stack gas, V_{spt}			
Velocity pressure coefficient, C_p	-	0.84	
Average stack gas temperature, T_s	°C	30.0	
Velocity of stack gas (pre-test from traverse), V_{spt}	m/s	5.37	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	3.14	
$Q_a = (60)(A_s)(V_s)$	m^3/min	1012.6	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	914.9	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	882.2	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	11.91	
Nozzle area, A_n	mm^2	111.36	
Total sampling time, q	min	30	
Velocity at nozzle, V_n	m/s	5.21	
$\%I = V_n / V_{spt} \times 100$	%	97.0	

PM_{10}: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	09:48 - 10:18	
Sampling Dates	-	14/06/2018	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	0.9516	
2nd Stage of Cascade Impactor (PM_{10} to $PM_{2.5}$)			
Filter I.D. Number (2nd Stage)	-	PM2 - 01613	
Start Filter Mass (2nd Stage)	g	0.11849	
End Filter Mass (2nd Stage)	g	0.11873	
Total Mass	g	0.00024	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3 - 01613	
Start Filter Mass (3rd Stage)	g	0.15439	
End Filter Mass (3rd Stage)	g	0.15504	
Total Mass	g	0.00065	
Total Mass Collected	mg	0.89	
Calculated Concentration	mg/m^3	0.94	
Balance Uncertainty / LOD	mg/m^3	0.28	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	14/06/2018	
Average Volume Sampled (REF)	m^3	0.9516	
2nd Stage of Cascade Impactor (PM_{10} to $PM_{2.5}$)			
Filter I.D. Number (2nd Stage)	-	PM2 - 01706	
Start Filter Mass (2nd Stage)	g	0.13087	
End Filter Mass (2nd Stage)	g	0.13093	
Total Mass	g	0.00006	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3 - 01706	
Start Filter Mass (3rd Stage)	g	0.15429	
End Filter Mass (3rd Stage)	g	0.15438	
Total Mass	g	0.00009	
Total Mass Collected	mg	0.15	
Calculated Concentration	mg/m^3	0.16	
Balance Uncertainty / LOD	mg/m^3	0.28	

PM_{10}: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1	
Expected Sampling Rate	l/min	40.00	
Pre-Sampling Leak Rate	l/min	0.11	
Allowable Leak Rate	l/min	0.80	
Leak Test Acceptable	-	Yes	

Water Droplets	Units	Run 1	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	Units	Run 1	
Measurement Uncertainty (MU)	%	5.0	
Allowable MU	%	20	
MU Acceptable	%	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	
Less than 50% Faded	%	Yes	

Isokinetic Criterion Compliance	Units	Run 1	
Isokinetic Variation	%	97.0	
Allowable Isokinetic Range	%	90 - 130	
Isokineticity Acceptable	-	Yes	

Filter Temperatures	Units	Run 1	
Pre-Conditioning Temperature	°C	180	
Post-Conditioning Temperature	°C	160	
Maximum Filter Temperature	°C	30	

Test Conditions	Units	Run 1	
Ambient Temperature Recorded?	-	Yes	

Cut Size	Units	Run 1	
D_{50} Cut Size	µm	10.00	
Allowable D_{50} Cut Size	µm	9 - 11	
D_{50} Cut Size Acceptable	-	Yes	

PM_{10}: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	40.00	
Pre-Sampling Leak Rate	l/min	0.19	
Allowable Leak Rate	l/min	0.80	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m^3	N/A	
Blank Acceptable	-	N/A	

Method Deviations

Nature of Deviation	Run Number	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	**1**	
There are no deviations associated with the sampling employed.	wx	

PM_{10}: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value Symbol	Value Run 1		Standard uncertainty Symbol	Units	Run 1	
Sampled Volume (Actual)	V_m	0.9380		uV_m	m^3	0.0188	
Sampled Gas Temperature	T_m	290.1		uT_m	K	2.0	
Sampled Gas Pressure	ρ_m	101.6		$u\rho_m$	kPa	0.5	
Sampled Gas Humidity	H_m	0.0		uH_m	% v/v	1.0	
Leak	L	0.28		uL	%	-	
Mass of Particulate	m	0.89		um	mg	0.27	
Uncollected Mass	UCM	0.15		uUCM	mg	-	
Particulate Sizing	PS	10.00		uPS	%	-	

Measured Quantities	Uncertainty as a Percentage Units	Run 1		Requirement of Standard
Sampled Volume (Actual)	%	2.0000		≤2%
Sampled Gas Temperature	%	0.7		≤1%
Sampled Gas Pressure	%	0.5		≤1%
Sampled Gas Humidity	%	1.0		≤1%
Leak	%	0.28		≤2%
Mass of Particulate	%	-		<5% of ELV
Uncollected Mass	%	-		-
Particulate Sizing	%	10.00		-

Measured Quantities	Uncertainty in Measurement Units Symbol	Units	Run 1		Sensitivity Coefficient Run 1	
Sampled Volume (STP)	V_m	m^3	0.9176		1.02	
Leak	L	mg/m^3	0.001		1.00	
Mass of Particulate	L_r	mg	0.890		1.05	
Uncollected Mass	UCM	mg	0.09		1.05	
Particulate Sizing	PS	mg	0.05		1.00	

Measured Quantities	Uncertainty in Result Units	Run 1	
Sampled Volume (STP)	mg/m^3	0.023	
Leak	mg/m^3	0.0015	
Mass of Particulate	mg/m^3	0.2837	
Uncollected Mass	mg/m^3	0.0910	
Particulate Sizing	mg/m^3	0.0540	

Measured Quantities	Oxygen Correction Part of MU Budget Units	Run 1	
O_2 Correction Factor	-	N/A	
Stack Gas O_2 Content	% v/v	N/A	
MU for O_2 Correction	-	N/A	
Overall MU For O_2 Measurement	%	N/A	

Parameter	Units	Run 1	
Combined uncertainty	mg/m^3	0.30	
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.60	
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.60	
Reported Uncertainty	mg/m^3	0.60	
Expanded uncertainty (95% confidence), without Oxygen Correction	%	63.6	
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	63.6	
Reported Uncertainty	%	63.6	

$PM_{2.5}$: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Belt Dryer No.1

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.68		0.68
Uncertainty	±mg/m³	0.69		0.69
Mass Emission	g/hr	52.9		52.9
Uncertainty	±g/hr	53.7		53.7

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	3.6		3.6
Uncertainty	±% v/v	0.18		0.18

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.35		0.35

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	BS EN ISO 23210	
Technical Procedure	CAT-TP-18	
Sizing Device	TCR Tecora MSSI 3-Stage Cascade Impactor	
Sizing Device Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A3	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

$PM_{2.5}$: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	762.0	
Stack static pressure, P_{static}	mmH_2O	2.0	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	762.2	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	22.1	
Total mass collected in impingers (silica trap)	g	5.2	
Total mass of liquid collected, V_{lc}	g	27.3	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0340	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	0.9380	
Gas meter correction factor, Y_d	-	1.0180	
Average dry gas meter temperature, T_m	°C	17.1	
Average pressure drop across orifice, ΔH	mmH_2O	192.7	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.9176	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0357	
B_{wo} as a percentage	% v/v	3.57	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	3.57	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	0.9516	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet (O_{2REFw}) = (21 - $REF\%O_2$) / (21 - $ACT\%O_{2w}$)	-	N/A	
O_2 Reference Factor dry (O_{2REFd}) = (21 - $REF\%O_2$) / (21 - $ACT\%O_{2d}$)	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2 (Estimated)	% v/v	0.06	
O_2	% v/v	20.94	
Total	% v/v	21.00	
N_2	% v/v	79.00	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.85	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.46	
Velocity of stack gas, V_{spt}			
Velocity pressure coefficient, C_p	-	0.84	
Average stack gas temperature, T_s	°C	30.0	
Velocity of stack gas (pre-test from traverse), V_{spt}	m/s	5.37	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	3.14	
$Q_a = (60)(A_s)(V_s)$	m^3/min	1012.6	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	914.9	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	882.2	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	11.91	
Nozzle area, A_n	mm^2	111.36	
Total sampling time, q	min	30	
Velocity at nozzle, V_n	m/s	5.21	
$\%I = V_n / V_{spt} \times 100$	%	97.0	

$PM_{2.5}$: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	09:48 - 10:18	
Sampling Dates	-	14/06/2018	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	0.9516	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3 - 01613	
Start Filter Mass (3rd Stage)	g	0.15439	
End Filter Mass (3rd Stage)	g	0.15504	
Total Mass	g	0.00065	
Total Mass Collected	mg	0.65	
Calculated Concentration	mg/m^3	0.68	
Balance Uncertainty / LOD	mg/m^3	0.35	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	14/06/2018	
Average Volume Sampled (REF)	m^3	0.9516	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3 - 01706	
Start Filter Mass (3rd Stage)	g	0.15429	
End Filter Mass (3rd Stage)	g	0.15438	
Total Mass	g	0.00009	
Total Mass Collected	mg	0.09	
Calculated Concentration	mg/m^3	0.09	
Balance Uncertainty / LOD	mg/m^3	0.35	

$PM_{2.5}$: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1	
Expected Sampling Rate	l/min	40.00	
Pre-Sampling Leak Rate	l/min	0.11	
Allowable Leak Rate	l/min	0.80	
Leak Test Acceptable	-	Yes	

Water Droplets	Units	Run 1	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	Units	Run 1	
Measurement Uncertainty (MU)	%	5.0	
Allowable MU	%	20	
MU Acceptable	%	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	
Less than 50% Faded	%	Yes	

Isokinetic Criterion Compliance	Units	Run 1	
Isokinetic Variation	%	97.0	
Allowable Isokinetic Range	%	90 - 130	
Isokineticity Acceptable	-	Yes	

Filter Temperatures	Units	Run 1	
Pre-Conditioning Temperature	°C	180	
Post-Conditioning Temperature	°C	160	
Maximum Filter Temperature	°C	30	

Test Conditions	Units	Run 1	
Ambient Temperature Recorded?	-	Yes	

Cut Size	Units	Run 1	
D_{50} Cut Size	µm	2.52	
Allowable D_{50} Cut Size	µm	2.25 - 2.75	
D_{50} Cut Size Acceptable	-	Yes	

$PM_{2.5}$: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	40.00
Pre-Sampling Leak Rate	l/min	0.19
Allowable Leak Rate	l/min	0.80
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m³	N/A
Blank Acceptable	-	N/A

Method Deviations

Nature of Deviation	Run Number
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	1
There are no deviations associated with the sampling employed.	wx

$PM_{2.5}$: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value				Standard uncertainty			
Measured Quantities	**Symbol**	**Run 1**			**Symbol**	**Units**	**Run 1**	
Sampled Volume (Actual)	V_m	0.9380			uV_m	m^3	0.0188	
Sampled Gas Temperature	T_m	290.1			uT_m	K	2.0	
Sampled Gas Pressure	ρ_m	101.6			$u\rho_m$	kPa	0.5	
Sampled Gas Humidity	H_m	0.0			uH_m	% v/v	1.0	
Leak	L	0.28			uL	%	-	
Mass of Particulate	m	0.65			um	mg	0.33	
Uncollected Mass	UCM	0.09			uUCM	mg	-	
Particulate Sizing	PS	10.00			uPS	%	-	

	Uncertainty as a Percentage			
Measured Quantities	**Units**	**Run 1**		**Requirement of Standard**
Sampled Volume (Actual)	%	2.0000		≤2%
Sampled Gas Temperature	%	0.7		≤1%
Sampled Gas Pressure	%	0.5		≤1%
Sampled Gas Humidity	%	1.0		≤1%
Leak	%	0.28		≤2%
Mass of Particulate	%	-		<5% of ELV
Uncollected Mass	%	-		-
Particulate Sizing	%	10.00		-

	Uncertainty in Measurement Units					Sensitivity Coefficient	
Measured Quantities	**Symbol**	**Units**	**Run 1**			**Run 1**	
Sampled Volume (STP)	V_m	m^3	0.9176			0.74	
Leak	L	mg/m^3	0.001			1.00	
Mass of Particulate	L_r	mg	0.650			1.05	
Uncollected Mass	UCM	mg	0.05			1.05	
Particulate Sizing	PS	mg	0.04			1.00	

	Uncertainty in Result		
Measured Quantities	**Units**	**Run 1**	
Sampled Volume (STP)	mg/m^3	0.017	
Leak	mg/m^3	0.0011	
Mass of Particulate	mg/m^3	0.3468	
Uncollected Mass	mg/m^3	0.0546	
Particulate Sizing	mg/m^3	0.0394	

	Oxygen Correction Part of MU Budget		
Measured Quantities	**Units**	**Run 1**	
O_2 Correction Factor	-	N/A	
Stack Gas O_2 Content	% v/v	N/A	
MU for O_2 Correction	-	N/A	
Overall MU For O_2 Measurement	%	N/A	

Parameter	**Units**	**Run 1**	
Combined uncertainty	mg/m^3	0.35	
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.69	
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.69	
Reported Uncertainty	mg/m^3	0.69	
Expanded uncertainty (95% confidence)	%	101.5	
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	101.5	
Reported Uncertainty	%	101.5	

OXYGEN: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Belt Dryer No.1

Sample Runs

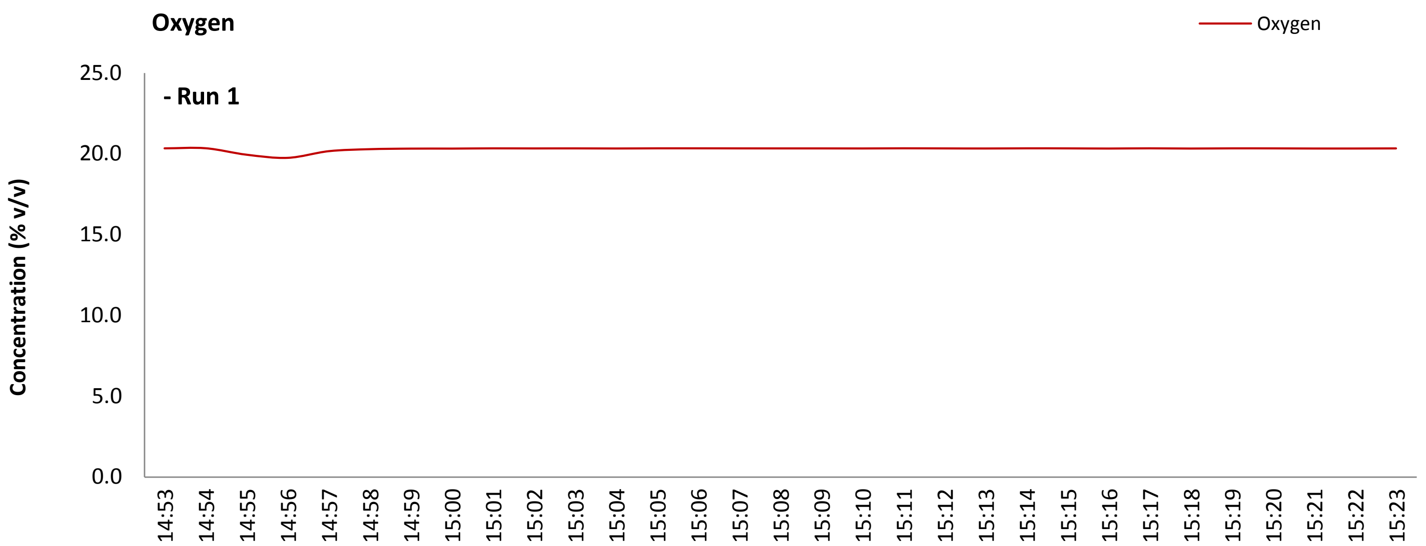
Parameter	Units	Run 1	Run 2	Run 3	Mean
Concentration	% v/v	20.3	20.3	20.2	20.2
Uncertainty	±% v/v	0.51	0.51	0.52	0.51

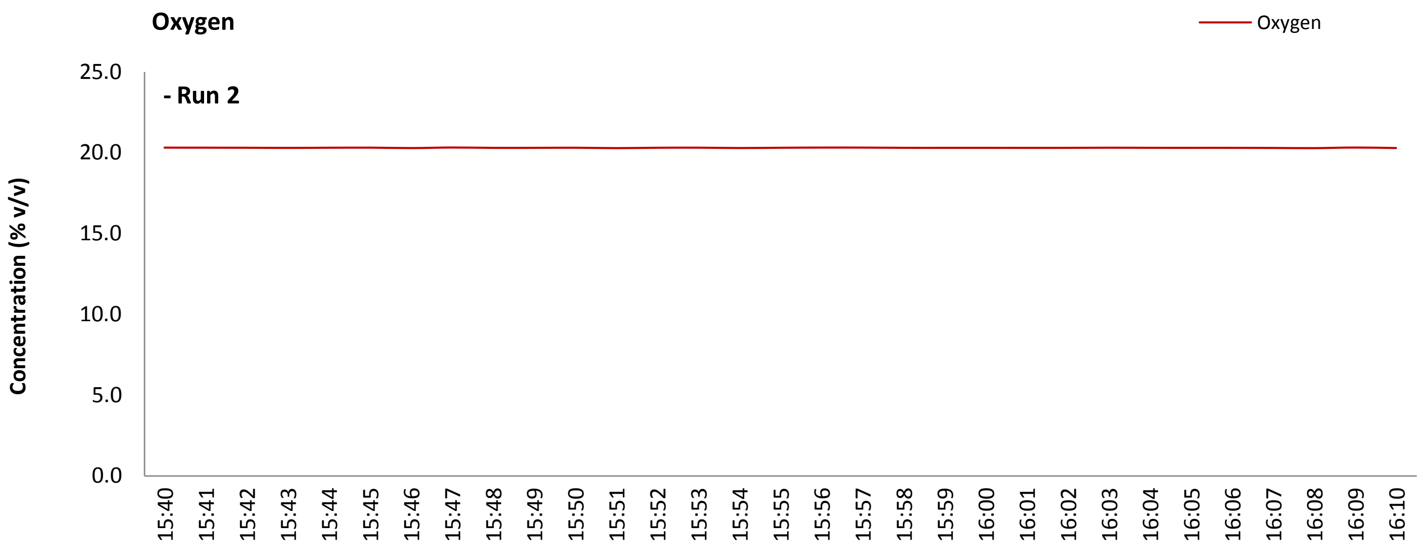
General Sampling Information

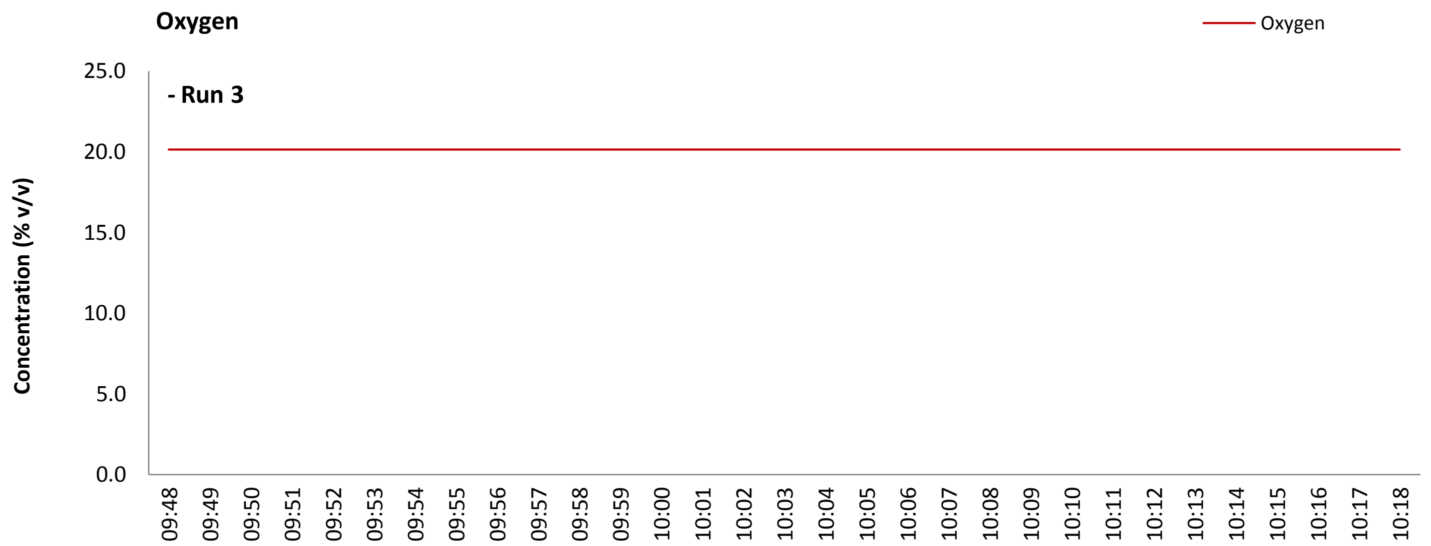
Parameter	Value	
Standard	EN 14789	
Technical Procedure	CAT-TP-21	
Probe Material	Titanium	
Filtration Type / Size	0.3µm Plane Glass Fibre	
Heated Head Filter Used	No	
Heated Line Temperature	Orsat Used	
Span Gas Type	Synthetic Air (5 Grade)	
Span Gas Reference Number	CYL 11.0307	
Span Gas Expiry Date	11/10/2022	
Span Gas Start Pressure (bar)	50	
Gas Cylinder Concentration (% v/v)	21.62	
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A3	

OXYGEN: DATA TREND

Graphical Trend of Data







OXYGEN: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	Run 2	Run 3
Sampling Times	-	14:53 - 15:23	15:40 - 16:10	09:48 - 10:18
Sampling Dates	-	13/06/2018	13/06/2018	14/06/2018
Instrument Range	% v/v	25	25	25
Span Gas Value	% v/v	21.62	21.62	21.62

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	Run 2	Run 3
Average Temperature	°C	N/A	N/A	N/A
Allowable Temperature	< °C	N/A	N/A	N/A
Temperature Acceptable	-	N/A	N/A	N/A

	Zero Drift	Units	Run 1	Run 2	Run 3
CAL 1	Zero at Analyser (Pre)	% v/v	0.00	0.00	0.00
	Zero at Analyser (Post)	% v/v	0.04	0.04	0.04
	Zero Drift	% v/v	0.04	0.04	0.04
	Allowable Zero Drift	± % v/v	1.08	1.08	1.08
	Zero Drift Acceptable	-	Yes	Yes	Yes

	Span Drift	Units	Run 1	Run 2	Run 3
CAL 1	Span at Analyser (Pre)	% v/v	21.62	21.60	21.62
	Span at Analyser (Post)	% v/v	21.62	21.62	21.66
	Span Drift	% v/v	0.00	0.00	0.04
	Allowable Span Drift	± % v/v	1.08	1.08	1.08
	Span Drift Acceptable	-	Yes	Yes	Yes

Test Conditions	Units	Run 1	Run 2	Run 3
Run Ambient Temperature Range	°C	22 - 24	22 - 24	20 - 22

Method Deviations

Nature of Deviation	Run Number		
(x = deviation applies to the associated run)	1	2	3
There are no deviations associated with the sampling employed.	x	x	x

OXYGEN: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	RUN 2	RUN 3	Units
Limit value	N/A	N/A	N/A	%vol
TGN M2 Allowable MU	6.0	6.0	6.0	%
Measured concentration	21.07	21.10	20.94	%vol
Range Used	25.0	25.0	25.0	%vol
Cal gas conc.	21.6	21.6	21.6	%vol

Performance characteristics	RUN 1	RUN 2	RUN 3	Units
Response time	60	60	60	seconds
Number of readings in measurement	30	30	30	-
Repeatability at zero	0.04	0.04	0.04	% full scale
Repeatability at span level	0.04	0.04	0.04	% full scale
Deviation from linearity	0.11	0.11	0.11	% of value
Zero drift	0.19	0.19	0.19	% full scale
Span drift	0.00	0.00	0.19	% full scale
Volume or pressure flow dependence	0.20	0.20	0.20	% of full scale
Atmospheric pressure dependence	0.30	0.30	0.30	% of value/kPa
Ambient temperature dependence	-0.07	-0.07	-0.07	% full scale/10K
Combined interference	0.56	0.56	0.56	% range
Dependence on voltage	0.02	0.02	0.02	% full scale/10V
Losses in the line (leak)	0.09	0.09	0.09	% of value
Uncertainty of calibration gas	2.00	2.00	2.00	% of value

Performance characteristic	RUN 1	RUN 2	RUN 3	Units
Standard deviation of repeatability at zero	use rep at span	use rep at span	use rep at span	%vol
Standard deviation of repeatability at span level	0.01	0.01	0.01	%vol
Lack of fit	0.02	0.02	0.02	%vol
Drift	0.02	0.02	0.05	%vol
Volume or pressure flow dependence	0.00	0.00	0.00	%vol
Atmospheric pressure dependence	0.02	0.02	0.02	%vol
Ambient temperature dependence	-0.01	-0.01	-0.01	%vol
Combined interference (from MCERTS Certificate)	0.08	0.08	0.08	%vol
Dependence on voltage	0.00	0.00	0.00	%vol
Losses in the line (leak)	0.01	0.01	0.01	%vol
Uncertainty of calibration gas	0.24	0.24	0.24	%vol

			RUN 1	RUN 2	RUN 3	Units
Measurement uncertainty		**Result**	21.07	21.10	20.94	%vol
Combined uncertainty			0.27	0.27	0.27	%vol
Expanded uncertainty	k =	1.96	0.53	0.53	0.54	%vol

	RUN 1	RUN 2	RUN 3	Units
Expanded uncertainty (no O_2) - at 95% Confidence	2.53	2.53	2.56	% of Value
Result of Compliance with Uncertainty Requirement in M2	**COMPLIANT**	**COMPLIANT**	**COMPLIANT**	-

Requirement for SRM is that Uncertainty should be 0.5%vol absolute or 6% relative whichever is the lower, on a dry gas basis. Ref EA TGN M2.

Exova Catalyst, Unit C6, Emery Court, The Embankment Business Park, Heaton Mersey, Stockport, SK4 3GL
E: toby.campbell@exova.com
Your Exova Catalyst Contact: Toby Campbell (07825 130 074)

Stack Emissions Testing Report Commissioned by
Newbridge Energy Ltd

Installation Name & Address
Blazers Fuels Ltd
Brickfield Lane
Ruthin
Denbighshire
North Wales
LL15 2TN

Stack Reference
Belt Dryer No. 2

Dates of the Monitoring Campaign
14th June 2018

Job Reference Number
CAT-4238

Report Written by
Brian Jacob Team Leader MCERTS Level 2 MM 06 693 TE1 TE2 TE3 TE4

Report Approved by
Michelle Edwards Team Leader MCERTS Level 2 MM 05 659 TE1 TE2 TE3 TE4

Report Date
19th June 2018

Version
Version 1

Signature of Report Approver
MEdwards

CONTENTS

Opinions and interpretations expressed herein are outside the scope of Exova Catalyst's ISO 17025 accreditation.

MONITORING OBJECTIVES

Blazers Fuels Ltd, Ruthin
Belt Dryer No. 2
14th June 2018

Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by Newbridge Energy Ltd to carry out stack emissions testing for Blazers Fuels Ltd on the Belt Dryer No. 2 at Ruthin.

The aim of the monitoring campaign was to perform testing, as requested by the customer, for a number of prescribed pollutants. There are no emission limits set for any of the pollutants at this time.

Special Requirements

There were no special requirements.

Target Parameters

Total Particulate Matter, PM_{10}, $PM_{2.5}$

MONITORING RESULTS

Blazers Fuels Ltd, Ruthin
Belt Dryer No. 2
14th June 2018

where MU = Measurement Uncertainty associated with the Result

Parameter			Concentration				Mass Emission			
			Units	Result	MU +/-	Limit	Units	Result	MU +/-	Limit
Total Particulate Matter [1]			mg/m³	7.5	2.6	-	g/hr	1780	620	-
PM_{10} [1]			mg/m³	0.24	0.72	-	g/hr	56.7	171	-
$PM_{2.5}$ [1]			mg/m³	0.29	0.87	-	g/hr	69.3	206	-
Oxygen	% v/v	Wet 19.96	% v/v	Dry 20.9	0.53					
Water Vapour			% v/v	4.7	0.24					
Stack Gas Temperature			°C	30.0						
Stack Gas Velocity			m/s	23.1	0.21					
Volumetric Flow Rate (ACTUAL)			m³/hr	261631	12079					
Volumetric Flow Rate (REF) [1]			m³/hr	237738	10976					

NOTE: VOLUMETRIC FLOW RATE & VELOCITY DATA TAKEN FROM AN AVERAGE OF ALL OF THE ISOKINETIC RUNS.

[1] Reference Conditions (REF) are: 273K, 101.3kPa, without correction for water vapour content.

MONITORING DATE(S) & TIMES

Blazers Fuels Ltd, Ruthin
Belt Dryer No. 2
14th June 2018

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m³	3.0	g/hr	702	14/06/2018	10:55 - 11:25	30
Total Particulate Matter	R2	mg/m³	12.0	g/hr	2859	14/06/2018	11:35 - 12:05	30
PM_{10}	R1	mg/m³	0.24	g/hr	56.7	14/06/2018	12:14 - 12:44	30
$PM_{2.5}$	R1	mg/m³	0.29	g/hr	69.3	14/06/2018	12:14 - 12:44	30
Oxygen	R1	% v/v	20.0			14/06/2018	10:55 - 11:25	30
Oxygen	R2	% v/v	20.0			14/06/2018	11:35 - 12:05	30
Oxygen	R3	% v/v	19.9			14/06/2018	12:14 - 12:44	30
Velocity Traverse	R1					14/06/2018	10:10 - 10:30	

All results are expressed at the respective reference conditions.

Executive Summary

PROCESS DETAILS

Blazers Fuels Ltd, Ruthin
Belt Dryer No. 2
14th June 2018

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operation
Capacity (of 100%) and Tonnes / Hour	4 - 5 Tonne / Hour
Continuous or Batch Process	Continuous
Feedstock (if applicable)	Wood Chips
Abatement System	N/A
Abatement System Running Status	N/A
Fuel	Waste Heat From CHP
Plume Appearance	None Visible

MONITORING & ANALYTICAL METHODS

Blazers Fuels Ltd, Ruthin
Belt Dryer No. 2
14th June 2018

	Monitoring				Analysis					
Parameter	**Standard**	**Technical Procedure**	**ISO 17025 Testing**	**Testing Lab**	**Analytical Procedure**	**Analytical Technique**	**ISO 17025 Analysis**	**Analysis Lab**	**MCERTS Testing**	**LOD (Average)**
Total Particulate Matter	EN 13284-1	CAT-TP-01	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.4 mg/m³
PM_{10}	BS EN ISO 23210	CAT-TP-18	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.24 mg/m³
$PM_{2.5}$	BS EN ISO 23210	CAT-TP-18	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.29 mg/m³
Water Vapour	EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.1 % v/v
Oxygen	EN 14789	CAT-TP-21	Yes	CAT	Dry Zirconia Cell by Horiba PG-250				Yes	0.1 %
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41	Yes	CAT	Pitot Tube and Thermocouple				Yes	1.2 m/s

ANALYSIS LABORATORIES

(with short name reference as appears in the table above)

Exova Catalyst (CAT)	ISO 17025 Accreditation Number: 4279

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
Total Particulate Matter	All Runs	Due to the restricted access, it was not possible to sample at all of the sample points on the available sampling lines.
Total Particulate Matter	All Runs	In order to maintain isokinetic sampling, a nozzle size smaller than that specified in the Standard was used.
Total Particulate Matter / PM_{10} / $PM_{2.5}$	All Runs	The sample points where the angle of swirl was > 15° were omitted from the sampling exercise.

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	2.00
Width	m	-
Area	m²	3.14
Port Depth	cm	15
Orientation of Duct	-	Vertical
Number of Ports	-	2
Sample Port Size	-	4" BSP

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	MEWP
Inside / Outside	Outside

Platform Details

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	No
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	Yes
Platform has vertical base boards (approx. 0.25m high)	Yes
Platform has chains / self closing gates at top of ladders	Yes
There are no obstructions present which hamper insertion of sampling equipment	No
Safe Access Available	Yes
Easy Access Available	Yes

Sampling Location / Platform Improvement Recommendations

The sampling location does not meet all of the Flow Criteria requirements in the Environment Agency's Technical Guidance Note M1 and EN 15259 (see Validation Criteria Table below).

EN 15259 Homogeneity Test Requirements

There is no requirement to perform a EN 15259 Homogeneity Test on this Stack.

Sampling Plane Validation Criteria (from EN 15259)

Criteria in EN 15259	Units	Traverse 1		Required	Compliant
Lowest Differential Pressure	Pa	370.0		> 5 Pa	Yes
Mean Velocity	m/s	22.35		-	-
Lowest Gas Velocity	m/s	21.22		-	-
Highest Gas Velocity	m/s	23.30		-	-
Ratio of Above	: 1	1.10		< 3 : 1	Yes
Maximum Angle of Swirl	°	23		< 15°	No
No Local Negative Flow	-	Yes		-	Yes

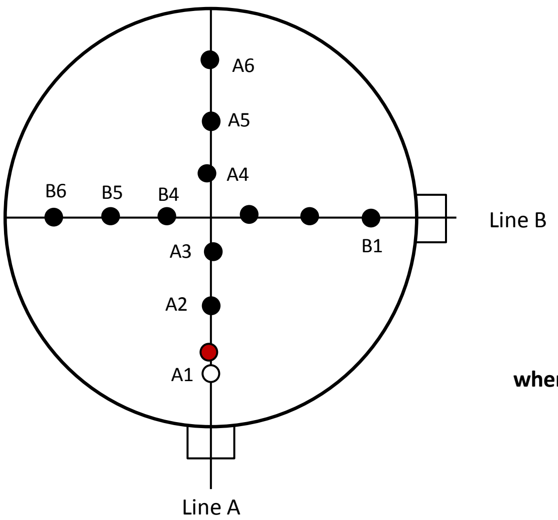
Executive Summary

PLANT PHOTOS

Photo 1

Photo 2

SAMPLE POINTS



where ○ = isokinetic point sampled at

● = isokinetic point not sampled at

● = combustion gases sample point

● = non-isokinetic sample point

APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Brian Jacob	MCERTS Level 2	MM 06 693	TE1 TE2 TE3 TE4
Trainee	Danny Williams	MCERTS Trainee	Pending	None

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	CAT 7.39
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.10
Box Thermocouples (2)	-
Umbilical (1)	CAT 3.10
Umbilical (2)	-
Oven Box (1)	-
Oven Box (2)	-
Heated Probe (1)	CAT 5.7
Heated Probe (2)	-
Heated Probe (3)	-
S-Pitot (1)	CAT 21p.43
S-Pitot (2)	-
L-Pitot	-
Site Balance	CAT 17.13
500g / 1Kg Check Weights	CAT 17.13
Last Impinger Arm	-
Callipers	CAT 23.10
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-250	CAT 9.11
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Testo 350 XL	-
JCT JCC P1 Cooler	CAT 4.135
Gasmet DX4000	-
Gasmet Sampling System	-
Bernath 3006 FID	-
M&C PSS	CAT 12.93
Mass Flow Controller (1)	CAT 6.3
Mass Flow Controller (2)	CAT 6.4
Mass View (1)	-
Mass View (2)	-
Easylogger EN-EL-12 Bit	-
Easylogger EN-EL-12 Bit	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer (1)	CAT 3.25
Digital Manometer (2)	-
Digital Temperature Meter	CAT 3.25
Stopwatch	CAT 14.53
Barometer	CAT 13.20
Stack Thermocouple (1)	CAT 4.140
Stack Thermocouple (2)	-
Stack Thermocouple (3)	-
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	-
20m Heated Line (1)	CAT 20.69
20m Heated Line (2)	-
Dual Channel Heater Controller	-
Single Channel Heater Controller	-
Laboratory Balance	CAT 1.18 / 1.18a
Tape Measure	CAT 16.14

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	EN 13284-1	CAT-TP-01
PM_{10}	BS EN ISO 23210	CAT-TP-18
$PM_{2.5}$	BS EN ISO 23210	CAT-TP-18
Water Vapour	EN 14790	CAT-TP-05
Oxygen	EN 14789	CAT-TP-21
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41

PRELIMINARY STACK SURVEY: CALCULATIONS

General Stack Details

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	2.00
Stack Width, W	m	-
Stack Area, A	m²	3.14
Average Stack Gas Temperature, T_a	°C	30.3
Average Stack Gas Pressure	Pa	410.8
Average Stack Static Pressure, P_{static}	kPa	2.179
Average Barometric Pressure, P_b	kPa	100.6
Average Pitot Tube Calibration Coefficient, C_p	-	0.84

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m³ p	Conc kg/m³ p_i
CO_2 (Estimated)	-	0.06	0.06	0.0006	44.01	1.9635	0.00118
O_2	-	20.94	19.96	0.2094	32.00	1.4277	0.29900
N_2	-	79.00	75.28	0.7900	28.01	1.2498	0.98734
Moisture (H_2O)	-	-	4.71	0.0471	18.02	0.8037	0.03786

Where: p = M / 22.41

p_i = r x p

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m³	1.288
Wet Density (STP), P_{STW}	kg/m³	1.265
Dry Density (Actual), P_{Actual}	kg/m³	1.176
Average Wet Density (Actual), $P_{ActualW}$	kg/m³	1.155

Where: P_{STD} = sum of component concentrations, kg/m³ (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m³ (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (at each sampling point) = $P_{STW} \times (T_s / P_s) \times (P_a / T_a)$

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF [1]
Temperature	°C	30.3	0.0
Total Pressure	kPa	102.8	101.3
Moisture	%	4.71	4.71

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m³/hr	252750
Gas Volumetric Flowrate (STP, Wet)	m³/hr	230852
Gas Volumetric Flowrate (STP, Dry)	m³/hr	219979
Gas Volumetric Flowrate REF [1]	m³/hr	230852

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID)

(1 of 1)

Parameter	Units	Value
Date of Survey	-	14/06/2018
Time of Survey	-	10:10 - 10:30
Atmospheric Pressure	kPa	100.6
Average Stack Static Pressure	Pa	2179
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 200 (500Pa)	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C_p	-	0.84
Number of Lines Available	-	2
Number of Lines Used	-	2

		Sampling Line A					Sampling Line B				
Traverse Point	**Depth m**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**
STATIC (Units: Pa)		*2145.0*					*2212.0*				
Mean		**410.8**	**30.2**	**1.155**	**22.35**		**410.7**	**30.3**	**1.155**	**22.34**	
1	0.09	400.0	30.1	1.156	22.06	14.0	370.0	30.3	1.155	21.22	15.0
2	0.29	420.0	30.2	1.155	22.60	14.0	389.0	30.3	1.155	21.76	20.0
3	0.59	440.0	30.2	1.155	23.14	14.0	422.0	30.2	1.155	22.66	23.0
4	1.41	440.0	30.3	1.155	23.14	13.0	436.0	30.3	1.155	23.03	18.0
5	1.71	389.0	30.3	1.155	21.76	14.0	446.0	30.3	1.155	23.30	14.0
6	1.91	376.0	30.3	1.155	21.39	14.0	401.0	30.3	1.155	22.09	15.0

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID) - MEASUREMENT UNCERTAINTY

(1 of 1)

Performance characteristics (Uncertainty Components)	**Uncertainty**	**Value**	**Units**
Standard Uncertainty on the coefficient of the Pitot Tube	u(k)	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	u(Δpi)	7.891	Pa
- Resolution	u(res)	0.00087	
- Calibration	u(cal)	17.567	
- Drift	u(drift)	0.083	
- Lack of Fit	u(fit)	43.617	
- Overall corrections to dynamic measurements	u(Cf)	61.268	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00003	-
- $\varphi O_2,w$	-	19.957	
- $\varphi CO_2,w$	-	0.057	
- Oxygen, dry	u(ϕO_2,d)	0.641	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.002	
- Water Vapour	u(ϕH_2O)	0.240	
- Oxygen, wet	u(ϕO_2,w)	0.613	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.002	
Standard uncertainty associated with the stack temperature	u(Tc)	1.547	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.781	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	5.580	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00622	-
Standard uncertainty associated with the local velocities	u(vi)	0.231	Pa
Standard uncertainty associated with the mean velocity	u(v)	0.104	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	0.203	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	0.91	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	11668.6	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00055	
- $u^2(qV,w)$	-	35442408	
- $u(qV,w)$	-	5953.4	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	4.62	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Belt Dryer No. 2

Sample Runs

Parameter	Units	Run 1	Run 2		Mean
Concentration	mg/m³	3.0	12.0		7.5
Uncertainty	±mg/m³	2.5	2.7		2.6
Mass Emission	g/hr	702	2859		1780
Uncertainty	±g/hr	591	650		620

Parameter	Units	Run 1	Run 2		Mean
Water Vapour	% v/v	5.0	4.6		4.8
Uncertainty	±% v/v	0.27	0.25		0.26

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	1.1		1.1

General Sampling Information

Parameter	Value	
Standard	EN 13284-1	
Technical Procedure	CAT-TP-01	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Glass Fibre	
Number of Sampling Lines Used	1 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 12	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	Run 2
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	754.5	754.5
Stack static pressure, P_{static}	mmH_2O	224.3	224.3
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	771.0	771.0
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	15.0	11.2
Total mass collected in impingers (silica trap)	g	4.1	6.1
Total mass of liquid collected, V_{lc}	g	19.1	17.3
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0238	0.0216
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	0.4740	0.4760
Gas meter correction factor, Y_d	-	1.0180	1.0180
Average dry gas meter temperature, T_m	°C	19.8	20.9
Average pressure drop across orifice, ΔH	mmH_2O	28.7	28.5
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.4479	0.4481
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0505	0.0459
B_{wo} as a percentage	% v/v	5.05	4.59
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	5.04	4.59
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	0.4717	0.4696
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	No
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	N/A
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	N/A
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	N/A
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	N/A
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	N/A
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	N/A
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	N/A
Molecular weight of dry gas stream, M_d			
CO_2 (Estimated)	% v/v	0.06	0.06
O_2	% v/v	20.95	20.96
Total	% v/v	21.01	21.02
N_2	% v/v	78.99	78.98
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.85	28.85
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.30	28.35
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	-	34.97	34.97
Velocity pressure coefficient, C_p	-	0.84	0.84
Average of velocity heads, ΔP_{avg}	mmH_2O	43.43	43.00
Average square root of velocity heads, $\sqrt{\Delta P}$	$\sqrt{mmH_2O}$	6.59	6.56
Average stack gas temperature, T_s	°C	30.0	30.0
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s + 273})) / (\sqrt{(M_s)(P_s)})$	m/s	22.81	22.68
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	3.14	3.14
$Q_a = (60)(A_s)(V_s)$	m^3/min	4300.5	4275.4
Conversion factor (K/mm.Hg), C_f	-	0.3592	0.3592
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	3930.7	3907.8
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	3732.4	3728.4
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	N/A
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	N/A
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	4.02	4.02
Nozzle area, A_n	mm^2	12.69	12.69
Total sampling time, q	min	30	30
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	99.0	99.1

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	Run 2	
Sampling Times	-	10:55 - 11:25	11:35 - 12:05	
Sampling Dates	-	14/06/2018	14/06/2018	
Sampling Device	-	ISO	ISO	
Volume Sampled (REF)	m^3	0.4719	0.4696	
Filter I.D. Number	-	47-50386	47-48600	
Start Filter Mass	g	0.14802	0.15968	
End Filter Mass	g	0.14908	0.16429	
Total Mass on Filter	g	0.00106	0.00461	
Probe Rinse I.D. Number	-	PR-47-50386	PR-47-48600	
Start Probe Rinse Mass	g	2.72826	2.90723	
End Probe Rinse Mass	g	2.72859	2.90827	
Total Mass in Probe Rinse	g	0.00033	0.00104	
Total Mass Collected	mg	1.39	5.65	
Calculated Concentration	mg/m^3	2.95	12.02	
Balance Uncertainty / LOD	mg/m^3	0.40	0.40	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	14/06/2018	
Average Volume Sampled (REF)	m^3	0.4707	
Filter I.D. Number	-	47-49819	
Start Filter Mass	g	0.15065	
End Filter Mass	g	0.15114	
Total Mass on Filter	g	0.00049	
Probe Rinse I.D. Number	-	PR-47-49819	
Start Probe Rinse Mass	g	2.86523	
End Probe Rinse Mass	g	2.86526	
Total Mass in Probe Rinse	g	0.00004	
Total Mass Collected	mg	0.53	
Calculated Concentration	mg/m^3	1.13	
Balance Uncertainty / LOD	mg/m^3	0.40	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	**Units**	**Run 1**	**Run 2**	
Mean Sampling Rate	l/min	16.08	16.15	
Pre-Sampling Leak Rate	l/min	0.10	0.19	
Post-Sampling Leak Rate	l/min	0.11	0.21	
Allowable Leak Rate	l/min	0.32	0.32	
Leak Test Acceptable	-	Yes	Yes	

Water Droplets	**Units**	**Run 1**	**Run 2**	
Are Water Droplets Present	-	No	No	

MU (Concurrent Water Vapour)	**Units**	**Run 1**	**Run 2**	
Measurement Uncertainty (MU)	%	5.3	5.5	
Allowable MU	%	20	20	
MU Acceptable	%	Yes	Yes	

Silica Gel (Concurrent Water Vapour)	**Units**	**Run 1**	**Run 2**	
Less than 50% Faded	%	Yes	Yes	

Isokinetic Criterion Compliance	**Units**	**Run 1**	**Run 2**	
Isokinetic Variation	%	99.0	99.1	
Allowable Isokinetic Range	%	95 - 115	95 - 115	
Isokineticity Acceptable	-	Yes	Yes	

Weighing Uncertainty Criteria	**Units**	**Run 1**	**Run 2**	
Overall Weighing Uncertainty	± mg	0.33	0.33	
Overall Weighing Uncertainty	± mg/m³	0.69	0.69	
ELV [Daily ELV for IED]	mg/m³	N/A	N/A	
Allowable Weighing Uncertainty	mg/m³	N/A	N/A	
Weighing Uncertainty Acceptable	-	N/A	N/A	

Filter Temperatures	**Units**	**Run 1**	**Run 2**	
Pre-Conditioning Temperature	°C	180	180	
Post-Conditioning Temperature	°C	160	160	
Maximum Filter Temperature	°C	30	30	

Test Conditions	**Units**	**Run 1**	**Run 2**	
Ambient Temperature Recorded?	-	Yes	Yes	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	15.00	
Pre-Sampling Leak Rate	l/min	0.11	
Post-Sampling Leak Rate	l/min	0.14	
Allowable Leak Rate	l/min	0.30	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m^3	N/A	
Blank Acceptable	-	N/A	

Acetone / Water Rinse Blank	Units	Blank
Acetone / Water Rinse Value	mg/l	2.7
Allowable Blank	mg/l	10
Blank Acceptable	-	Yes

Method Deviations

Nature of Deviation (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number 1	Run Number 2	
Due to the restricted access, it was not possible to sample at all of the sample points on the available sampling lines.	x	x	
In order to maintain isokinetic sampling, a nozzle size smaller than that specified in the Standard was used.	x	x	
The sample points where the angle of swirl was > 15° were omitted from the sampling exercise.	x	x	

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value					Standard uncertainty				
Measured Quantities	**Symbol**	**Run 1**	**Run 2**			**Symbol**	**Units**	**Run 1**	**Run 2**	
Sampled Volume (Actual)	V_m	0.4740	0.4760			uV_m	m³	0.0095	0.0095	
Sampled Gas Temperature	T_m	292.8	293.9			uT_m	K	2.0	2.0	
Sampled Gas Pressure	ρ_m	102.8	102.8			$u\rho_m$	kPa	0.5	0.5	
Sampled Gas Humidity	H_m	0.0	0.0			uH_m	% v/v	1.0	1.0	
Leak	L	0.68	1.30			uL	%	-	-	
Mass of Particulate	m	1.39	5.65			um	mg	0.19	0.19	
Uncollected Mass	UCM	0.53	0.53			uUCM	mg	-	-	

	Uncertainty as a Percentage				
Measured Quantities	**Units**	**Run 1**	**Run 2**		**Requirement of Standard**
Sampled Volume (Actual)	%	2.00	2.00		≤2%
Sampled Gas Temperature	%	0.68	0.68		≤1%
Sampled Gas Pressure	%	0.49	0.49		≤1%
Sampled Gas Humidity	%	1.00	1.00		≤1%
Leak	%	0.68	1.30		≤2%
Mass of Particulate	%	-	-		<5% of ELV
Uncollected Mass	%	-	-		-

	Uncertainty in Measurement Units						Sensitivity Coefficient		
Measured Quantities	**Symbol**	**Units**	**Run 1**	**Run 2**			**Run 1**	**Run 2**	
Sampled Volume (STP)	V_m	m³	0.4481	0.4481			6.59	26.84	
Leak	L	mg/m³	0.012	0.090			1.00	1.00	
Mass of Particulate	L_r	mg	1.393	5.647			2.12	2.13	
Uncollected Mass	UCM	mg	0.31	0.31			2.12	2.13	

	Uncertainty in Result			
Measured Quantities	**Units**	**Run 1**	**Run 2**	
Sampled Volume (STP)	mg/m³	0.073	0.300	
Leak	mg/m³	0.0117	0.0903	
Mass of Particulate	mg/m³	0.4026	0.4046	
Uncollected Mass	mg/m³	0.6485	0.6516	

	Oxygen Correction Part of MU Budget			
Measured Quantities	**Units**	**Run 1**	**Run 2**	
O_2 Correction Factor	-	N/A	N/A	
Stack Gas O_2 Content	% v/v	N/A	N/A	
MU for O_2 Correction	-	N/A	N/A	
Overall MU For O_2 Measurement	%	N/A	N/A	

Parameter	**Units**	**Run 1**	**Run 2**	
Combined uncertainty	mg/m³	0.77	0.83	
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m³	1.50	1.62	
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m³	N/A	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m³	2.48	2.68	
Reported Uncertainty	mg/m³	2.48	2.68	
Expanded uncertainty (95% confidence), without Oxygen Correction	%	50.9	13.5	
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	84.0	22.3	
Reported Uncertainty	%	84.0	22.3	

PM_{10}: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Belt Dryer No. 2

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.24		0.24
Uncertainty	±mg/m³	0.72		0.72
Mass Emission	g/hr	56.7		56.7
Uncertainty	±g/hr	171		171

NOTE: Where the maximum Blank concentration is higher than the Sample concentration, the maximum Blank concentration has been reported.

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	4.7		4.7
Uncertainty	±% v/v	0.23		0.23

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.24		0.24

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	BS EN ISO 23210	
Technical Procedure	CAT-TP-18	
Sizing Device	TCR Tecora MSSI 3-Stage Cascade Impactor	
Sizing Device Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

PM_{10}: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	762.0	
Stack static pressure, P_{static}	mmH_2O	2.0	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	762.2	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	35.6	
Total mass collected in impingers (silica trap)	g	6.7	
Total mass of liquid collected, V_{lc}	g	42.3	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0527	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	1.1170	
Gas meter correction factor, Y_d	-	1.0180	
Average dry gas meter temperature, T_m	°C	20.8	
Average pressure drop across orifice, ΔH	mmH_2O	192.7	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	1.0791	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0466	
B_{wo} as a percentage	% v/v	4.66	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	4.66	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	1.1318	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2 (Estimated)	% v/v	0.06	
O_2	% v/v	20.80	
Total	% v/v	20.86	
N_2	% v/v	79.14	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.84	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.34	
Velocity of stack gas, V_{spt}			
Velocity pressure coefficient, C_p	-	0.84	
Average stack gas temperature, T_s	°C	30.0	
Velocity of stack gas (pre-test from traverse), V_{spt}	m/s	23.52	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	3.14	
$Q_a = (60)(A_s)(V_s)$	m^3/min	4433.1	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	4005.4	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	3818.8	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	5.93	
Nozzle area, A_n	mm^2	27.65	
Total sampling time, q	min	30	
Velocity at nozzle, V_n	m/s	25.16	
$\%I = V_n / V_{spt} \times 100$	%	107.0	

PM_{10}: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	12:14 - 12:44	
Sampling Dates	-	14/06/2018	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	1.1318	
2nd Stage of Cascade Impactor (PM_{10} to $PM_{2.5}$)			
Filter I.D. Number (2nd Stage)	-	PM2-01700	
Start Filter Mass (2nd Stage)	g	0.13260	
End Filter Mass (2nd Stage)	g	0.13264	
Total Mass	g	0.00004	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3-01700	
Start Filter Mass (3rd Stage)	g	0.14933	
End Filter Mass (3rd Stage)	g	0.14932	
Total Mass	g	-0.00001	
Total Mass Collected	mg	0.03	
Calculated Concentration	mg/m^3	0.03	
Balance Uncertainty / LOD	mg/m^3	0.24	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	14/06/2018	
Average Volume Sampled (REF)	m^3	1.1318	
2nd Stage of Cascade Impactor (PM_{10} to $PM_{2.5}$)			
Filter I.D. Number (2nd Stage)	-	PM2-01697	
Start Filter Mass (2nd Stage)	g	0.13210	
End Filter Mass (2nd Stage)	g	0.13212	
Total Mass	g	0.00002	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3-01697	
Start Filter Mass (3rd Stage)	g	0.15477	
End Filter Mass (3rd Stage)	g	0.15485	
Total Mass	g	0.00008	
Total Mass Collected	mg	0.10	
Calculated Concentration	mg/m^3	0.09	
Balance Uncertainty / LOD	mg/m^3	0.24	

PM_{10}: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1	
Expected Sampling Rate	l/min	40.00	
Pre-Sampling Leak Rate	l/min	0.11	
Allowable Leak Rate	l/min	0.80	
Leak Test Acceptable	-	Yes	

Water Droplets	Units	Run 1	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	Units	Run 1	
Measurement Uncertainty (MU)	%	5.0	
Allowable MU	%	20	
MU Acceptable	%	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	
Less than 50% Faded	%	Yes	

Isokinetic Criterion Compliance	Units	Run 1	
Isokinetic Variation	%	107.0	
Allowable Isokinetic Range	%	90 - 130	
Isokineticity Acceptable	-	Yes	

Filter Temperatures	Units	Run 1	
Pre-Conditioning Temperature	°C	180	
Post-Conditioning Temperature	°C	160	
Maximum Filter Temperature	°C	30	

Test Conditions	Units	Run 1	
Ambient Temperature Recorded?	-	Yes	

Cut Size	Units	Run 1	
D_{50} Cut Size	µm	10.00	
Allowable D_{50} Cut Size	µm	9 - 11	
D_{50} Cut Size Acceptable	-	Yes	

PM_{10}: QUALITY ASSURANCE

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Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	40.00	
Pre-Sampling Leak Rate	l/min	0.19	
Allowable Leak Rate	l/min	0.80	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m^3	N/A	
Blank Acceptable	-	N/A	

Method Deviations

Nature of Deviation (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number 1	
One out of two sampling lines was used due to sampling location restrictions.	x	
Due to the restricted access, it was not possible to sample at all of the sample points on the available sampling lines.	x	
The sample points where the angle of swirl was > 15° were omitted from the sampling exercise.	x	

PM_{10}: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value: Symbol	Value: Run 1	Standard uncertainty: Symbol	Units	Run 1
Sampled Volume (Actual)	V_m	1.1170	uV_m	m^3	0.0223
Sampled Gas Temperature	T_m	293.8	uT_m	K	2.0
Sampled Gas Pressure	ρ_m	101.6	$u\rho_m$	kPa	0.5
Sampled Gas Humidity	H_m	0.0	uH_m	% v/v	1.0
Leak	L	0.28	uL	%	-
Mass of Particulate	m	0.27	um	mg	0.27
Uncollected Mass	UCM	0.10	uUCM	mg	-
Particulate Sizing	PS	10.00	uPS	%	-

Measured Quantities	Uncertainty as a Percentage: Units	Run 1	Requirement of Standard
Sampled Volume (Actual)	%	2.0000	≤2%
Sampled Gas Temperature	%	0.7	≤1%
Sampled Gas Pressure	%	0.5	≤1%
Sampled Gas Humidity	%	1.0	≤1%
Leak	%	0.28	≤2%
Mass of Particulate	%	-	<5% of ELV
Uncollected Mass	%	-	-
Particulate Sizing	%	10.00	-

Measured Quantities	Uncertainty in Measurement Units: Symbol	Units	Run 1	Sensitivity Coefficient: Run 1
Sampled Volume (STP)	V_m	m^3	1.0791	0.22
Leak	L	mg/m^3	0.000	1.00
Mass of Particulate	L_r	mg	0.270	0.88
Uncollected Mass	UCM	mg	0.06	0.88
Particulate Sizing	PS	mg	0.01	1.00

Measured Quantities	Uncertainty in Result: Units	Run 1
Sampled Volume (STP)	mg/m^3	0.006
Leak	mg/m^3	0.0004
Mass of Particulate	mg/m^3	0.2386
Uncollected Mass	mg/m^3	0.0510
Particulate Sizing	mg/m^3	0.0138

Measured Quantities	Oxygen Correction Part of MU Budget: Units	Run 1
O_2 Correction Factor	-	N/A
Stack Gas O_2 Content	% v/v	N/A
MU for O_2 Correction	-	N/A
Overall MU For O_2 Measurement	%	N/A

Parameter	Units	Run 1
Combined uncertainty	mg/m^3	0.24
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.48
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.72
Reported Uncertainty	mg/m^3	0.72
Expanded uncertainty (95% confidence), without Oxygen Correction	%	200.8
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	301.2
Reported Uncertainty	%	301.2

$PM_{2.5}$: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Belt Dryer No. 2

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.29		0.29
Uncertainty	±mg/m³	0.87		0.87
Mass Emission	g/hr	69.3		69.3
Uncertainty	±g/hr	206		206

NOTE: Where the maximum Blank concentration is higher than the Sample concentration, the maximum Blank concentration has been reported.

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	4.7		4.7
Uncertainty	±% v/v	0.23		0.23

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.29		0.29

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	BS EN ISO 23210	
Technical Procedure	CAT-TP-18	
Sizing Device	TCR Tecora MSSI 3-Stage Cascade Impactor	
Sizing Device Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

$PM_{2.5}$: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	762.0	
Stack static pressure, P_{static}	mmH_2O	2.0	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	762.2	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	35.6	
Total mass collected in impingers (silica trap)	g	6.7	
Total mass of liquid collected, V_{lc}	g	42.3	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0527	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	1.1170	
Gas meter correction factor, Y_d	-	1.0180	
Average dry gas meter temperature, T_m	°C	20.8	
Average pressure drop across orifice, ΔH	mmH_2O	192.7	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	1.0791	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0466	
B_{wo} as a percentage	% v/v	4.66	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	4.66	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	1.1318	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet (O_{2REFw}) = (21 - $REF\%O_2$) / (21 - $ACT\%O_{2w}$)	-	N/A	
O_2 Reference Factor dry (O_{2REFd}) = (21 - $REF\%O_2$) / (21 - $ACT\%O_{2d}$)	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2 (Estimated)	% v/v	0.06	
O_2	% v/v	20.80	
Total	% v/v	20.86	
N_2	% v/v	79.14	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.84	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.34	
Velocity of stack gas, V_{spt}			
Velocity pressure coefficient, C_p	-	0.84	
Average stack gas temperature, T_s	°C	30.0	
Velocity of stack gas (pre-test from traverse), V_{spt}	m/s	23.52	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	3.14	
$Q_a = (60)(A_s)(V_s)$	m^3/min	4433.1	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	4005.4	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	3818.8	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	5.93	
Nozzle area, A_n	mm^2	27.65	
Total sampling time, q	min	30	
Velocity at nozzle, V_n	m/s	25.16	
$\%I = V_n / V_{spt} \times 100$	%	107.0	

$PM_{2.5}$: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	12:14 - 12:44	
Sampling Dates	-	14/06/2018	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	1.1318	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3-01700	
Start Filter Mass (3rd Stage)	g	0.14933	
End Filter Mass (3rd Stage)	g	0.14932	
Total Mass	g	-0.00001	
Total Mass Collected	mg	-0.01	
Calculated Concentration	mg/m^3	-0.01	
Balance Uncertainty / LOD	mg/m^3	0.29	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	14/06/2018	
Average Volume Sampled (REF)	m^3	1.1318	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3-01697	
Start Filter Mass (3rd Stage)	g	0.15477	
End Filter Mass (3rd Stage)	g	0.15485	
Total Mass	g	0.00008	
Total Mass Collected	mg	0.08	
Calculated Concentration	mg/m^3	0.07	
Balance Uncertainty / LOD	mg/m^3	0.29	

$PM_{2.5}$: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1	
Expected Sampling Rate	l/min	40.00	
Pre-Sampling Leak Rate	l/min	0.11	
Allowable Leak Rate	l/min	0.80	
Leak Test Acceptable	-	Yes	

Water Droplets	Units	Run 1	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	Units	Run 1	
Measurement Uncertainty (MU)	%	5.0	
Allowable MU	%	20	
MU Acceptable	%	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	
Less than 50% Faded	%	Yes	

Isokinetic Criterion Compliance	Units	Run 1	
Isokinetic Variation	%	107.0	
Allowable Isokinetic Range	%	90 - 130	
Isokineticity Acceptable	-	Yes	

Filter Temperatures	Units	Run 1	
Pre-Conditioning Temperature	°C	180	
Post-Conditioning Temperature	°C	160	
Maximum Filter Temperature	°C	30	

Test Conditions	Units	Run 1	
Ambient Temperature Recorded?	-	Yes	

Cut Size	Units	Run 1	
D_{50} Cut Size	µm	2.52	
Allowable D_{50} Cut Size	µm	2.25 - 2.75	
D_{50} Cut Size Acceptable	-	Yes	

$PM_{2.5}$: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	40.00	
Pre-Sampling Leak Rate	l/min	0.19	
Allowable Leak Rate	l/min	0.80	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m^3	N/A	
Blank Acceptable	-	N/A	

Method Deviations

Nature of Deviation	Run Number	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	1	
One out of two sampling lines was used due to sampling location restrictions.	x	
Due to the restricted access, it was not possible to sample at all of the sample points on the available sampling lines.	x	
The sample points where the angle of swirl was > 15° were omitted from the sampling exercise.	x	

$PM_{2.5}$: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value			Standard uncertainty		
Measured Quantities	**Symbol**	**Run 1**	**Symbol**	**Units**	**Run 1**	
Sampled Volume (Actual)	V_m	1.1170	uV_m	m³	0.0223	
Sampled Gas Temperature	T_m	293.8	uT_m	K	2.0	
Sampled Gas Pressure	ρ_m	101.6	$u\rho_m$	kPa	0.5	
Sampled Gas Humidity	H_m	0.0	uH_m	% v/v	1.0	
Leak	L	0.28	uL	%	-	
Mass of Particulate	m	0.33	um	mg	0.33	
Uncollected Mass	UCM	0.08	uUCM	mg	-	
Particulate Sizing	PS	10.00	uPS	%	-	

	Uncertainty as a Percentage		
Measured Quantities	**Units**	**Run 1**	**Requirement of Standard**
Sampled Volume (Actual)	%	2.0000	≤2%
Sampled Gas Temperature	%	0.7	≤1%
Sampled Gas Pressure	%	0.5	≤1%
Sampled Gas Humidity	%	1.0	≤1%
Leak	%	0.28	≤2%
Mass of Particulate	%	-	<5% of ELV
Uncollected Mass	%	-	-
Particulate Sizing	%	10.00	-

	Uncertainty in Measurement Units			Sensitivity Coefficient
Measured Quantities	**Symbol**	**Units**	**Run 1**	**Run 1**
Sampled Volume (STP)	V_m	m³	1.0791	0.27
Leak	L	mg/m³	0.000	1.00
Mass of Particulate	L_r	mg	0.330	0.88
Uncollected Mass	UCM	mg	0.05	0.88
Particulate Sizing	PS	mg	0.02	1.00

	Uncertainty in Result	
Measured Quantities	**Units**	**Run 1**
Sampled Volume (STP)	mg/m³	0.007
Leak	mg/m³	0.0005
Mass of Particulate	mg/m³	0.2916
Uncollected Mass	mg/m³	0.0408
Particulate Sizing	mg/m³	0.0168

	Oxygen Correction Part of MU Budget	
Measured Quantities	**Units**	**Run 1**
O_2 Correction Factor	-	N/A
Stack Gas O_2 Content	% v/v	N/A
MU for O_2 Correction	-	N/A
Overall MU For O_2 Measurement	%	N/A

Parameter	**Units**	**Run 1**
Combined uncertainty	mg/m³	0.29
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m³	0.58
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m³	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m³	0.87
Reported Uncertainty	mg/m³	0.87
Expanded uncertainty (95% confidence)	%	198.3
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	297.4
Reported Uncertainty	%	297.4

OXYGEN: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Belt Dryer No. 2

Sample Runs

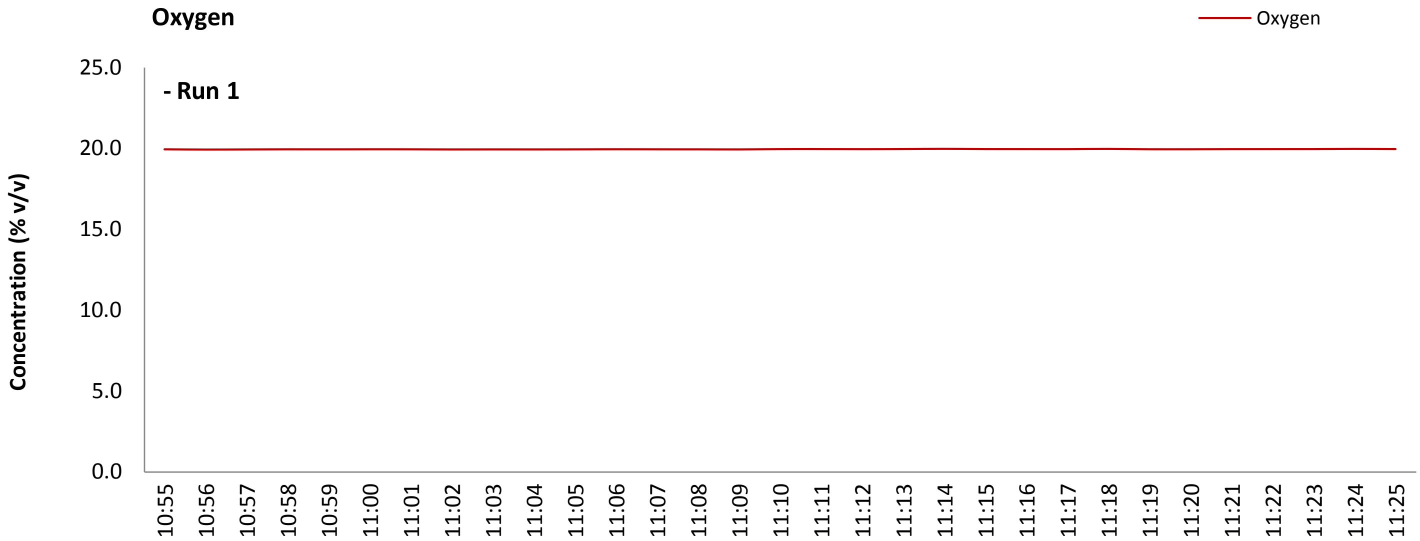
Parameter	Units	Run 1	Run 2	Run 3	Mean
Concentration	% v/v	20.0	20.0	19.9	20.0
Uncertainty	±% v/v	0.51	0.51	0.50	0.51

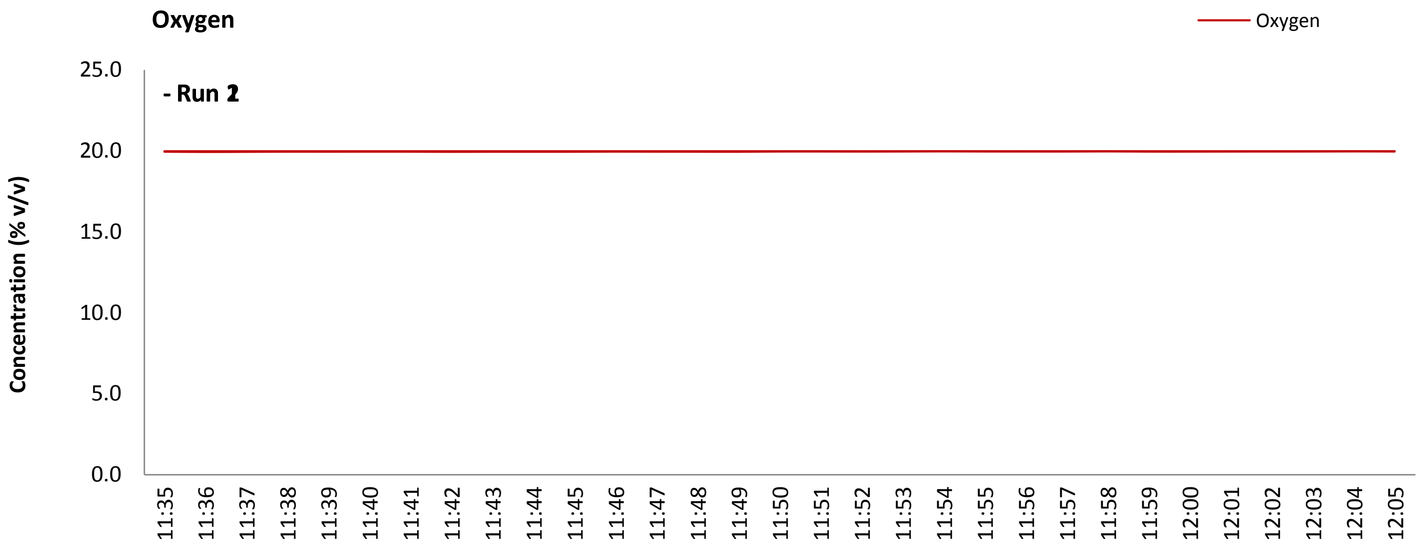
General Sampling Information

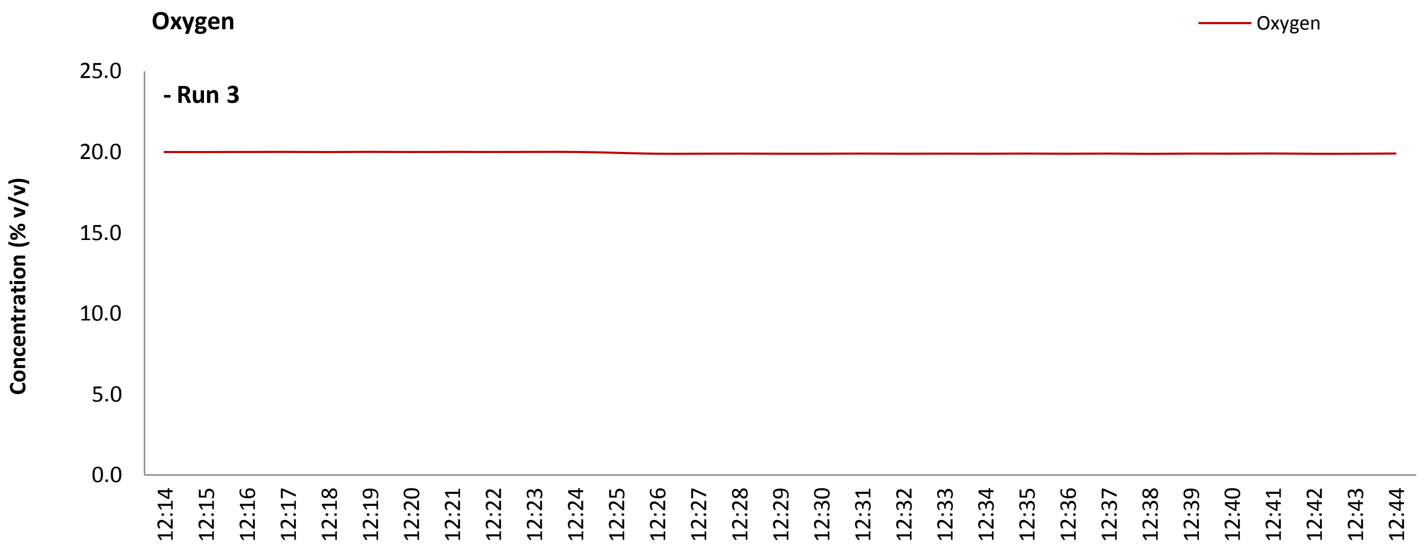
Parameter	Value	
Standard	EN 14789	
Technical Procedure	CAT-TP-21	
Probe Material	Titanium	
Filtration Type / Size	0.3µm Plane Glass Fibre	
Heated Head Filter Used	No	
Heated Line Temperature	Orsat Used	
Span Gas Type	Synthetic Air (5 Grade)	
Span Gas Reference Number	CYL 11.0307	
Span Gas Expiry Date	11/10/2022	
Span Gas Start Pressure (bar)	50	
Gas Cylinder Concentration (% v/v)	21.62	
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

OXYGEN: DATA TREND

Graphical Trend of Data







OXYGEN: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	Run 2	Run 3
Sampling Times	-	10:55 - 11:25	11:35 - 12:05	12:14 - 12:44
Sampling Dates	-	14/06/2018	14/06/2018	14/06/2018
Instrument Range	% v/v	25	25	25
Span Gas Value	% v/v	21.62	21.62	21.62

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	Run 2	Run 3
Average Temperature	°C	N/A	N/A	N/A
Allowable Temperature	< °C	N/A	N/A	N/A
Temperature Acceptable	-	N/A	N/A	N/A

	Zero Drift	Units	Run 1	Run 2	Run 3
CAL 1	Zero at Analyser (Pre)	% v/v	0.00	0.00	0.00
CAL 1	Zero at Analyser (Post)	% v/v	0.04	0.04	0.04
CAL 1	Zero Drift	% v/v	0.04	0.04	0.04
	Allowable Zero Drift	± % v/v	1.08	1.08	1.08
	Zero Drift Acceptable	-	Yes	Yes	Yes

	Span Drift	Units	Run 1	Run 2	Run 3
CAL 1	Span at Analyser (Pre)	% v/v	21.62	21.57	21.62
CAL 1	Span at Analyser (Post)	% v/v	21.59	21.59	21.59
CAL 1	Span Drift	% v/v	-0.03	-0.03	-0.03
	Allowable Span Drift	± % v/v	1.08	1.08	1.08
	Span Drift Acceptable	-	Yes	Yes	Yes

Test Conditions	Units	Run 1	Run 2	Run 3
Run Ambient Temperature Range	°C	20 - 22	20 - 22	20 - 22

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	2	3
There are no deviations associated with the sampling employed.	x	x	x

OXYGEN: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	RUN 2	RUN 3	Units
Limit value	N/A	N/A	N/A	%vol
TGN M2 Allowable MU	6.0	6.0	6.0	%
Measured concentration	20.95	20.96	20.92	%vol
Range Used	25.0	25.0	25.0	%vol
Cal gas conc.	21.6	21.6	21.6	%vol

Performance characteristics	RUN 1	RUN 2	RUN 3	Units
Response time	60	60	60	seconds
Number of readings in measurement	30	30	30	-
Repeatability at zero	0.04	0.04	0.04	% full scale
Repeatability at span level	0.04	0.04	0.04	% full scale
Deviation from linearity	0.11	0.11	0.11	% of value
Zero drift	0.19	0.19	0.19	% full scale
Span drift	-0.14	-0.14	-0.14	% full scale
Volume or pressure flow dependence	0.20	0.20	0.20	% of full scale
Atmospheric pressure dependence	0.30	0.30	0.30	% of value/kPa
Ambient temperature dependence	-0.07	-0.07	-0.07	% full scale/10K
Combined interference	0.56	0.56	0.56	% range
Dependence on voltage	0.02	0.02	0.02	% full scale/10V
Losses in the line (leak)	0.23	0.23	0.23	% of value
Uncertainty of calibration gas	2.00	2.00	2.00	% of value

Performance characteristic	RUN 1	RUN 2	RUN 3	Units
Standard deviation of repeatability at zero	use rep at span	use rep at span	use rep at span	%vol
Standard deviation of repeatability at span level	0.01	0.01	0.01	%vol
Lack of fit	0.02	0.02	0.02	%vol
Drift	0.01	0.01	0.01	%vol
Volume or pressure flow dependence	0.00	0.00	0.00	%vol
Atmospheric pressure dependence	0.02	0.02	0.02	%vol
Ambient temperature dependence	-0.01	-0.01	-0.01	%vol
Combined interference (from MCERTS Certificate)	0.08	0.08	0.08	%vol
Dependence on voltage	0.00	0.00	0.00	%vol
Losses in the line (leak)	0.03	0.03	0.03	%vol
Uncertainty of calibration gas	0.24	0.24	0.24	%vol

			RUN 1	RUN 2	RUN 3	Units
Measurement uncertainty		**Result**	20.95	20.96	20.92	%vol
Combined uncertainty			0.27	0.27	0.27	%vol
Expanded uncertainty	k =	1.96	0.53	0.53	0.53	%vol

	RUN 1	RUN 2	RUN 3	Units
Expanded uncertainty (no O_2) - at 95% Confidence	2.53	2.53	2.53	% of Value
Result of Compliance with Uncertainty Requirement in M2	**COMPLIANT**	**COMPLIANT**	**COMPLIANT**	-

Requirement for SRM is that Uncertainty should be 0.5%vol absolute or 6% relative whichever is the lower, on a dry gas basis. Ref EA TGN M2.

Exova Catalyst, Unit C6, Emery Court, The Embankment Business Park, Heaton Mersey, Stockport, SK4 3GL
E: toby.campbell@exova.com
Your Exova Catalyst Contact: Toby Campbell (07825 130 074)

Stack Emissions Testing Report Commissioned by
Newbridge Energy Ltd

Installation Name & Address
Blazers Fuels Ltd
Brickfield Lane
Ruthin
Denbeighshire
North Wales
LL15 2TN

Stack Reference
Biomass CHP Plant Exhaust

Dates of the Monitoring Campaign
5th October 2017

Job Reference Number
CAT-3701

Report Written by
Danny Pryke Team Leader MCERTS Level 2 MM 03 163 TE1 TE2 TE3 TE4

Report Approved by
Matthew Pendlebury Team Leader MCERTS Level 2 MM 04 535 TE1 TE2 TE3 TE4

Report Date
18th October 2017

Version
Version 1

Signature of Report Approver

CONTENTS

Opinions and interpretations expressed herein are outside the scope of Exova Catalyst's ISO 17025 accreditation.

MONITORING OBJECTIVES

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust
5th October 2017

Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by Newbridge Energy Ltd to carry out stack emissions testing for Blazers Fuels Ltd on the Biomass CHP Plant Exhaust at Ruthin.

The aim of the monitoring campaign was to perform testing, as requested by the customer, for a number of prescribed pollutants. There are no emission limits set for any of the pollutants at this time.

Special Requirements

There were no special requirements.

Target Parameters

Total Particulate Matter, PM_{10}, $PM_{2.5}$, Oxides of Nitrogen (as NO_2), Carbon Monoxide

MONITORING RESULTS

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust
5th October 2017

where MU = Measurement Uncertainty associated with the Result

Parameter				Concentration Units	Concentration Result		Concentration MU +/-	Concentration Limit	Mass Emission Units	Mass Emission Result	Mass Emission MU +/-	Mass Emission Limit
Total Particulate Matter [1]				mg/m³	6.4		0.40	-	g/hr	56.9	4.6	-
PM_{10} [1]				mg/m³	0.29		0.46	-	g/hr	2.6	4.1	-
$PM_{2.5}$ [1]				mg/m³	0.21		0.35	-	g/hr	1.9	3.1	-
Oxides of Nitrogen (as NO_2) [1]				mg/m³	82.1		2.5	-	g/hr	725	43.8	-
Carbon Monoxide [1]				mg/m³	10.5		1.1	-	g/hr	92.6	10.9	-
Carbon Dioxide	% v/v	**Wet**	7.92	% v/v	**Dry**	8.95	0.28					
Oxygen	% v/v	**Wet**	10.2	% v/v	**Dry**	11.6	0.35					
Water Vapour				% v/v	11.6		0.58					
Stack Gas Temperature				°C	160							
Stack Gas Velocity				m/s	6.1		0.16					
Volumetric Flow Rate (ACTUAL)				m³/hr	14061		729					
Volumetric Flow Rate (REF) [1]				m³/hr	8827		458					

NOTE: VOLUMETRIC FLOW RATE & VELOCITY DATA TAKEN FROM AN AVERAGE OF ALL OF THE ISOKINETIC RUNS.

[1] Reference Conditions (REF) are: 273K, 101.3kPa, without correction for water vapour content.

MONITORING DATE(S) & TIMES

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust
5th October 2017

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m³	6.4	g/hr	56.9	05/10/2017	10:50 - 11:20, 11:22 - 11:52	60
PM_{10}	R1	mg/m³	0.29	g/hr	2.6	05/10/2017	13:45 - 14:45	60
$PM_{2.5}$	R1	mg/m³	0.21	g/hr	1.9	05/10/2017	13:45 - 14:45	60
Oxides of Nitrogen (as NO_2)	R1	mg/m³	82.1	g/hr	725	05/10/2017	10:50 - 11:50	60
Carbon Monoxide	R1	mg/m³	10.5	g/hr	92.6	05/10/2017	10:50 - 11:50	60
Carbon Dioxide	R1	% v/v	8.95			05/10/2017	10:50 - 11:50	60
Oxygen	R1	% v/v	10.2			05/10/2017	10:50 - 11:50	60
Velocity & Volumetric Flow Rate	R1					05/10/2017	09:43 - 10:03	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust
5th October 2017

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operation
Capacity (of 100%) and Tonnes / Hour	Full Capacity
Continuous or Batch Process	Continuous Batch
Feedstock (if applicable)	Wood Chip Pallets
Abatement System	Bag Filter and Cyclone
Abatement System Running Status	On
Fuel	Natural Gas
Plume Appearance	None Visible

MONITORING & ANALYTICAL METHODS

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust
5th October 2017

Parameter	Standard	Technical Procedure	ISO 17025 Testing	Testing Lab	Analytical Procedure	Analytical Technique	ISO 17025 Analysis	Analysis Lab	MCERTS Testing	LOD (Average)
	Monitoring				Analysis					
Total Particulate Matter	EN 13284-1	CAT-TP-01	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.12 mg/m³
PM_{10}	BS EN ISO 23210	CAT-TP-26	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.23 mg/m³
$PM_{2.5}$	BS EN ISO 23210	CAT-TP-26	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.18 mg/m³
Water Vapour	EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.10 % v/v
Oxides of Nitrogen (as NO_2)	EN 14792	CAT-TP-21	Yes	CAT	Chemiluminescence by Horiba PG-250				Yes	0.41 mg/m³
Carbon Monoxide	EN 15058	CAT-TP-21	Yes	CAT	NDIR by Horiba PG-250				Yes	0.42 mg/m³
Carbon Dioxide	ISO 12039	CAT-TP-21	Yes	CAT	NDIR by Horiba PG-250				Yes	0.10 % v/v
Oxygen	EN 14789	CAT-TP-21	Yes	CAT	Dry Zirconia Cell by Horiba PG-250				Yes	0.06 %
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41	Yes	CAT	Pitot Tube and Thermocouple				Yes	1.2 m/s

ANALYSIS LABORATORIES

(with short name reference as appears in the table above)

Exova Catalyst (CAT)	ISO 17025 Accreditation Number: 4279

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
All Parameters	All Runs	There are no deviations associated with the sampling employed.

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.90
Width	m	-
Area	m²	0.64
Port Depth	cm	24
Orientation of Duct	-	Vertical
Number of Ports	-	2
Sample Port Size	-	5" Flange

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	Permanent
Inside / Outside	Inside

Platform Details

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	Yes
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	Yes
Platform has vertical base boards (approx. 0.25m high)	Yes
Platform has chains / self closing gates at top of ladders	Yes
There are no obstructions present which hamper insertion of sampling equipment	Yes
Safe Access Available	Yes
Easy Access Available	Yes

Sampling Location / Platform Improvement Recommendations

Although this platform does not meet the requirements in the Environment Agency's Technical Guidance Note M1 and EN 15259, it is adequate for the testing carried out on this stack.

EN 15259 Homogeneity Test Requirements

There is no requirement to perform a EN 15259 Homogeneity Test on this Stack.

Sampling Plane Validation Criteria (from EN 15259)

Criteria in EN 15259	Units	Traverse 1		Required	Compliant
Lowest Differential Pressure	Pa	22.0		> 5 Pa	Yes
Mean Velocity	m/s	6.48		-	-
Lowest Gas Velocity	m/s	6.24		-	-
Highest Gas Velocity	m/s	6.65		-	-
Ratio of Above	: 1	1.07		< 3 : 1	Yes
Maximum Angle of Swirl	°	5		< 15°	Yes
No Local Negative Flow	-	Yes		-	Yes

PLANT PHOTOS

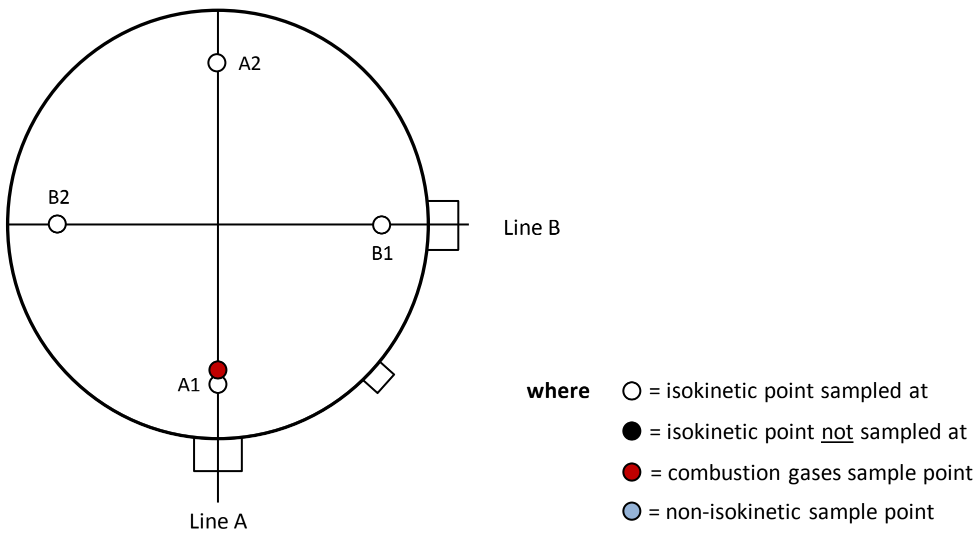
Photo 1

Photo 2

Photo 3

Photo 4

SAMPLE POINTS



APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Danny Pryke	MCERTS Level 2	MM 03 163	TE1 TE2 TE3 TE4
Trainee	Lee Heaton	MCERTS Trainee	MM 17 1433	None

LIST OF EQUIPMENT

Extractive Sampling

Equipment Type	Equipment I.D.
Control Box DGM (1)	CAT 7.62
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.132
Box Thermocouples (2)	-
Umbilical (1)	-
Umbilical (2)	-
Oven Box (1)	-
Oven Box (2)	-
Heated Probe (1)	CAT 5.108
Heated Probe (2)	CAT 5.013
Heated Probe (3)	CAT 5.017
S-Pitot (1)	CAT 21S.51
S-Pitot (2)	-
L-Pitot	-
Site Balance	CAT 17.26
500g / 1Kg Check Weights	CAT 17.26
Last Impinger Arm	-
Callipers	CAT 23.27
Tubes Kit Thermocouple	-

Instrumental Analysers

Equipment Type	Equipment I.D.
Horiba PG-250	CAT 39.11
Horiba PG-350E	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Servomex 5200MP	-
Ankersmid APS 313	CAT 4.753
Gasmet DX4000	-
Gasmet Sampling System	-
Bernath 3006 FID	-
M&C PSS	CAT 12.87
Mass Flow Controller (1)	CAT 25.1
Mass Flow Controller (2)	CAT 25.2
Mass View (1)	-
Mass View (2)	-
Easylogger EN-EL-12 Bit	-
Hioki 5043 (V)	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items

Equipment Type	Equipment I.D.
Digital Manometer (1)	CAT 3.25
Digital Manometer (2)	-
Digital Temperature Meter	CAT 3.25
Stopwatch	CAT 14.72
Barometer	CAT 13.38
Stack Thermocouple (1)	-
Stack Thermocouple (2)	-
Stack Thermocouple (3)	-
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	CAT 20.92
20m Heated Line (1)	-
20m Heated Line (2)	-
Dual Channel Heater Controller	-
Single Channel Heater Controller	-
Laboratory Balance	CAT 1.18 / 1.18a
Tape Measure	CAT 16.31

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	EN 13284-1	CAT-TP-01
PM_{10}	BS EN ISO 23210	CAT-TP-26
$PM_{2.5}$	BS EN ISO 23210	CAT-TP-26
Water Vapour	EN 14790	CAT-TP-05
Oxides of Nitrogen (as NO_2)	EN 14792	CAT-TP-21
Carbon Monoxide	EN 15058	CAT-TP-21
Carbon Dioxide	ISO 12039	CAT-TP-21
Oxygen	EN 14789	CAT-TP-21
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41

PRELIMINARY STACK SURVEY: CALCULATIONS

General Stack Details

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	0.90
Stack Width, W	m	-
Stack Area, A	m²	0.64
Average Stack Gas Temperature, T_a	°C	160
Average Stack Gas Pressure	Pa	23.8
Average Stack Static Pressure, P_{static}	kPa	0.02
Average Barometric Pressure, P_b	kPa	100.2
Average Pitot Tube Calibration Coefficient, C_p	-	0.84

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m³ p	Conc kg/m³ p_i
CO_2	-	8.95	7.92	0.0895	44.01	1.9635	0.1757
O_2	-	11.56	10.23	0.1156	32.00	1.4277	0.1651
N_2	-	79.48	70.30	0.7948	28.01	1.2498	0.9934
Moisture (H_2O)	-	-	11.56	0.1156	18.02	0.8037	0.0929

Where: p = M / 22.41

p_i = r x p

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m³	1.334
Wet Density (STP), P_{STW}	kg/m³	1.273
Dry Density (Actual), P_{Actual}	kg/m³	0.833
Average Wet Density (Actual), $P_{ActualW}$	kg/m³	0.794

Where: P_{STD} = sum of component concentrations, kg/m³ (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m³ (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (at each sampling point) = $P_{STW} \times (T_s / P_s) \times (P_a / T_a)$

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF [1]
Temperature	°C	160	0.00
Total Pressure	kPa	100.2	101.3
Moisture	%	11.6	11.6

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m³/hr	14843
Gas Volumetric Flowrate (STP, Wet)	m³/hr	9264
Gas Volumetric Flowrate (STP, Dry)	m³/hr	8193
Gas Volumetric Flowrate REF [1]	m³/hr	9264

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID)

(1 of 1)

Parameter	Units	Value
Date of Survey	-	05/10/2017
Time of Survey	-	09:43 - 10:03
Atmospheric Pressure	kPa	100.2
Average Stack Static Pressure	Pa	20
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 200 (500Pa)	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C_p	-	0.84
Number of Lines Available	-	2
Number of Lines Used	-	2

		Sampling Line A					Sampling Line B				
Traverse Point	**Depth m**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**	**ΔP Pa**	**Temp °C**	**Wet Density kg/m³**	**Velocity m/s**	**Swirl °**
STATIC (Units: Pa)		*18.0*					*22.0*				
Mean		**24.5**	**160.1**	**0.794**	**6.59**		**23.0**	**159.5**	**0.795**	**6.38**	
1	0.13	24.0	160.1	0.794	6.52	3.0	22.0	159.5	0.795	6.24	3.0
2	0.77	25.0	160.0	0.794	6.65	2.0	24.0	159.4	0.795	6.51	5.0

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID) - MEASUREMENT UNCERTAINTY

(1 of 1)

Performance characteristics (Uncertainty Components)	Uncertainty	Value	Units
Standard Uncertainty on the coefficient of the Pitot Tube	u(k)	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	u(Δpi)	1.072	Pa
- Resolution	u(res)	0.00087	
- Calibration	u(cal)	0.059	
- Drift	u(drift)	0.083	
- Lack of Fit	u(fit)	0.007	
- Overall corrections to dynamic measurements	u(Cf)	0.150	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00007	-
- $\varphi O_2,w$	-	10.228	
- $\varphi CO_2,w$	-	7.916	
- Oxygen, dry	u(ϕO_2,d)	0.354	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.274	
- Water Vapour	u(ϕH_2O)	0.590	
- Oxygen, wet	u(ϕO_2,w)	0.320	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.248	
Standard uncertainty associated with the stack temperature	u(Tc)	2.208	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.694	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	0.758	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00429	-
Standard uncertainty associated with the local velocities	u(vi)	0.152	Pa
Standard uncertainty associated with the mean velocity	u(v)	0.084	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	0.164	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	2.53	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	770.0	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00070	
- $u^2(qV,w)$	-	154341	
- $u(qV,w)$	-	392.9	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	5.19	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	6.4		6.4
Uncertainty	±mg/m³	0.40		0.40
Mass Emission	g/hr	56.9		56.9
Uncertainty	±g/hr	4.6		4.6

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	12.2		12.2
Uncertainty	±% v/v	0.62		0.62

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.12		0.12

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	EN 13284-1	
Technical Procedure	CAT-TP-01	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Positioning of Filter	Out Stack	
Filter Size and Material	47mm Glass Fibre	
Number of Sampling Lines Used	2 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	4 / 4	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1, A2, B1 & B2	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	751.5	
Stack static pressure, P_{static}	mmH_2O	1.5	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	751.6	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	113.0	
Total mass collected in impingers (silica trap)	g	6.2	
Total mass of liquid collected, V_{lc}	g	119.2	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.1485	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	1.1450	
Gas meter correction factor, Y_d	-	1.0140	
Average dry gas meter temperature, T_m	°C	21.4	
Average pressure drop across orifice, ΔH	mmH_2O	36.2	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	1.0683	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.1221	
B_{wo} as a percentage	% v/v	12.21	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	12.21	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	1.2168	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2	% v/v	9.00	
O_2	% v/v	11.00	
Total	% v/v	20.00	
N_2	% v/v	80.00	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	29.88	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.43	
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	-	34.97	
Velocity pressure coefficient, C_p	-	0.84	
Average of velocity heads, ΔP_{avg}	mmH_2O	2.13	
Average square root of velocity heads, $\sqrt{\Delta P}$	$\sqrt{mmH_2O}$	1.46	
Average stack gas temperature, T_s	°C	159.9	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s + 273})) / (\sqrt{(M_s)(P_s)})$	m/s	6.09	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	0.64	
$Q_a = (60)(A_s)(V_s)$	m^3/min	232.7	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	145.1	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	127.4	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	9.97	
Nozzle area, A_n	mm^2	78.13	
Total sampling time, q	min	60	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	113.8	

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	10:50 - 11:20, 11:22 - 11:52	
Sampling Dates	-	05/10/2017	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	1.2168	
Filter I.D. Number	-	47-46158	
Start Filter Mass	g	0.15270	
End Filter Mass	g	0.15407	
Total Mass on Filter	g	0.00137	
Probe Rinse I.D. Number	-	PR-47-46158	
Start Probe Rinse Mass	g	2.64765	
End Probe Rinse Mass	g	2.65412	
Total Mass in Probe Rinse	g	0.00647	
Total Mass Collected	mg	7.84	
Calculated Concentration	mg/m^3	6.44	
Balance Uncertainty / LOD	mg/m^3	0.12	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	05/10/2017	
Average Volume Sampled (REF)	m^3	1.2168	
Filter I.D. Number	-	47-46157	
Start Filter Mass	g	0.15484	
End Filter Mass	g	0.15485	
Total Mass on Filter	g	0.00001	
Probe Rinse I.D. Number	-	PR-47-46157	
Start Probe Rinse Mass	g	2.69527	
End Probe Rinse Mass	g	2.69532	
Total Mass in Probe Rinse	g	0.00005	
Total Mass Collected	mg	0.06	
Calculated Concentration	mg/m^3	0.05	
Balance Uncertainty / LOD	mg/m^3	0.12	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

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Sample Runs

Leak Test Results	Units	Run 1	
Mean Sampling Rate	l/min	19.4	
Pre-Sampling Leak Rate	l/min	0.13	
Post-Sampling Leak Rate	l/min	0.13	
Allowable Leak Rate	l/min	0.39	
Leak Test Acceptable	-	Yes	

Water Droplets	Units	Run 1	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	Units	Run 1	
Measurement Uncertainty (MU)	%	5.1	
Allowable MU	%	20	
MU Acceptable	%	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	
Less than 50% Faded	%	Yes	

Isokinetic Criterion Compliance	Units	Run 1	
Isokinetic Variation	%	113.8	
Allowable Isokinetic Range	%	95 - 115	
Isokineticity Acceptable	-	Yes	

Weighing Uncertainty Criteria	Units	Run 1	
Overall Weighing Uncertainty	± mg	0.25	
Overall Weighing Uncertainty	± mg/m³	0.21	
ELV [Daily ELV for IED]	mg/m³	N/A	
Allowable Weighing Uncertainty	mg/m³	N/A	
Weighing Uncertainty Acceptable	-	N/A	

Filter Temperatures	Units	Run 1	
Pre-Conditioning Temperature	°C	180	
Post-Conditioning Temperature	°C	160	
Maximum Filter Temperature	°C	160	

Test Conditions	Units	Run 1	
Ambient Temperature Recorded?	-	Yes	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

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Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	20.0	
Pre-Sampling Leak Rate	l/min	0.11	
Post-Sampling Leak Rate	l/min	0.12	
Allowable Leak Rate	l/min	0.40	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m³	N/A	
Blank Acceptable	-	N/A	

Acetone / Water Rinse Blank	Units	Blank
Acetone / Water Rinse Value	mg/l	2.7
Allowable Blank	mg/l	10
Blank Acceptable	-	Yes

Method Deviations

Nature of Deviation	Run Number	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	1	
There are no deviations associated with the sampling employed.	wx	

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value				Standard uncertainty			
Measured Quantities	**Symbol**	**Run 1**			**Symbol**	**Units**	**Run 1**	
Sampled Volume (Actual)	V_m	1.15			uV_m	m^3	0.02	
Sampled Gas Temperature	T_m	294.4			uT_m	K	2.00	
Sampled Gas Pressure	ρ_m	100.2			$u\rho_m$	kPa	0.50	
Sampled Gas Humidity	H_m	0.00			uH_m	% v/v	1.00	
Leak	L	0.67			uL	%	-	
Mass of Particulate	m	7.84			um	mg	0.14	
Uncollected Mass	UCM	0.06			uUCM	mg	-	

	Uncertainty as a Percentage			
Measured Quantities	**Units**	**Run 1**		**Requirement of Standard**
Sampled Volume (Actual)	%	2.00		≤2%
Sampled Gas Temperature	%	0.68		≤1%
Sampled Gas Pressure	%	0.50		≤1%
Sampled Gas Humidity	%	1.00		≤1%
Leak	%	0.67		≤2%
Mass of Particulate	%	-		<5% of ELV
Uncollected Mass	%	-		-

	Uncertainty in Measurement Units					Sensitivity Coefficient	
Measured Quantities	**Symbol**	**Units**	**Run 1**			**Run 1**	
Sampled Volume (STP)	V_m	m^3	1.07			6.03	
Leak	L	mg/m^3	0.02			1.00	
Mass of Particulate	L_r	mg	7.84			0.82	
Uncollected Mass	UCM	mg	0.04			0.82	

	Uncertainty in Result		
Measured Quantities	**Units**	**Run 1**	
Sampled Volume (STP)	mg/m^3	0.16	
Leak	mg/m^3	0.02	
Mass of Particulate	mg/m^3	0.12	
Uncollected Mass	mg/m^3	0.03	

	Oxygen Correction Part of MU Budget		
Measured Quantities	**Units**	**Run 1**	
O_2 Correction Factor	-	N/A	
Stack Gas O_2 Content	% v/v	N/A	
MU for O_2 Correction	-	N/A	
Overall MU For O_2 Measurement	%	N/A	

Parameter	**Units**	**Run 1**	
Combined uncertainty	mg/m^3	0.20	
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.40	
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.40	
Reported Uncertainty	mg/m^3	0.40	
Expanded uncertainty (95% confidence), without Oxygen Correction	%	6.2	
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	6.2	
Reported Uncertainty	%	6.2	

PM_{10}: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.29		0.29
Uncertainty	±mg/m³	0.46		0.46
Mass Emission	g/hr	2.6		2.6
Uncertainty	±g/hr	4.1		4.1

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	11.2		11.2
Uncertainty	±% v/v	0.56		0.56

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.23		0.23

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	BS EN ISO 23210	
Technical Procedure	CAT-TP-26	
Sizing Device	TCR Tecora MSSI 3-Stage Cascade Impactor	
Sizing Device Material	Stainless Steel	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

PM_{10}: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	759.0	
Stack static pressure, P_{static}	mmH_2O	1.8	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	759.1	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	125.3	
Total mass collected in impingers (silica trap)	g	28.4	
Total mass of liquid collected, V_{lc}	g	153.7	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.1915	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	1.5950	
Gas meter correction factor, Y_d	-	1.0140	
Average dry gas meter temperature, T_m	°C	21.8	
Average pressure drop across orifice, ΔH	mmH_2O	124.9	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	1.5136	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.1123	
B_{wo} as a percentage	% v/v	11.23	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	11.23	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	1.7051	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet (O_{2REFw}) = $(21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	
O_2 Reference Factor dry (O_{2REFd}) = $(21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2	% v/v	9.00	
O_2	% v/v	11.00	
Total	% v/v	20.00	
N_2	% v/v	80.00	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	29.88	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.55	
Velocity of stack gas, V_{spt}			
Velocity pressure coefficient, C_p	-	0.83	
Average stack gas temperature, T_s	°C	159.9	
Velocity of stack gas (pre-test from traverse), V_{spt}	m/s	6.16	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	0.64	
$Q_a = (60)(A_s)(V_s)$	m^3/min	235.2	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	148.1	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	131.5	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	13.00	
Nozzle area, A_n	mm^2	132.75	
Total sampling time, q	min	60	
Velocity at nozzle, V_n	m/s	5.66	
$\%I = V_n / V_{spt} \times 100$	%	91.9	

PM_{10}: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	13:45 - 14:45	
Sampling Dates	-	05/10/2017	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	1.7051	
2nd Stage of Cascade Impactor (PM_{10} to $PM_{2.5}$)			
Filter I.D. Number (2nd Stage)	-	PM2-01519	
Start Filter Mass (2nd Stage)	g	0.12710	
End Filter Mass (2nd Stage)	g	0.12724	
Total Mass	g	0.00014	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3-01519	
Start Filter Mass (3rd Stage)	g	0.14576	
End Filter Mass (3rd Stage)	g	0.14612	
Total Mass	g	0.00036	
Total Mass Collected	mg	0.50	
Calculated Concentration	mg/m^3	0.29	
Balance Uncertainty / LOD	mg/m^3	0.23	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	05/10/2017	
Average Volume Sampled (REF)	m^3	1.7051	
2nd Stage of Cascade Impactor (PM_{10} to $PM_{2.5}$)			
Filter I.D. Number (2nd Stage)	-	PM2-01543	
Start Filter Mass (2nd Stage)	g	0.12894	
End Filter Mass (2nd Stage)	g	0.12895	
Total Mass	g	0.00001	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3-01543	
Start Filter Mass (3rd Stage)	g	0.15180	
End Filter Mass (3rd Stage)	g	0.15186	
Total Mass	g	0.00006	
Total Mass Collected	mg	0.07	
Calculated Concentration	mg/m^3	0.04	
Balance Uncertainty / LOD	mg/m^3	0.23	

PM_{10}: QUALITY ASSURANCE

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Sample Runs

Leak Test Results	**Units**	**Run 1**	
Expected Sampling Rate	l/min	25.0	
Pre-Sampling Leak Rate	l/min	0.16	
Allowable Leak Rate	l/min	0.50	
Leak Test Acceptable	-	Yes	

Water Droplets	**Units**	**Run 1**	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	**Units**	**Run 1**	
Measurement Uncertainty (MU)	%	5.0	
Allowable MU	%	20	
MU Acceptable	%	Yes	

Silica Gel (Concurrent Water Vapour)	**Units**	**Run 1**	
Less than 50% Faded	%	Yes	

Isokinetic Criterion Compliance	**Units**	**Run 1**	
Isokinetic Variation	%	91.9	
Allowable Isokinetic Range	%	90 - 130	
Isokineticity Acceptable	-	Yes	

Filter Temperatures	**Units**	**Run 1**	
Pre-Conditioning Temperature	°C	180	
Post-Conditioning Temperature	°C	160	
Maximum Filter Temperature	°C	160	

Test Conditions	**Units**	**Run 1**	
Ambient Temperature Recorded?	-	Yes	

Cut Size	**Units**	**Run 1**	
D_{50} Cut Size	µm	10.05	
Allowable D_{50} Cut Size	µm	9 - 11	
D_{50} Cut Size Acceptable	-	Yes	

PM_{10}: QUALITY ASSURANCE

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Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	25.0	
Pre-Sampling Leak Rate	l/min	0.22	
Allowable Leak Rate	l/min	0.50	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m^3	N/A	
Blank Acceptable	-	N/A	

Method Deviations

Nature of Deviation	Run Number	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	1	
There are no deviations associated with the sampling employed.	wx	

PM_{10}: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value				Standard uncertainty			
Measured Quantities	**Symbol**	**Run 1**			**Symbol**	**Units**	**Run 1**	
Sampled Volume (Actual)	V_m	1.60			uV_m	m^3	0.03	
Sampled Gas Temperature	T_m	294.8			uT_m	K	2.00	
Sampled Gas Pressure	ρ_m	101.2			$u\rho_m$	kPa	0.50	
Sampled Gas Humidity	H_m	0.00			uH_m	% v/v	1.00	
Leak	L	0.64			uL	%	-	
Mass of Particulate	m	0.50			um	mg	0.40	
Uncollected Mass	UCM	0.07			uUCM	mg	-	
Particulate Sizing	PS	10.0			uPS	%	-	

	Uncertainty as a Percentage			
Measured Quantities	**Units**	**Run 1**		**Requirement of Standard**
Sampled Volume (Actual)	%	2.00		≤2%
Sampled Gas Temperature	%	0.68		≤1%
Sampled Gas Pressure	%	0.49		≤1%
Sampled Gas Humidity	%	1.00		≤1%
Leak	%	0.64		≤2%
Mass of Particulate	%	-		<5% of ELV
Uncollected Mass	%	-		-
Particulate Sizing	%	10.0		-

	Uncertainty in Measurement Units					Sensitivity Coefficient	
Measured Quantities	**Symbol**	**Units**	**Run 1**			**Run 1**	
Sampled Volume (STP)	V_m	m^3	1.51			0.19	
Leak	L	mg/m^3	0.00			1.00	
Mass of Particulate	L_r	mg	0.50			0.59	
Uncollected Mass	UCM	mg	0.04			0.59	
Particulate Sizing	PS	mg	0.02			1.00	

	Uncertainty in Result		
Measured Quantities	**Units**	**Run 1**	
Sampled Volume (STP)	mg/m^3	0.01	
Leak	mg/m^3	0.00	
Mass of Particulate	mg/m^3	0.23	
Uncollected Mass	mg/m^3	0.02	
Particulate Sizing	mg/m^3	0.02	

	Oxygen Correction Part of MU Budget		
Measured Quantities	**Units**	**Run 1**	
O_2 Correction Factor	-	N/A	
Stack Gas O_2 Content	% v/v	N/A	
MU for O_2 Correction	-	N/A	
Overall MU For O_2 Measurement	%	N/A	

Parameter	**Units**	**Run 1**	
Combined uncertainty	mg/m^3	0.24	
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.46	
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.46	
Reported Uncertainty	mg/m^3	0.46	
Expanded uncertainty (95% confidence), without Oxygen Correction	%	159.1	
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	159.1	
Reported Uncertainty	%	159.1	

$PM_{2.5}$: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.21		0.21
Uncertainty	±mg/m³	0.35		0.35
Mass Emission	g/hr	1.9		1.9
Uncertainty	±g/hr	3.1		3.1

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	11.2		11.2
Uncertainty	±% v/v	0.56		0.56

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.18		0.18

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	BS EN ISO 23210	
Technical Procedure	CAT-TP-26	
Sizing Device	TCR Tecora MSSI 3-Stage Cascade Impactor	
Sizing Device Material	Stainless Steel	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

$PM_{2.5}$: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	759.0	
Stack static pressure, P_{static}	mmH_2O	1.8	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	759.1	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	125.3	
Total mass collected in impingers (silica trap)	g	28.4	
Total mass of liquid collected, V_{lc}	g	153.7	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.1915	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	1.5950	
Gas meter correction factor, Y_d	-	1.0140	
Average dry gas meter temperature, T_m	°C	21.8	
Average pressure drop across orifice, ΔH	mmH_2O	124.9	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	1.5136	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.1123	
B_{wo} as a percentage	% v/v	11.23	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	11.23	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	1.7051	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet (O_{2REFw}) = $(21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	
O_2 Reference Factor dry (O_{2REFd}) = $(21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2	% v/v	9.00	
O_2	% v/v	11.00	
Total	% v/v	20.00	
N_2	% v/v	80.00	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	29.88	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.55	
Velocity of stack gas, V_{spt}			
Velocity pressure coefficient, C_p	-	0.83	
Average stack gas temperature, T_s	°C	159.9	
Velocity of stack gas (pre-test from traverse), V_{spt}	m/s	6.16	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	0.64	
$Q_a = (60)(A_s)(V_s)$	m^3/min	235.2	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	148.1	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	131.5	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	13.00	
Nozzle area, A_n	mm^2	132.75	
Total sampling time, q	min	60	
Velocity at nozzle, V_n	m/s	5.66	
$\%I = V_n / V_{spt} \times 100$	%	91.9	

$PM_{2.5}$: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	13:45 - 14:45	
Sampling Dates	-	05/10/2017	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	1.7051	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3-01519	
Start Filter Mass (3rd Stage)	g	0.14576	
End Filter Mass (3rd Stage)	g	0.14612	
Total Mass	g	0.00036	
Total Mass Collected	mg	0.36	
Calculated Concentration	mg/m^3	0.21	
Balance Uncertainty / LOD	mg/m^3	0.18	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	05/10/2017	
Average Volume Sampled (REF)	m^3	1.7051	
3rd Stage of Cascade Impactor (≤ $PM_{2.5}$)			
Filter I.D. Number (3rd Stage)	-	PM3-01543	
Start Filter Mass (3rd Stage)	g	0.15180	
End Filter Mass (3rd Stage)	g	0.15186	
Total Mass	g	0.00006	
Total Mass Collected	mg	0.06	
Calculated Concentration	mg/m^3	0.04	
Balance Uncertainty / LOD	mg/m^3	0.18	

$PM_{2.5}$: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1	
Expected Sampling Rate	l/min	25.0	
Pre-Sampling Leak Rate	l/min	0.16	
Allowable Leak Rate	l/min	0.50	
Leak Test Acceptable	-	Yes	

Water Droplets	Units	Run 1	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	Units	Run 1	
Measurement Uncertainty (MU)	%	5.0	
Allowable MU	%	20	
MU Acceptable	%	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	
Less than 50% Faded	%	Yes	

Isokinetic Criterion Compliance	Units	Run 1	
Isokinetic Variation	%	91.9	
Allowable Isokinetic Range	%	90 - 130	
Isokineticity Acceptable	-	Yes	

Filter Temperatures	Units	Run 1	
Pre-Conditioning Temperature	°C	180	
Post-Conditioning Temperature	°C	160	
Maximum Filter Temperature	°C	160	

Test Conditions	Units	Run 1	
Ambient Temperature Recorded?	-	Yes	

Cut Size	Units	Run 1	
D_{50} Cut Size	µm	2.50	
Allowable D_{50} Cut Size	µm	2.25 - 2.75	
D_{50} Cut Size Acceptable	-	Yes	

$PM_{2.5}$: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	25.0	
Pre-Sampling Leak Rate	l/min	0.22	
Allowable Leak Rate	l/min	0.50	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m^3	N/A	
Blank Acceptable	-	N/A	

Method Deviations

Nature of Deviation	Run Number	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	1	
There are no deviations associated with the sampling employed.	wx	

$PM_{2.5}$: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value Symbol	Value Run 1	Standard uncertainty Symbol	Units	Run 1
Sampled Volume (Actual)	V_m	1.60	uV_m	m^3	0.03
Sampled Gas Temperature	T_m	294.8	uT_m	K	2.00
Sampled Gas Pressure	ρ_m	101.2	$u\rho_m$	kPa	0.50
Sampled Gas Humidity	H_m	0.00	uH_m	% v/v	1.00
Leak	L	0.64	uL	%	-
Mass of Particulate	m	0.36	um	mg	0.30
Uncollected Mass	UCM	0.06	uUCM	mg	-
Particulate Sizing	PS	10.0	uPS	%	-

Measured Quantities	Uncertainty as a Percentage Units	Run 1	Requirement of Standard
Sampled Volume (Actual)	%	2.00	≤2%
Sampled Gas Temperature	%	0.68	≤1%
Sampled Gas Pressure	%	0.49	≤1%
Sampled Gas Humidity	%	1.00	≤1%
Leak	%	0.64	≤2%
Mass of Particulate	%	-	<5% of ELV
Uncollected Mass	%	-	-
Particulate Sizing	%	10.0	-

Measured Quantities	Uncertainty in Measurement Units Symbol	Units	Run 1	Sensitivity Coefficient Run 1
Sampled Volume (STP)	V_m	m^3	1.51	0.14
Leak	L	mg/m^3	0.00	1.00
Mass of Particulate	L_r	mg	0.36	0.59
Uncollected Mass	UCM	mg	0.03	0.59
Particulate Sizing	PS	mg	0.01	1.00

Measured Quantities	Uncertainty in Result Units	Run 1
Sampled Volume (STP)	mg/m^3	0.01
Leak	mg/m^3	0.00
Mass of Particulate	mg/m^3	0.18
Uncollected Mass	mg/m^3	0.02
Particulate Sizing	mg/m^3	0.01

Measured Quantities	Oxygen Correction Part of MU Budget Units	Run 1
O_2 Correction Factor	-	N/A
Stack Gas O_2 Content	% v/v	N/A
MU for O_2 Correction	-	N/A
Overall MU For O_2 Measurement	%	N/A

Parameter	Units	Run 1
Combined uncertainty	mg/m^3	0.18
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.35
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.35
Reported Uncertainty	mg/m^3	0.35
Expanded uncertainty (95% confidence)	%	164.9
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	164.9
Reported Uncertainty	%	164.9

OXIDES OF NITROGEN (as NO_2): RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	82.1		82.1
Uncertainty	±mg/m³	2.5		2.5
Mass Emission	g/hr	725		725
Uncertainty	±g/hr	43.8		43.8

General Sampling Information

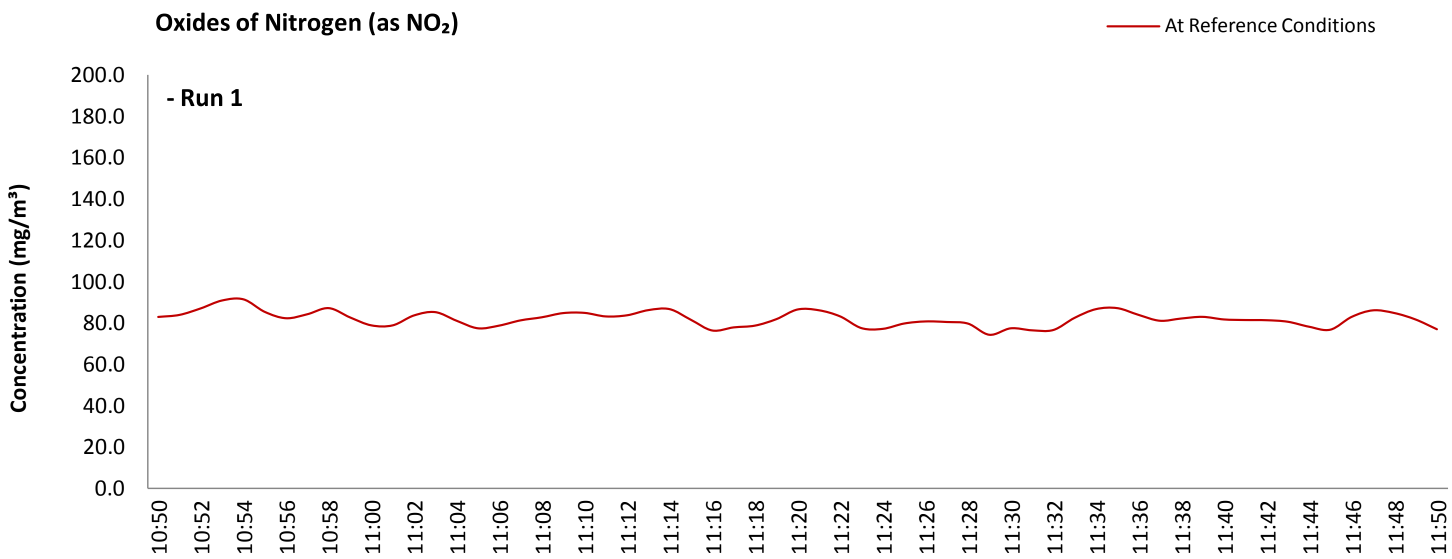
Parameter	Value	
Standard	EN 14792	
Technical Procedure	CAT-TP-21	
Probe Material	Stainless Steel	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Date & Result of Last Converter Check	17/05/2017 - 95.9%	
Span Gas Type	Nitrogen Monoxide	
Span Gas Reference Number	CYL 4.0186	
Span Gas Expiry Date	16/09/2020	
Span Gas Start Pressure (bar)	100	
Gas Cylinder Concentration (ppm)	395.7	NOTE: Dilution performed to achieve correct span value
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

OXIDES OF NITROGEN (as NO_2): DATA TREND

Graphical Trend of Data



OXIDES OF NITROGEN (as NO_2): SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	
Sampling Times	-	10:50 - 11:50	
Sampling Dates	-	05/10/2017	
Instrument Range	ppm	500	
Span Gas Value	ppm	396	

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	
Average Temperature	°C	N/A	
Allowable Temperature	< °C	N/A	
Temperature Acceptable	-	N/A	

	Zero Drift	Units	Run 1	
CAL 1	Zero Down Sampling Line (Pre)	ppm	0.10	
CAL 1	Zero Down Sampling Line (Post)	ppm	0.20	
CAL 1	Zero Drift	ppm	0.10	
	Allowable Zero Drift	± ppm	19.8	
	Zero Drift Acceptable	-	Yes	

	Span Drift	Units	Run 1	
CAL 1	Span Down Sampling Line (Pre)	ppm	395.5	
CAL 1	Span Down Sampling Line (Post)	ppm	394.9	
CAL 1	Span Drift	ppm	-0.60	
	Allowable Span Drift	± ppm	19.8	
	Span Drift Acceptable	-	Yes	

Test Conditions	Units	Run 1	
Run Ambient Temperature Range	°C	15 - 18	

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	
There are no deviations associated with the sampling employed.	x	

OXIDES OF NITROGEN (as NO_2): MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1		Units
Limit value	-		mg/m³ (REF)
TGN M2 Allowable MU	10.0		%
Measured concentration	92.81		mg/m³ (STP, dry)
Ration NO / NO_2	5		%
Range Used	500.0		ppm
Range Used [A]	1026.1		mg/m³
Cal gas conc.	395.7		ppm
Conversion	2.05		ppm to mg/m³
MCERTS Range [B]	125.0		mg/m³
Lower of [A] or [B]	125.0		mg/m³
Cal gas conc.	812.1		mg/m³

Performance characteristics	RUN 1		Units
Response time	60		seconds
Number of readings in measurement	60		-
Repeatability at zero	0.40		% full scale
Repeatability at span level	0.40		% full scale
Deviation from linearity	0.25		% of value
Zero drift	0.03		% full scale
Span drift	-0.15		% full scale
Volume or pressure flow dependence	0.40		% of full scale
Atmospheric pressure dependence	0.30		% of value/kPa
Ambient temperature dependence	0.18		% full scale/10K
Combined interference	0.60		% range
Dependence on voltage	0.40		% full scale/10V
Converter efficiency	95.9		%
Losses in the line (leak)	0.03		% of value
Uncertainty of calibration gas blending	1.40		% of value
Uncertainty of calibration gas	2.00		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		mg/m³
Standard deviation of repeatability at span level	0.05		mg/m³
Lack of fit	0.18		mg/m³
Drift	0.04		mg/m³
Volume or pressure flow dependence	0.00		mg/m³
Atmospheric pressure dependence	0.11		mg/m³
Ambient temperature dependence	0.03		mg/m³
Combined interference (from MCERTS Certificate)	0.43		mg/m³
Dependence on voltage	0.05		mg/m³
Converter efficiency	0.11		mg/m³
Losses in the line (leak)	0.01		mg/m³
Uncertainty of calibration gas blending	0.75		mg/m³
Uncertainty of calibration gas	1.07		mg/m³

			RUN 1		Units
Measurement uncertainty		**Result**	92.81		mg/m³
Combined uncertainty			1.47		mg/m³
Expanded uncertainty	k =	1.96	2.87		mg/m³
Uncertainty corrected to std conds. (O_2)			2.87		mg/m³ (REF)

	RUN 1		Units
Expanded uncertainty (no O_2) - at 95% Confidence	3.10		% of Value
Expanded uncertainty (no O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (no O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**		-

	RUN 1		Units
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% of Value
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**		-

Requirement for SRM is that Uncertainty should be <10% of the value at the ELV, on a dry gas basis, or if O_2 correction is applied less than 10% + the uncertainty associated with the O_2 correction (using sqrt of sum squares to add uncertainty components). Ref EA TGN M2.

CARBON MONOXIDE: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	10.5		10.5
Uncertainty	±mg/m³	1.1		1.1
Mass Emission	g/hr	92.6		92.6
Uncertainty	±g/hr	10.9		10.9

General Sampling Information

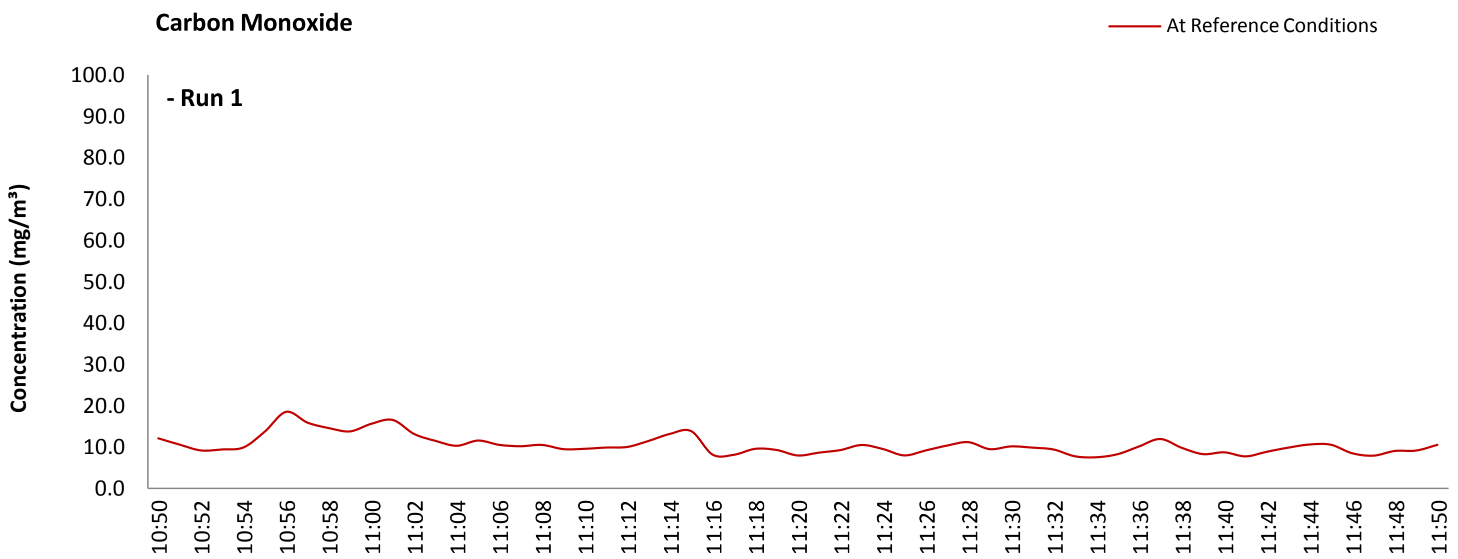
Parameter	Value	
Standard	EN 15058	
Technical Procedure	CAT-TP-21	
Probe Material	Stainless Steel	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Carbon Monoxide	
Span Gas Reference Number	CYL 2.0124	
Span Gas Expiry Date	22/07/2021	
Span Gas Start Pressure (bar)	150	
Gas Cylinder Concentration (ppm)	402.3	NOTE: Dilution performed to achieve correct span value
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

CARBON MONOXIDE: DATA TREND

Graphical Trend of Data



CARBON MONOXIDE: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	
Sampling Times	-	10:50 - 11:50	
Sampling Dates	-	05/10/2017	
Instrument Range	ppm	500	
Span Gas Value	ppm	402	

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	
Average Temperature	°C	N/A	
Allowable Temperature	< °C	N/A	
Temperature Acceptable	-	N/A	

	Zero Drift	Units	Run 1	
CAL 1	Zero Down Sampling Line (Pre)	ppm	0.00	
CAL 1	Zero Down Sampling Line (Post)	ppm	0.10	
CAL 1	Zero Drift	ppm	0.10	
	Allowable Zero Drift	± ppm	20.1	
	Zero Drift Acceptable	-	Yes	

	Span Drift	Units	Run 1	
CAL 1	Span Down Sampling Line (Pre)	ppm	402.3	
CAL 1	Span Down Sampling Line (Post)	ppm	402.0	
CAL 1	Span Drift	ppm	-0.30	
	Allowable Span Drift	± ppm	20.1	
	Span Drift Acceptable	-	Yes	

Test Conditions	Units	Run 1	
Run Ambient Temperature Range	°C	15 - 18	

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	
There are no deviations associated with the sampling employed.	x	

CARBON MONOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1		Units
Limit value	-		mg/m^3 (REF)
TGN M2 Allowable MU	6.0		%
Measured concentration	11.86		mg/m^3 (STP, dry)
Range Used	500.0		ppm
Range Used [A]	624.6		mg/m^3
Cal gas conc.	402.3		ppm
Conversion	1.25		ppm to mg/m^3
MCERTS Range [B]	95.0		mg/m^3
Lower of [A] or [B]	95.0		mg/m^3
Cal gas conc.	502.6		mg/m^3

Performance characteristics	RUN 1		Units
Response time	60		seconds
Number of readings in measurement	60		-
Repeatability at zero	0.40		% full scale
Repeatability at span level	0.40		% full scale
Deviation from linearity	0.41		% of value
Zero drift	0.02		% full scale
Span drift	-0.07		% full scale
Volume or pressure flow dependence	0.40		% of full scale
Atmospheric pressure dependence	0.30		% of value/kPa
Ambient temperature dependence	0.05		% full scale/10K
Combined interference	0.73		% range
Dependence on voltage	0.40		% full scale/10V
Losses in the line (leak)	0.00		% of value
Uncertainty of calibration gas blending	1.40		% of value
Uncertainty of calibration gas	2.00		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		mg/m^3
Standard deviation of repeatability at span level	0.05		mg/m^3
Lack of fit	0.22		mg/m^3
Drift	0.07		mg/m^3
Volume or pressure flow dependence	0.00		mg/m^3
Atmospheric pressure dependence	0.08		mg/m^3
Ambient temperature dependence	0.01		mg/m^3
Combined interference (from MCERTS Certificate)	0.40		mg/m^3
Dependence on voltage	0.05		mg/m^3
Losses in the line (leak)	0.00		mg/m^3
Uncertainty of calibration gas blending	0.10		mg/m^3
Uncertainty of calibration gas	0.14		mg/m^3

			RUN 1		Units
Measurement uncertainty		**Result**	11.86		mg/m^3
Combined uncertainty			0.64		mg/m^3
Expanded uncertainty	k =	1.96	1.26		mg/m^3
Uncertainty corrected to std conds. (O_2)			1.26		mg/m^3 (REF)

	RUN 1		Units
Expanded uncertainty (no O_2) - at 95% Confidence	10.59		% of Value
Expanded uncertainty (no O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (no O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**		-

	RUN 1		Units
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% of Value
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement in M2	**N/A**		-

Requirement for SRM is that Uncertainty should be <6% of the value at the ELV, on a dry gas basis, or if O_2 correction is applied less than 6% + the uncertainty associated with the O_2 correction (using sqrt of sum squares to add uncertainty components). Ref EA TGN M2.

CARBON DIOXIDE: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

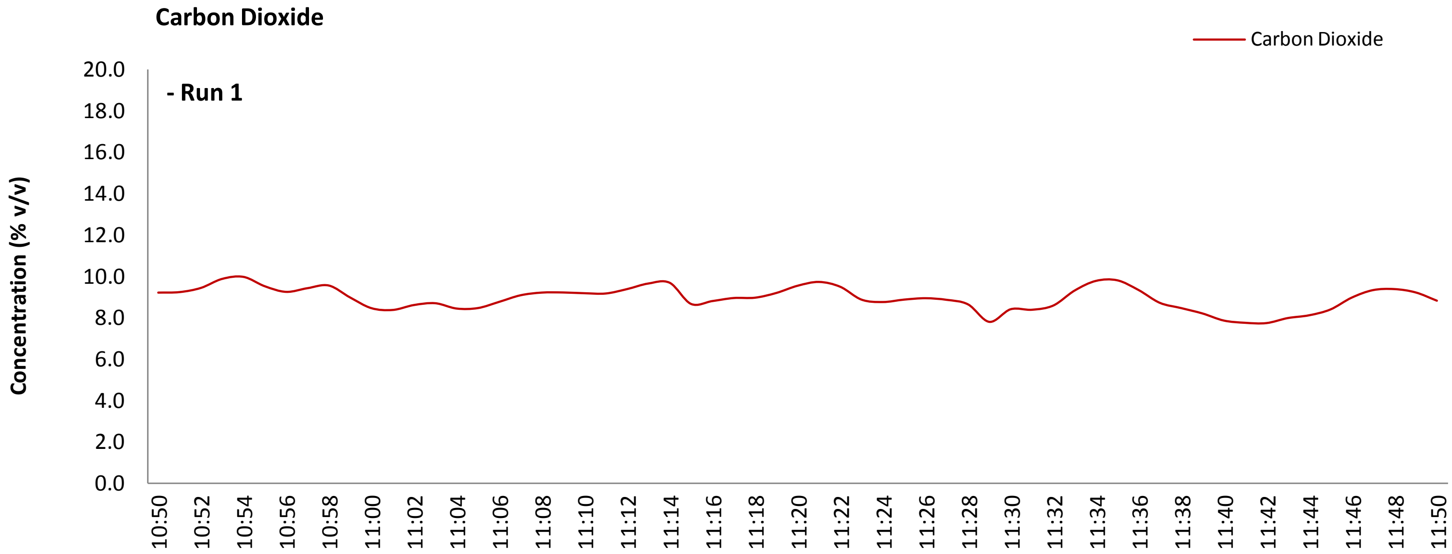
Parameter	Units	Run 1		Mean
Concentration	% v/v	8.95		8.95
Uncertainty	±% v/v	0.28		0.28

General Sampling Information

Parameter	Value	
Standard	ISO 12039	
Technical Procedure	CAT-TP-21	
Probe Material	Stainless Steel	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Carbon Dioxide	
Span Gas Reference Number	CYL 6.0035	
Span Gas Expiry Date	06/05/2022	
Span Gas Start Pressure (bar)	140	
Gas Cylinder Concentration (% v/v)	16.18	
Span Gas Uncertainty (%)	2.00	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

CARBON DIOXIDE: DATA TREND

Graphical Trend of Data



CARBON DIOXIDE: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	
Sampling Times	-	10:50 - 11:50	
Sampling Dates	-	05/10/2017	
Instrument Range	% v/v	20.0	
Span Gas Value	% v/v	16.2	

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	
Average Temperature	°C	N/A	
Allowable Temperature	< °C	N/A	
Temperature Acceptable	-	N/A	

	Zero Drift	Units	Run 1	
CAL 1	Zero Down Sampling Line (Pre)	% v/v	0.02	
CAL 1	Zero Down Sampling Line (Post)	% v/v	0.03	
CAL 1	Zero Drift	% v/v	0.01	
	Allowable Zero Drift	± % v/v	0.81	
	Zero Drift Acceptable	-	Yes	

	Span Drift	Units	Run 1	
CAL 1	Span Down Sampling Line (Pre)	% v/v	16.17	
CAL 1	Span Down Sampling Line (Post)	% v/v	16.14	
CAL 1	Span Drift	% v/v	-0.03	
	Allowable Span Drift	± % v/v	0.81	
	Span Drift Acceptable	-	Yes	

Test Conditions	Units	Run 1	
Run Ambient Temperature Range	°C	15 - 18	

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	
There are no deviations associated with the sampling employed.	x	

CARBON DIOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1		Units
Limit value	N/A		%vol
TGN M2 Allowable MU	25.0		%
Measured concentration	8.95		%vol
Range Used	20.0		%vol
Cal gas conc.	16.2		%vol

Performance characteristics	RUN 1		Units
Response time	160		seconds
Number of readings in measurement	60		-
Repeatability at zero	0.40		% full scale
Repeatability at span level	0.40		% full scale
Deviation from linearity	0.59		% of value
Zero drift	0.06		% full scale
Span drift	-0.19		% full scale
Volume or pressure flow dependence	0.40		% of full scale
Atmospheric pressure dependence	0.30		% of value/kPa
Ambient temperature dependence	0.01		% full scale/10K
Combined interference	0.00		% range
Dependence on voltage	0.40		% full scale/10V
Losses in the line (leak)	0.06		% of value
Uncertainty of calibration gas	2.00		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		%vol
Standard deviation of repeatability at span level	0.05		%vol
Lack of fit	0.07		%vol
Drift	0.00		%vol
Volume or pressure flow dependence	0.00		%vol
Atmospheric pressure dependence	0.02		%vol
Ambient temperature dependence	0.00		%vol
Combined interference (from MCERTS Certificate)	0.00		%vol
Dependence on voltage	0.05		%vol
Losses in the line (leak)	0.00		%vol
Uncertainty of calibration gas	0.10		%vol

			RUN 1		Units
Measurement uncertainty		**Result**	8.95		%vol
Combined uncertainty			0.14		%vol
Expanded uncertainty	k =	1.96	0.28		%vol

	RUN 1		Units
Expanded uncertainty (no O_2) - at 95% Confidence	3.13		% of Value

OXYGEN: RESULTS SUMMARY

Blazers Fuels Ltd, Ruthin
Biomass CHP Plant Exhaust

Sample Runs

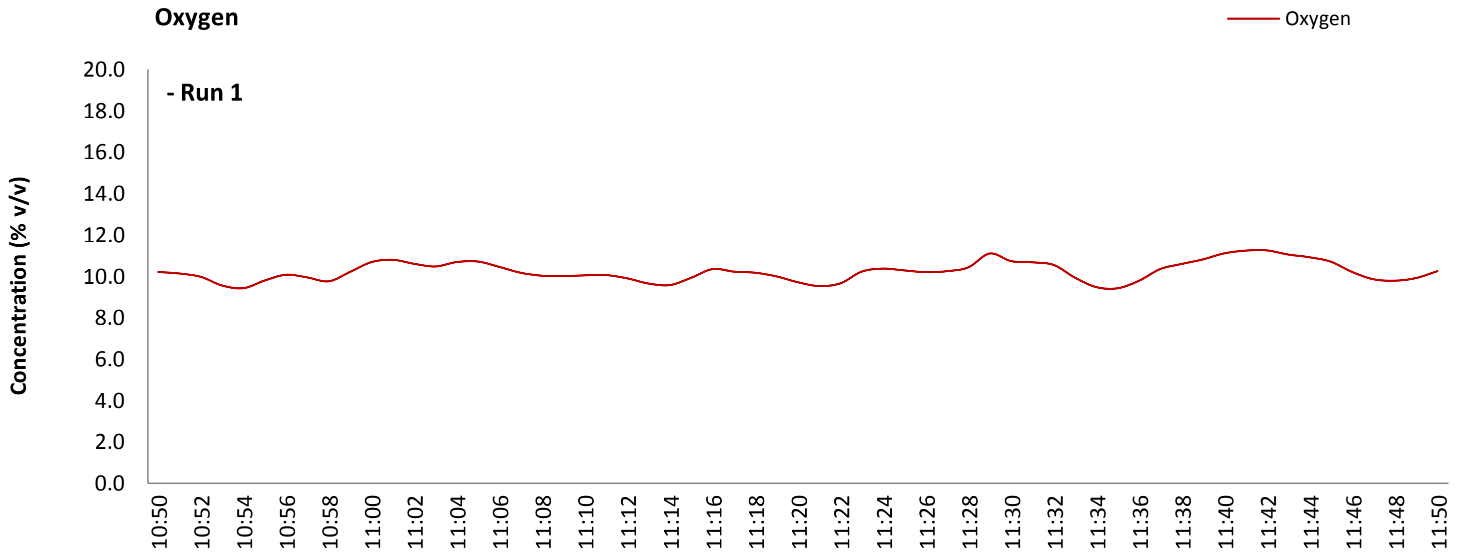
Parameter	Units	Run 1		Mean
Concentration	% v/v	10.2		10.2
Uncertainty	±% v/v	0.31		0.31

General Sampling Information

Parameter	Value	
Standard	EN 14789	
Technical Procedure	CAT-TP-21	
Probe Material	Stainless Steel	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Synthetic Air (5 Grade)	
Span Gas Reference Number	CYL 11.021	
Span Gas Expiry Date	29/05/2020	
Span Gas Start Pressure (bar)	90	
Gas Cylinder Concentration (% v/v)	21.3	NOTE: Dilution performed to achieve correct span value
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

OXYGEN: DATA TREND

Graphical Trend of Data



OXYGEN: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1	
Sampling Times	-	10:50 - 11:50	
Sampling Dates	-	05/10/2017	
Instrument Range	% v/v	25.0	
Span Gas Value	% v/v	21.0	

Quality Assurance

Conditioning Unit Temperature	Units	Run 1	
Average Temperature	°C	N/A	
Allowable Temperature	< °C	N/A	
Temperature Acceptable	-	N/A	

	Zero Drift	Units	Run 1	
CAL 1	Zero Down Sampling Line (Pre)	% v/v	0.01	
CAL 1	Zero Down Sampling Line (Post)	% v/v	0.00	
CAL 1	Zero Drift	% v/v	-0.01	
	Allowable Zero Drift	± % v/v	1.05	
	Zero Drift Acceptable	-	Yes	

	Span Drift	Units	Run 1	
CAL 1	Span Down Sampling Line (Pre)	% v/v	20.95	
CAL 1	Span Down Sampling Line (Post)	% v/v	20.97	
CAL 1	Span Drift	% v/v	0.02	
	Allowable Span Drift	± % v/v	1.05	
	Span Drift Acceptable	-	Yes	

Test Conditions	Units	Run 1	
Run Ambient Temperature Range	°C	15 - 18	

Method Deviations

Nature of Deviation	Run Number	
(x = deviation applies to the associated run)	1	
There are no deviations associated with the sampling employed.	x	

OXYGEN: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1		Units
Limit value	N/A		%vol
TGN M2 Allowable MU	6.0		%
Measured concentration	11.56		%vol
Range Used	25.0		%vol
Cal gas conc.	21.3		%vol

Performance characteristics	RUN 1		Units
Response time	60		seconds
Number of readings in measurement	60		-
Repeatability at zero	0.04		% full scale
Repeatability at span level	0.04		% full scale
Deviation from linearity	0.10		% of value
Zero drift	-0.05		% full scale
Span drift	0.10		% full scale
Volume or pressure flow dependence	0.20		% of full scale
Atmospheric pressure dependence	0.30		% of value/kPa
Ambient temperature dependence	-0.07		% full scale/10K
Combined interference	0.56		% range
Dependence on voltage	0.02		% full scale/10V
Losses in the line (leak)	0.00		% of value
Uncertainty of calibration gas	2.00		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		%vol
Standard deviation of repeatability at span level	0.01		%vol
Lack of fit	0.01		%vol
Drift	0.00		%vol
Volume or pressure flow dependence	0.00		%vol
Atmospheric pressure dependence	0.02		%vol
Ambient temperature dependence	-0.01		%vol
Combined interference (from MCERTS Certificate)	0.08		%vol
Dependence on voltage	0.00		%vol
Losses in the line (leak)	0.00		%vol
Uncertainty of calibration gas	0.13		%vol

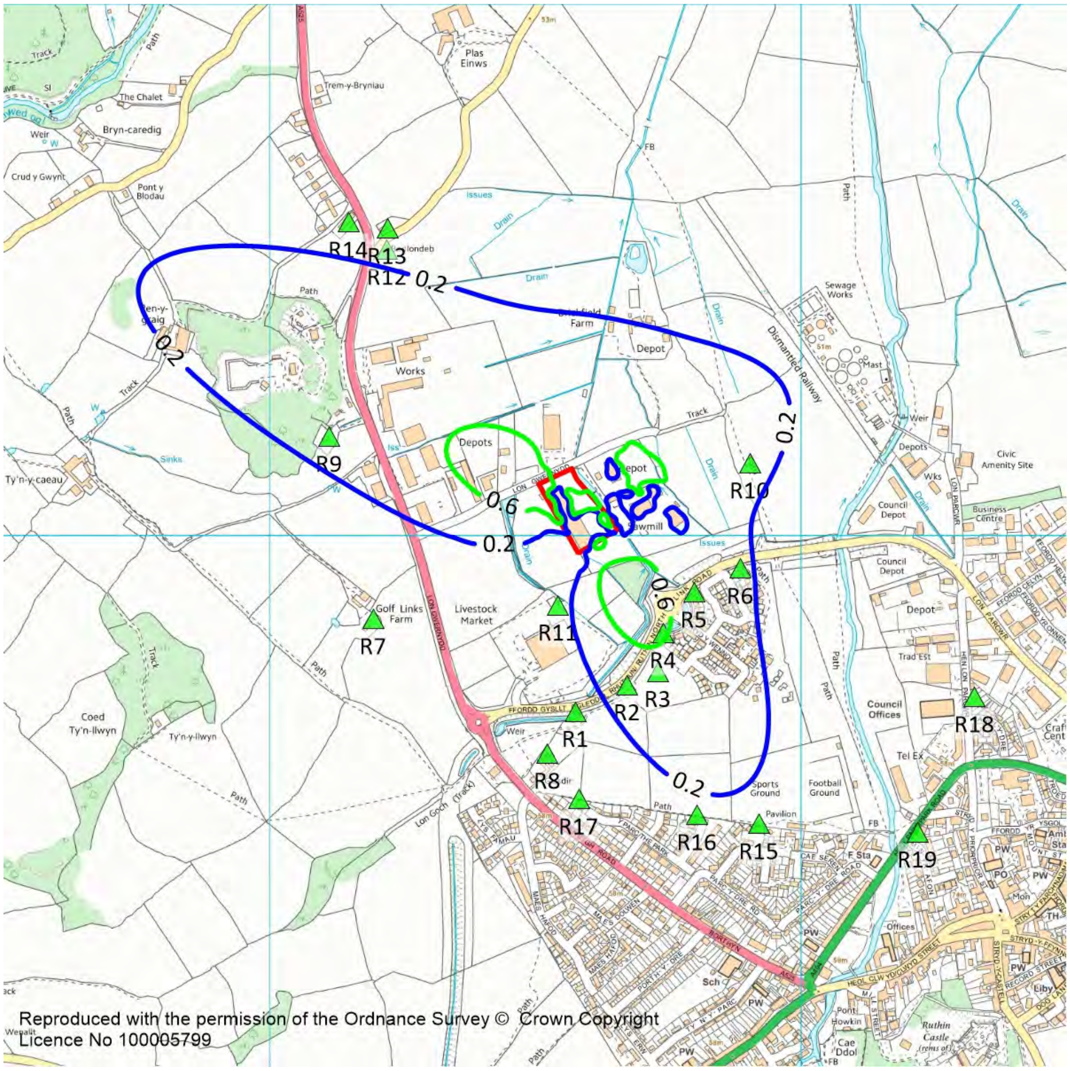
			RUN 1		Units
Measurement uncertainty		**Result**	11.56		%vol
Combined uncertainty			0.18		%vol
Expanded uncertainty	k =	1.96	0.35		%vol

	RUN 1		Units
Expanded uncertainty (no O_2) - at 95% Confidence	3.02		% of Value
Result of Compliance with Uncertainty Requirement in M2	**COMPLIANT**		-

Requirement for SRM is that Uncertainty should be 0.5%vol absolute or 6% relative whichever is the lower, on a dry gas basis. Ref EA TGN M2.

Appendix C

Stack Emission Model Outputs – NO_2 Contour Plots



Appendix Ci: Long-term NO_2 Process Contributions 2013:

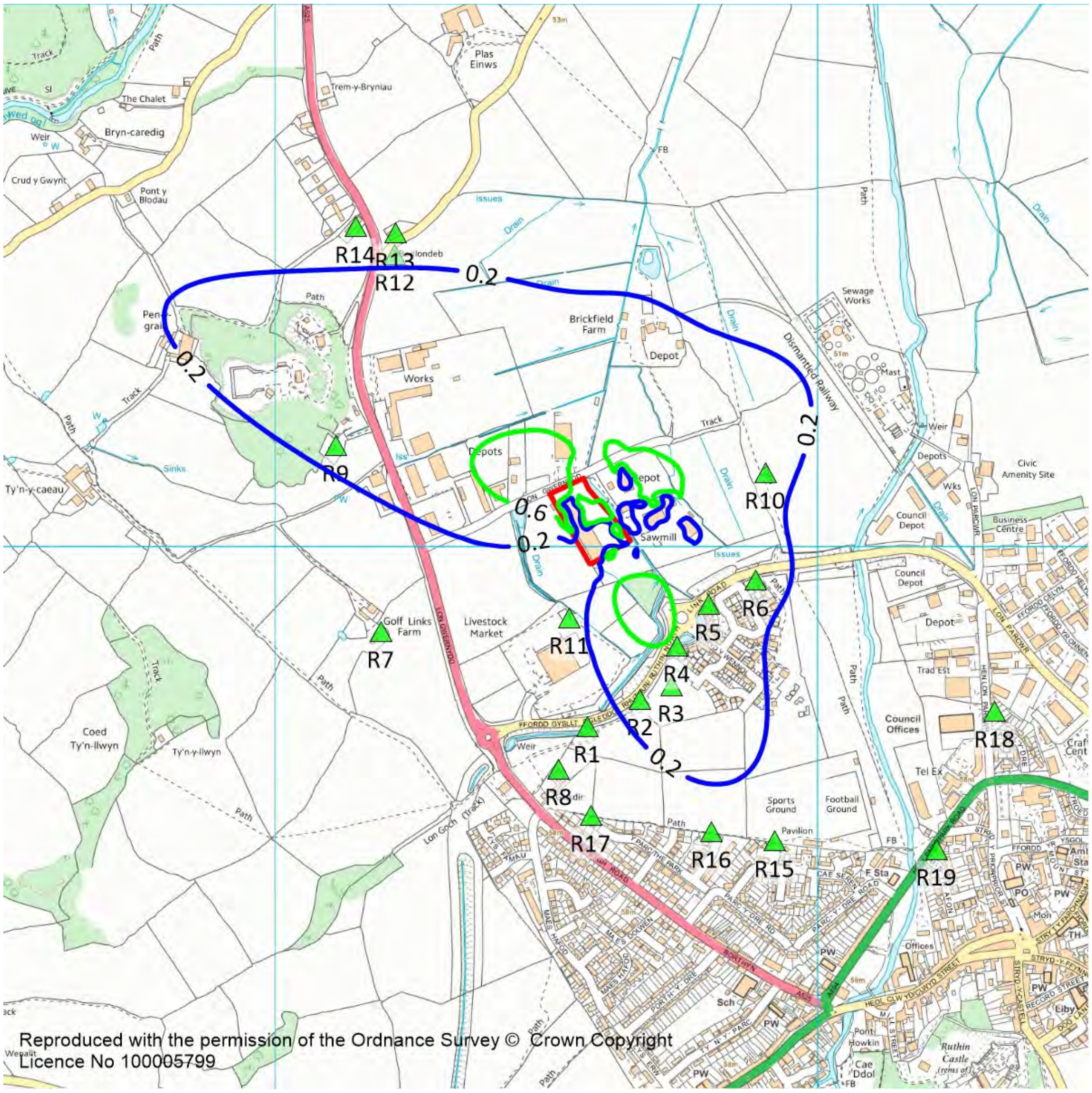
Scenario B2-A2 Monitored Emissions (assumes 70% NO_x to NO_2 conversion)

Key:

PM10 ($\mu g/m^3$, annual mean)

- 0.2 (blue)
- 0.6 (green)
- 2.2 (orange)
- 4.0 (red)

where 0.2 µg/m^3 represents 1% of AQAL following rounding; 0.6 µg/m^3 represents 2%, 2.2 µg/m^3 represents 6% etc



Appendix Cii: Long-term NO_2 Process Contributions 2014:

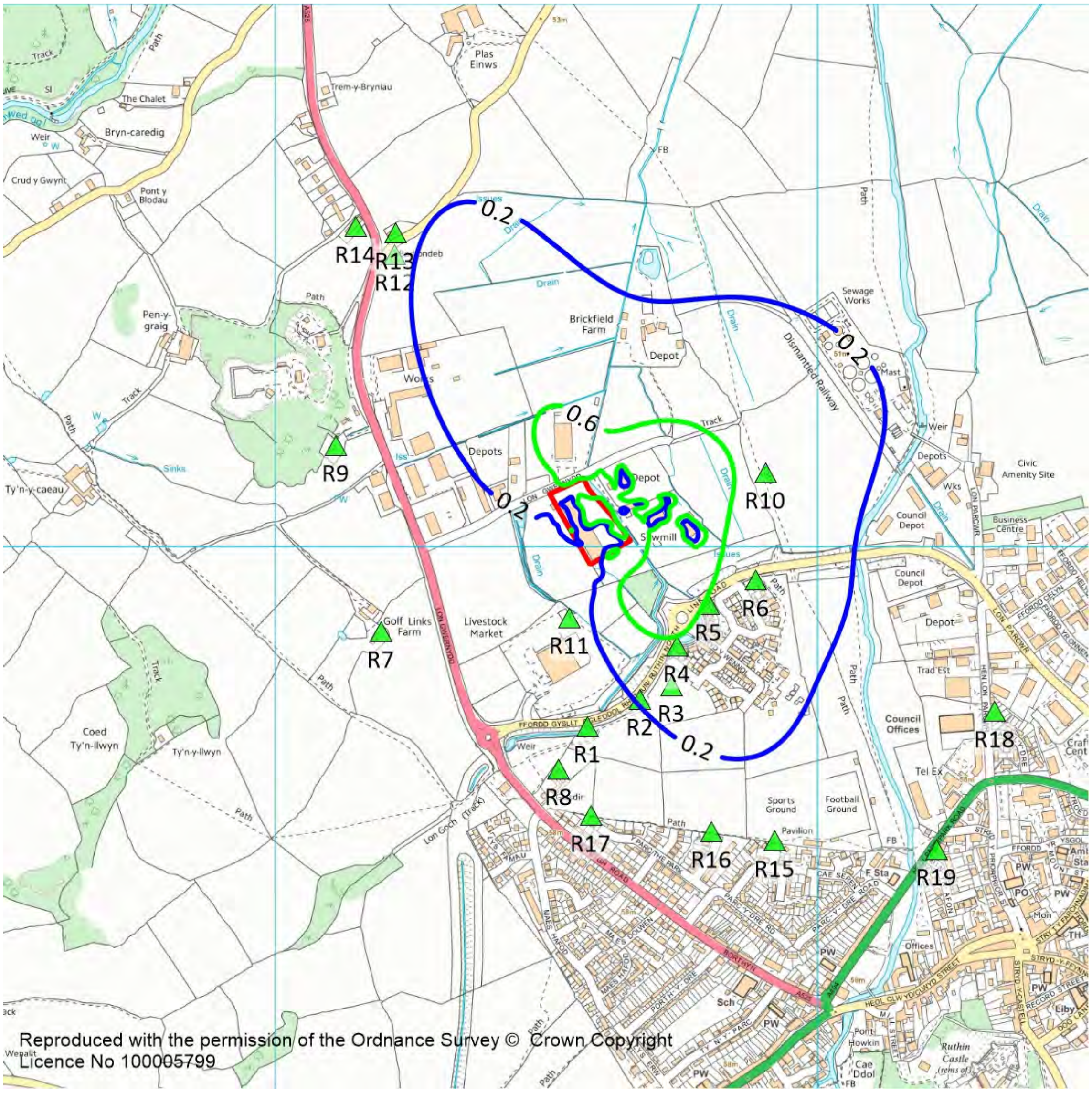
Scenario B2-A2 Monitored Emissions (assumes 70% NO_x to NO_2 conversion)

Key:

PM10 (μg/m^3 , annual mean)

- 0.2
- 0.6
- 2.2
- 4.0

where 0.2 µg/m^3 represents 1% of AQAL following rounding; 0.6 µg/m^3 represents 2%, 2.2 µg/m^3 represents 6% etc



Appendix Ciii: Long-term NO_2 Process Contributions 2015:

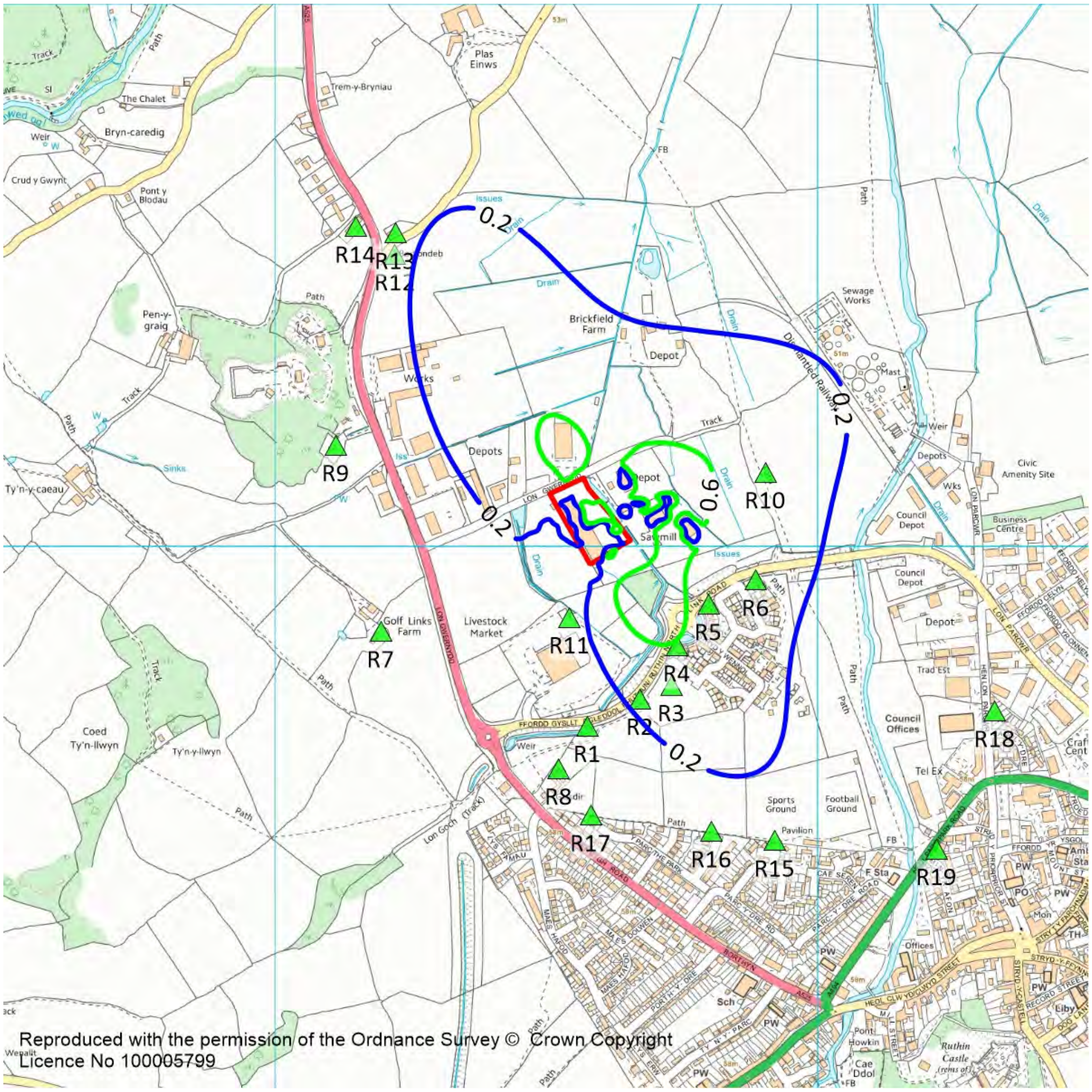
Scenario B2-A2 Monitored Emissions (assumes 70% NO_x to NO_2 conversion)

Key:

PM10 ($\mu g/m^3$, annual mean)

- 0.2
- 0.6
- 2.2
- 4.0

where 0.2 µg/m³ represents 1% of AQAL following rounding; 0.6 µg/m³ represents 2%, 2.2 µg/m³ represents 6% etc



Appendix Civ: Long-term NO_2 Process Contributions 2016:

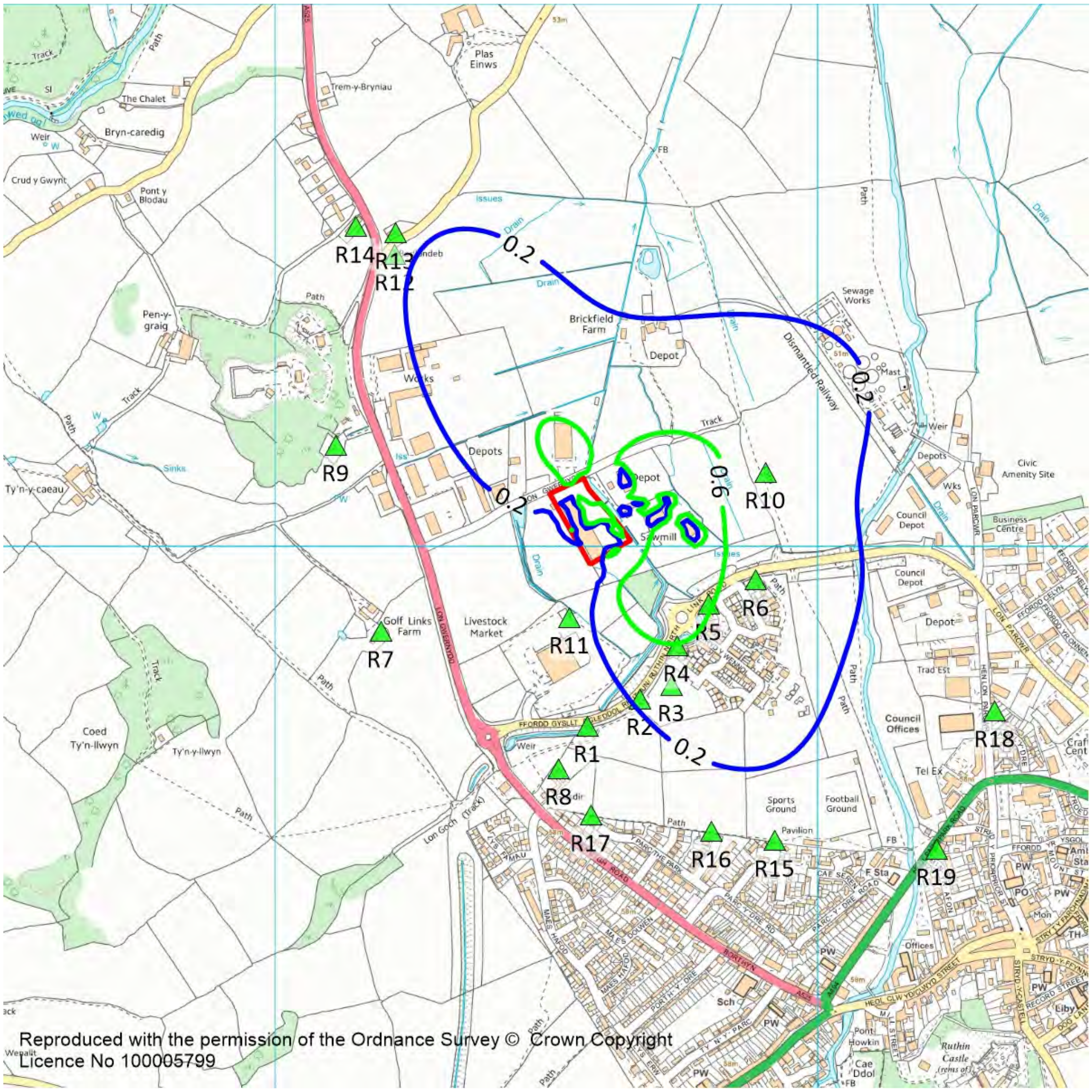
Scenario B2-A2 Monitored Emissions (assumes 70% NO_x to NO_2 conversion)

Key:

PM10 ($\mu g/m^3$, annual mean)

- 0.2 (blue)
- 0.6 (green)
- 2.2 (orange)
- 4.0 (red)

where 0.2 µg/m^3 represents 1% of AQAL following rounding; 0.6 µg/m^3 represents 2%, 2.2 µg/m^3 represents 6% etc



Appendix Cv: Long-term NO_2 Process Contributions 2017:

Scenario B2-A2 Monitored Emissions (assumes 70% NO_x to NO_2 conversion)

Key:

PM10 (μg/m^3 , annual mean)

- 0.2 (blue)
- 0.6 (green)
- 2.2 (orange)
- 4.0 (red)

where 0.2 μg/m^3 represents 1% of AQAL following rounding; 0.6 μg/m^3 represents 2%, 2.2 μg/m^3 represents 6% etc

APPENDIX D

Stack Emission Model Outputs – Detailed Results

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Maximum Predicted Process Contributions at Each Modelled Receptor

Scenario A2

Receptor name	X(m)	Y(m)	Z(m)	Long-term				Short-term		
				NO_2[1]	NO_2[2]	PM_{10}	$PM_{2.5}$	NO_2[1]	NO_2[3]	PM10
				µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
				annual mean	annual mean	annual mean	annual mean	99.79%ile of hourly means	99.79%ile of hourly means	90.41%ile of daily means
Residential, schools etc										
R1	311576	358668	0	0.13	0.09	0.03	0.02	6.03	2.11	0.12
R2	311673	358718	0	0.41	0.29	0.08	0.07	8.14	2.85	0.32
R3	311731	358743	0	0.69	0.48	0.12	0.10	9.14	3.20	0.46
R4	311741	358816	0	1.05	0.74	0.18	0.15	12.18	4.26	0.62
R5	311799	358892	0	1.08	0.75	0.18	0.15	13.52	4.73	0.59
R6	311886	358937	0	0.72	0.50	0.12	0.10	10.61	3.71	0.42
R7	311195	358842	0	0.07	0.05	0.01	0.01	3.87	1.36	0.05
R8	311523	358589	0	0.07	0.05	0.01	0.01	4.32	1.51	0.06
R9	311112	359186	0	0.39	0.28	0.09	0.07	5.42	1.90	0.23
R12	311221	359538	0	0.27	0.19	0.07	0.06	4.27	1.50	0.19
R13	311222	359578	0	0.27	0.19	0.07	0.05	4.14	1.45	0.20
R14	311148	359589	0	0.24	0.17	0.06	0.05	3.82	1.34	0.16
R15	311921	358457	0	0.25	0.18	0.04	0.04	3.66	1.28	0.17
R16	311805	358474	0	0.24	0.17	0.04	0.04	3.87	1.36	0.16
R17	311582	358503	0	0.08	0.06	0.02	0.01	3.77	1.32	0.07
R18	312327	358695	0	0.15	0.11	0.03	0.02	3.36	1.18	0.09
R19	312220	358441	0	0.16	0.11	0.03	0.02	3.06	1.07	0.10
		max		**1.08**	**0.75**	**0.18**	**0.15**	**13.52**	**4.73**	**0.62**
Leisure										
R10	311904	359136	0	0.71	0.49	0.12	0.10	7.74	2.71	0.35
R11	311543	358868	0	0.15	0.11	0.04	0.04	12.90	4.52	0.19
		max		**0.71**	**0.49**	**0.12**	**0.10**	**12.90**	**4.52**	**0.35**

Notes:

1 assumes 100% modelled NO_x to NO_2 conversion

2 assumes 70% modelled NO_x to NO_2 conversion

3 assumes 35% modelled NO_x to NO_2 conversion

Scenario B2

Receptor name	X(m)	Y(m)	Z(m)	Long-term				Short-term		
				NO_2[1]	NO_2[2]	PM_{10}	$PM_{2.5}$	NO_2[1]	NO_2[3]	PM10
				µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
				annual mean	annual mean	annual mean	annual mean	99.79%ile of hourly means	99.79%ile of hourly means	90.41%ile of daily means
Residential, schools etc										
R1	311576	358668	0	0.29	0.20	0.07	0.06	11.60	4.06	0.29
R2	311673	358718	0	0.88	0.62	0.22	0.18	15.51	5.43	0.89
R3	311731	358743	0	1.37	0.96	0.28	0.23	17.33	6.07	1.04
R4	311741	358816	0	1.95	1.37	0.36	0.29	23.24	8.13	1.30
R5	311799	358892	0	1.97	1.38	0.35	0.29	25.19	8.82	1.16
R6	311886	358937	0	1.33	0.93	0.22	0.18	19.27	6.75	0.80
R7	311195	358842	0	0.14	0.09	0.03	0.02	7.86	2.75	0.10
R8	311523	358589	0	0.15	0.11	0.03	0.03	8.55	2.99	0.14
R9	311112	359186	0	0.80	0.56	0.19	0.15	10.72	3.75	0.48
R12	311221	359538	0	0.54	0.38	0.13	0.10	8.61	3.01	0.36
R13	311222	359578	0	0.53	0.37	0.13	0.10	7.96	2.79	0.36
R14	311148	359589	0	0.48	0.34	0.11	0.09	7.59	2.66	0.32
R15	311921	358457	0	0.49	0.34	0.09	0.07	7.37	2.58	0.34
R16	311805	358474	0	0.49	0.34	0.10	0.08	7.66	2.68	0.36
R17	311582	358503	0	0.18	0.13	0.04	0.03	7.45	2.61	0.17
R18	312327	358695	0	0.29	0.20	0.05	0.04	6.10	2.14	0.17
R19	312220	358441	0	0.30	0.21	0.06	0.05	6.09	2.13	0.20
		max		**1.97**	**1.38**	**0.36**	**0.29**	**25.19**	**8.82**	**1.30**
R10	311904	359136	0	1.35	0.94	0.24	0.19	15.34	5.37	0.70
R11	311543	358868	0	0.34	0.24	0.11	0.09	23.82	8.34	0.48
		max		**1.35**	**0.94**	**0.24**	**0.19**	**23.82**	**8.34**	**0.70**

Notes:
1 assumes 100% modelled NO_x to NO_2 conversion
2 assumes 70% modelled NO_x to NO_2 conversion
3 assumes 35% modelled NO_x to NO_2 conversion

Scenario B2-A2

Receptor name	Long-term				Short-term		
	NO_2[1]	**NO_2[2]**	**PM_{10}**	**$PM_{2.5}$**	**NO_2[1]**	**NO_2[3]**	**PM10**
	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$
	annual mean	annual mean	annual mean	annual mean	99.79%ile of hourly means	99.79%ile of hourly means	90.41%ile of daily means
Residential, schools etc							
R1	0.16	0.11	0.04	0.03	5.57	1.95	0.17
R2	0.47	0.33	0.13	0.11	7.37	2.58	0.56
R3	0.68	0.47	0.16	0.13	8.20	2.87	0.58
R4	0.90	0.63	0.19	0.15	11.07	3.87	0.68
R5	0.89	0.63	0.17	0.14	11.67	4.08	0.57
R6	0.62	0.43	0.10	0.09	8.66	3.03	0.39
R7	0.07	0.05	0.02	0.01	3.99	1.40	0.05
R8	0.08	0.06	0.02	0.02	4.23	1.48	0.08
R9	0.40	0.28	0.10	0.08	5.30	1.86	0.25
R12	0.27	0.19	0.06	0.05	4.34	1.52	0.17
R13	0.26	0.18	0.06	0.05	3.82	1.34	0.17
R14	0.24	0.17	0.05	0.04	3.77	1.32	0.15
R15	0.24	0.17	0.05	0.04	3.71	1.30	0.18
R16	0.25	0.17	0.05	0.04	3.78	1.32	0.20
R17	0.10	0.07	0.02	0.02	3.68	1.29	0.10
R18	0.14	0.10	0.02	0.02	2.74	0.96	0.08
R19	0.15	0.10	0.03	0.02	3.03	1.06	0.10
max	**0.90**	**0.63**	**0.19**	**0.15**	**11.67**	**4.08**	**0.68**
R10	0.64	0.45	0.12	0.10	7.60	2.66	0.35
R11	0.19	0.13	0.07	0.05	10.92	3.82	0.28
max	**0.64**	**0.45**	**0.12**	**0.10**	**10.92**	**3.82**	**0.35**

Notes:
1 assumes 100% modelled NO_x to NO_2 conversion
2 assumes 70% modelled NO_x to NO_2 conversion
3 assumes 35% modelled NO_x to NO_2 conversion

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Maximum Predicted process Contributions within Modelled Domain

Maximums across 5 years modelled met data

Scenario A2						**Scenario B2**				**Scenario B2-A2**			
Pollutant	**Averaging Period**	**Max PC**	**AQAL**	**Notes**	**Max as % AQAL**	**Max PC**	**AQAL**	**Notes**	**Max as % AQAL**	**Max PC**	**AQAL**	**Notes**	**Max as % AQAL**
Long-Term Concentrations													
NO_2[1]	annual mean (1 hr)	2.61	40	as 100% NOx	7	5.06	40	as 100% NOx	13	2.45	40	as 100% NOx	6
NO_2[2]	annual mean (1 hr)	1.83	40	as 70% NOx	5	3.54	40	as 70% NOx	9	1.71	40	as 70% NOx	4
PM_{10}	annual mean (1 hr)	2.33	40		6	2.90	40		7	0.57	40		1
$PM_{2.5}$	annual mean (1 hr)	1.76	25		7	2.18	25		9	0.43	25		2
Short-Term Concentrations										*0.00*			
NO_2[1]	99.79th %ile of hourly means	31.89	200	as 100% NOx	16	62.29	200	as 100% NOx	31	30.40	200	as 100% NOx	15
NO_2[3]	99.79th %ile of hourly means	11.16	200	as 35% NOx	6	21.80	200	as 35% NOx	11	10.64	200	as 35% NOx	5
PM10	90.41th %ile of 24 hr means	3.32	50		7	4.99	50		10	1.67	50		3

All concentrations µg/m^3 unless stated otherwise

Notes: Highlighted cells indicate pollutants where maximum predicted process contribution within the modelled domain are less than screening threshold and no further assessment required; where:

long-term screening threshold; PC <1% AQAL

short-term screening threshold; PC ≤ 10% AQAL

R2298D Ruthin

Maximum Predicted Process Contributions with Modelled Domain

Maximums across 5 years modelled met data

Scenario A1

Receptor name	X(m)	Y(m)	Z(m)	Long-term NO_2[1]	NO_2[2]	PM_{10}	PM_{10}[4]	$PM_{2.5}$	$PM_{2.5}$[5]	Short-term NO_2[1]	NO_2[3]	PM10	PM_{10}[4]
				$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$
				annual mean	annual mean	annual mean	annual mean	annual mean	annual mean	99.79%ile of hourly means	99.79%ile of hourly means	90.41%ile of daily means	90.41%ile of daily means
Residential, schools etc													
R1	311576	358668		0.37	0.26	0.24	0.12	0.24	0.06	17.83	7.76	7.58	3.79
R2	311673	358718		1.20	0.84	0.69	0.34	0.69	0.17	23.87	8.21	7.69	3.85
R3	311731	358743		2.01	1.40	0.97	0.48	0.97	0.24	26.56	8.49	7.76	3.88
R4	311741	358816		3.03	2.12	1.38	0.69	1.38	0.34	35.69	8.90	7.86	3.93
R5	311799	358892		3.12	2.18	1.41	0.71	1.41	0.35	39.58	8.93	7.87	3.94
R6	311886	358937		2.11	1.48	0.91	0.45	0.91	0.23	30.87	8.43	7.75	3.87
R7	311195	358842		0.19	0.14	0.10	0.05	0.10	0.03	11.48	7.62	7.55	3.77
R8	311523	358589		0.21	0.14	0.12	0.06	0.12	0.03	12.37	7.64	7.55	3.77
R9	311112	359186		1.05	0.74	0.73	0.36	0.73	0.18	14.94	8.27	7.72	3.86
R12	311221	359538		0.75	0.53	0.58	0.29	0.58	0.15	11.85	8.12	7.69	3.84
R13	311222	359578		0.72	0.51	0.57	0.28	0.57	0.14	11.43	8.11	7.68	3.84
R14	311148	359589		0.68	0.47	0.49	0.24	0.49	0.12	10.55	8.03	7.66	3.83
R15	311921	358457		0.74	0.52	0.32	0.16	0.32	0.08	10.76	7.84	7.60	3.80
R16	311805	358474		0.71	0.49	0.33	0.16	0.33	0.08	11.15	7.85	7.60	3.80
R17	311582	358503		0.24	0.17	0.14	0.07	0.14	0.03	10.94	7.66	7.55	3.78
R18	312327	358695		0.44	0.31	0.20	0.10	0.20	0.05	9.35	7.89	7.74	3.87
R19	312220	358441		0.45	0.31	0.22	0.11	0.22	0.05	8.39	7.91	7.74	3.87
			max	**3.12**	**2.18**	**1.41**	**0.71**	**1.41**	**0.35**	**39.58**	**8.93**	**7.87**	**3.94**
Leisure													
R10	311904	359136		2.08	1.46	0.94	0.47	0.94	0.23	22.42	8.48		0.00
R11	311543	358868		0.43	0.30	0.43	0.21	0.43	0.11	37.81	7.95		0.00
			max	**2.08**	**1.46**	**0.94**	**0.47**	**0.94**	**0.23**	**37.81**	**8.48**	**0.00**	
			overall ma	**3.12**	**2.18**	**1.41**	**0.71**	**1.41**	**0.35**	**39.58**	**8.93**	**7.87**	

Scenario B1

	Long-term NO_2[1]	NO_2[2]	PM_{10}	PM_{10}[4]	$PM_{2.5}$	$PM_{2.5}$[5]	Short-term NO_2[1]	NO_2[3]	PM10	PM_{10}[4]
	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$
	annual mean	annual mean	annual mean	annual mean	annual mean	annual mean	99.79%ile of hourly means	99.79%ile of hourly means	90.41%ile of daily means	90.41%ile of daily means
Residential, schools etc										
R1	0.83	0.58	0.79	0.40	0.79	0.20	33.82	11.84	3.46	1.73
R2	2.56	1.79	2.47	1.24	2.47	0.62	45.15	15.80	9.81	4.91
R3	3.96	2.78	3.20	1.60	3.20	0.80	49.97	17.49	11.85	5.92
R4	5.60	3.92	4.07	2.04	4.07	1.02	66.45	23.26	14.75	7.38
R5	5.69	3.98	3.94	1.97	3.94	0.98	73.48	25.72	13.48	6.74
R6	3.91	2.74	2.58	1.29	2.58	0.65	56.91	19.92	9.56	4.78
R7	0.39	0.27	0.32	0.16	0.32	0.08	22.96	8.04	1.15	0.57
R8	0.45	0.31	0.39	0.19	0.39	0.10	24.47	8.57	1.68	0.84
R9	2.14	1.50	1.87	0.93	1.87	0.47	28.77	10.07	5.04	2.52
R12	1.52	1.06	1.28	0.64	1.28	0.32	23.00	8.05	3.75	1.87
R13	1.43	1.00	1.24	0.62	1.24	0.31	21.80	7.63	3.71	1.85
R14	1.36	0.95	1.11	0.55	1.11	0.28	21.16	7.41	3.22	1.61
R15	1.44	1.01	1.03	0.51	1.03	0.26	20.88	7.31	3.68	1.84
R16	1.43	1.00	1.10	0.55	1.10	0.28	21.98	7.69	4.11	2.06
R17	0.53	0.37	0.45	0.23	0.45	0.11	21.60	7.56	1.98	0.99
R18	0.85	0.60	0.58	0.29	0.58	0.15	17.76	6.21	2.02	1.01
R19	0.88	0.61	0.64	0.32	0.64	0.16	16.42	5.75	2.27	1.14
	5.69	**3.98**	**4.07**	**2.04**	**4.07**	**1.02**	**73.48**	**25.72**	**14.75**	**7.38**
Leisure										
R10	3.97	2.78	2.78	1.39	2.78	0.69	44.43	15.55	8.21	4.11
R11	0.94	0.66	1.18	0.59	1.18	0.29	68.52	23.98	5.06	2.53
	3.97	**2.78**	**2.78**	**1.39**	**2.78**	**0.69**	**68.52**	**23.98**	**8.21**	**4.11**
	5.69	**3.98**	**4.07**	**2.04**	**4.07**	**1.02**	**73.48**	**25.72**	**14.75**	**7.38**

Notes:
1 assumes 100% modelled NO_x to NO_2 conversion
2 assumes 70% modelled NO_x to NO_2 conversion
3 assumes 35% modelled NO_x to NO_2 conversion
4 assumes 50% of modelled emissoins
5 assumes 25% of modelled emissoins

Scenario B1-A1										
	Long-term						Short-term			
	NO_2[1]	NO_2[2]	PM_{10}	PM_{10}[4]	$PM_{2.5}$	$PM_{2.5}$[5]	NO_2[1]	NO_2[3]	PM10	PM_{10}[4]
	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³	μg/m³
	annual mean	annual mean	annual mean	annual mean	annual mean	annual mean	99.79%ile of hourly means	99.79%ile of hourly means	90.41%ile of daily means	90.41%ile of daily means
Residential, schools etc										
R1	0.46	0.32	0.55	0.28	0.55	0.14	15.99	5.60	2.45	1.22
R2	1.37	0.96	1.78	0.89	1.78	0.45	21.28	7.45	7.05	3.52
R3	1.96	1.37	2.24	1.12	2.24	0.56	23.41	8.20	8.18	4.09
R4	2.57	1.80	2.69	1.35	2.69	0.67	30.76	10.77	9.82	4.91
R5	2.57	1.80	2.53	1.26	2.53	0.63	33.90	11.86	8.85	4.42
R6	1.80	1.26	1.67	0.84	1.67	0.42	26.04	9.12	6.34	3.17
R7	0.20	0.14	0.21	0.11	0.21	0.05	11.48	4.02	0.74	0.37
R8	0.24	0.17	0.27	0.13	0.27	0.07	12.10	4.23	1.19	0.60
R9	1.09	0.76	1.14	0.57	1.14	0.28	13.83	4.84	3.15	1.57
R12	0.76	0.53	0.69	0.35	0.69	0.17	11.16	3.90	2.10	1.05
R13	0.71	0.50	0.67	0.34	0.67	0.17	10.38	3.63	2.08	1.04
R14	0.68	0.48	0.62	0.31	0.62	0.16	10.62	3.72	1.83	0.92
R15	0.70	0.49	0.70	0.35	0.70	0.18	10.12	3.54	2.43	1.22
R16	0.72	0.50	0.77	0.39	0.77	0.19	10.83	3.79	2.88	1.44
R17	0.28	0.20	0.32	0.16	0.32	0.08	10.66	3.73	1.42	0.71
R18	0.41	0.29	0.38	0.19	0.38	0.10	8.41	2.94	1.36	0.68
R19	0.43	0.30	0.42	0.21	0.42	0.10	8.02	2.81	1.49	0.74
	2.57	**1.80**	**2.69**	**1.35**	**2.69**	**0.67**	**33.90**	**11.86**	**9.82**	**4.91**
Leisure										
R10	1.89	1.32	1.84	0.92	1.84	0.46	22.01	7.70	5.45	2.73
R11	0.51	0.36	0.75	0.37	0.75	0.19	30.71	10.75	3.19	1.59
	1.89	**1.32**	**1.84**	**0.92**	**1.84**	**0.46**	**30.71**	**10.75**	**5.45**	**2.73**
	2.57	**1.80**	**2.69**	**1.35**	**2.69**	**0.67**	**33.90**	**11.86**	**9.82**	**4.91**

Wood Drying Facility and Associated CHP Plant, Brickfields Lane, Ruthin

Air Quality Assessment: Addendum

Provision of Additional Information in Support of Application to Vary Environmental Permit: Ref: PAN-005141

1. Introduction and Background

1.1. Newbridge Energy Limited (NEL) was recently granted an Environmental Permit (PAN-005141) by Natural Resources Wales (NRW) under the Environmental Permitting (England and Wales) Regulations 2016, as amended ('EPR').

1.2. Smith Grant LLP (SGP) is preparing an application to NRW to vary the existing Permit. The variation application is to be supported by an Air Quality Assessment (AQA) prepared by SGP[1] and included within the application supporting documentation[2].

1.3. During determination of the application for the existing Permit NRW requested additional information in relation to the AQA and assessment of potential impacts at nature conservation sites. SGP accordingly prepared two Addendums to provide the additional requested information[3]. The submitted Addendum presented information in relation to potential impacts of the existing CHP stack emissions on identified nature conservation sites.

1.4. The Addendum has now been revised in order to provide further information on the assessment of potential impacts at nature conservation sites in relation to the variation application. This considers the additional potential impacts associated with the proposed additional CHP stack and associated emissions. This Addendum should be read in conjunction with the original assessment[1].

2. Nature Conservation Sites: Screening Assessment

2.1. Identified Sites

2.1.1. The original AQA included identification of any international statutory designated sites (such as SPAs, SACs and Ramsar sites) within a 5km of the installation and national / local designated

[1] Additional Wood Drying Facility and Associated CHP Plant, Blazer's Fuels, Ruthin, Air Quality Assessment for Axis / Newbridge Energy Ltd, R2298D-R02-v4; July 2018, prepared by Smith Grant LLP
[2] CHP Plant, Blazers Fuels, Ruthin; Environmental Permit Variation Application Supporting Information Documentation, R2298E-R03-v1; Appendix F, February 2020, prepared by Smith Grant LLP
[3] Wood Drying Facility and Associated CHP Plant, Brickfields Lane, Ruthin, Air Quality Assessment: Addendum, Provision of Further Additional Information in Support of Environmental Permit Application: Ref: PAN-005141, R2298D-R05-v1; 12th November 2019, prepared by Smith Grant LLP

sites (such as SSIs, and local nature sites (ancient woods, local wildlife site and national and local nature reserves) within 2km. The sites identified within these search radii were subject to assessment as deemed relevant and detailed in the AQA.

2.1.2. NRW additionally requires consideration of international designated sites up to 10km of the installation. Information on such sites within a 5km to 10km radius of the installation, as obtained from the MAGIC website (www.magic.defra.gov.uk), is therefore provided below:

Table 2.1: International Designated Sites within 5-10km of installation

Description	Designation[1]	MAGIC / APIS Reference	Distance / Orientation from Site Boundary[2]
Llwyn	SAC	UK0030185	8.8km NW
Alyn Valley Woods	SAC	UK0030078	7.5 km NE

1: SPA – Special Protection Area; SAC – Special Area of Conservation

2: Distance & orientation of nearest point of nature conservation site to Site

2.1.3. During the original permit application the APIS website (www.apis.ac.uk) was initially referred to to determine the sensitivity of these sites to ambient NO_x, nitrification and acidification to inform the need for further assessment and was summarised in the original Addendum. Additional information on habitat sensitivity to nitrification at these sites was subsequently to SGP by NRW[4] which differed to the information provided on the APIS website. Full details are provided in Appendix A; it is noted that at the time of preparing this revised addendum the NRW and APIS information still differ.

2.1.4. The following assessment has therefore been undertaken based on the additional information provided by NRW that supplements the APIS information.

3. Nature Conservation Sites: Detailed Assessment

3.1. Methodology

3.1.1. The ADMS 5 model has been used to assess the potential impacts of ambient NO_x, nitrification and acidification on the designated sites detailed above. The model previously used for the original AQA has been re-run for a single year of meteorological data (2015) with the inclusion of specific modelled receptor points within the designated sites as follows:

[4] E-mail from Andy Collins, Permitting Consultant, NRW, ref: PAN-005141, dated 6th November 2019

Table 3.1: Modelled Receptor Points

ref	name	type	X (m)	Y (m)	distance (km) & orientation
E1	Llwyn SAC	ecological	308403	363827	8.8km NW
E2	Alyn Valley Woods SAC	ecological	318174	362477	7.5km ENE
E3		ecological	317734	364887	8.5km NE

3.1.2. These points represent the closest parts of these sites to the facility. The model has used the NO_x emission rates as per the original AQA to calculate ambient NO_x and annual dry deposition fluxes of NO_2 at these receptor points. The original AQA referred to both OEM and monitored data for both the existing plant and a proposed new plant; for this assessment reference has been made initially to the OEM data for the existing and proposed plants to which the Environmental Permit variation application applies. All other model set-up parameters have also been retained as previously.

3.1.3. Deposition velocities are based on those provided in EA guidance[2]:

Table 3.2: Pollutant Dry Deposition Velocities

Pollutant	EA Recommended Deposition Velocity (m/s)	
	grassland	woodland
NO_2	0.0015	0.003

3.1.4. The results are compared to the appropriate Critical Levels (in relation to ambient NO_x) and Critical Loads (in relation to nitrification and acidification) relevant to the sites as detailed in Appendix A.

3.1.5. The assessment is undertaken through reference to appropriate EA guidance which provides for the following screening thresholds with regards to nature conservation sites and pollutant contributions to indicate whether impacts will have likely significant effects and the need for further detailed assessment:

Table 3.3: Assessment Criteria for Nature Conservation Receptors

European Sites and SSSIs
$PC_{long\text{-}term}$ is *insignificant* where less than 1% of relevant Critical Level / Load $PC_{short\text{-}term}$ is *insignificant* where less than 10% of relevant Critical Level / Load $PEC_{long\text{-}term}$ will result in *no likely significant effect* where less than 70% of relevant Critical Level / Load
Local Nature Sites (NNRs, LNRs, LWSs and Ancient Woodland)
$PC_{long\text{-}term}$ is *insignificant* where less than 100% of relevant Critical Level / Load $PC_{short\text{-}term}$ is *insignificant* where less than 100% of relevant Critical Level / Load

PC = Process Contribution; PEC = Predicted Environmental Concentration

3.1.6. Where the $PC_{long-term}$ and $PC_{short-term}$ are less than the screening thresholds, no further assessment is necessary. Where necessary further assessment is undertaken considering background concentrations. Further guidance on such assessment is provided by internal EA guidance[5, 6, 7, 8]. Where the resulting $PEC_{long-term}$ is less than 70% of the relevant Critical Level / Load then it can be concluded there is no likely significant effect. This internal guidance is primarily aimed at undertaking 'appropriate assessments' as required under the Habitats Directive, but the principals are also applied to other nature conservation sites under the Environmental Permitting regime.

3.2. Critical Level Results and Assessment

3.2.1. The assessment has initially considered the combined PCs arising from both the existing and the proposed stack emissions. The combined predicted PCs at the modelled receptor points are:

Table 3.4: NO_x Critical Levels Assessment: Combined PCs from existing and proposed plants

receptor	averaging period	AQAL	PC[1]	PC%AQAL	BC	PEC	%AQAL
long-term							
Llwyn (E1)[2]	annual mean	30	0.102	0	*PC insignificant (≤1% AQAL)*		
Alyn Valley Woods (E2)	annual mean	30	0.018	0	*PC insignificant (≤1% AQAL)*		
Alyn Valley Woods (E3)	annual mean	30	0.013	0	*PC insignificant (≤1% AQAL)*		
short-term							
Llwyn (E1)[2]	daily mean (1 hr)	75	1.13	2	*PC insignificant (≤10% AQAL)*		
Alyn Valley Woods (E2)	daily mean (1 hr)	75	0.28	0	*PC insignificant (≤10% AQAL)*		
Alyn Valley Woods (E3)	daily mean (1 hr)	75	0.15	0	*PC insignificant (≤10% AQAL)*		

All concentrations are µg/m³ unless stated otherwise

1: Assumes 100% modelled NO_x
2: APIS states Llwyn SAC is not sensitive to ambient NOx; in light of NRW advice that Llwyn SAC is sensitive to nitrogen deposition to be conservative assessment has also been undertaken for ambient NOx.

3.2.2. The combined long-term and short-term NO_x PCs at the nearest point of Llwyn SAC and Alyn Valley Woods SAC are substantially below the relevant screening thresholds. No further assessment is required.

[5] AQTAQ 06, Environment Agency, Technical Guidance on detailed modelling approach for an appropriate assessment for emissions to air, approved March 2014
[6] Environment Agency: Operational Instruction 66_12 '*Simple assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation'; issued 08/05/12*
[7] Environment Agency: Operational Instruction 67_12 '*Detailed assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation', issued 01/03/12*
[8] AQTAG 21, Environment Agency, 'Likely significant effect' use of 1% and 4% long-term thresholds and 10% short-term threshold

3.3. Critical Loads Results and Assessment

3.3.1. The nutrient nitrogen and acid deposition for the receptor points have been calculated from the modelled deposition flux.

Nutrient Nitrogen

3.3.2. A range of habitat features for nutrient nitrogen deposition are provided by APIS for the statutory conservation sites as detailed in Appendix A. The assessment has therefore referred to the most sensitive habitats and Critical Loads classes deemed relevant to the nature conservation sites to provide a conservative assessment of potential impacts of emissions, as summarised below.

Table 3.5: Nitrogen Deposition – Critical Loads

Site	Status	Feature[1]	Habitat[1]	Critical Load Range (kg/N/ha/y)[2]
Llwyn (E1)[3]	SAC	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)[3]	Carex paniculata woodland, Urtica dioica woodland, Lysimachia nemorum woodland	10-20
			Mercurialis perennis woodland	15-20
Alyn Valley Woods (E2&E3)	SAC	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)[4]	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	10-20
		Tilio-Acerion forests of slopes, screes and ravines	Meso- and eutrophic Quercus woodland	15-20

1: most sensitive habitat feature and Critical Load range noted for the site, where feature is sensitive to nutrient nitrogen impacts on broad habitat; feature may not be present within area of impacts.

2: Critical Loads are dependent on aspects of habitat including the nature of the surface and sensitivity of the habitat to changing deposition rates

3: Llwyn SAC not identified on APIS as having any features sensitive to nitrogen deposition; NRW advises habitat features are sensitive

4: NRW advises differing sensitivities and Critical Loads to APIS at Alyn Valley Woods SAC

3.3.3. The assessment has considered the most sensitive feature within the nature conservation site. As above the assessment has initially considered the combined PCs arising from both the existing and the proposed stack emissions. The predicted nitrogen dry deposition rates due to NO_2 at the modelled receptor points within each site are as follows:

Table 3.6: Nutrient Nitrogen Assessment: Combined PCs from existing and proposed plants

receptor	NO_2-N		%PCs of CL	BC	PEC	% PEC of CL
	dry	as N	% of lowest CL			% of lowest CL
	µg/m²/s	kg/ha/y				
E1	2.14E-04	2.05E-02	0	*PC insignificant; PC≤1% AQAL*		
E2	3.82E-05	3.66E-03	0	*PC insignificant; PC≤1% AQAL*		
E3	2.77E-05	2.66E-03	0	*PC insignificant; PC≤1% AQAL*		

1: Deposition of NO negligible; NO_2 assumed as 70% modelled NO_x values

2: calculated based on conversion factor of 95.9 as provided in AQTAG06

3: where CL is as per Table 3.5

3.3.4. All combined PCs modelled in the closest parts of the nature conservation sites are ≤1% of the most sensitive Critical Load rages and are insignificant irrespective of background concentrations. No further assessment is required.

Acid Deposition

3.3.5. As for nitrogen deposition, a wide range of acid depiction Critical Load information is provided by APIS for the nature conservation sites. The assessment has therefore been undertaken for the relevant acid deposition Critical Loads for the most sensitive habitats:

Table 3.7: Acid Deposition – Critical Loads

Site	Status	Feature[1]	Habitat[2]	Critical Loads (kg/N/ha/y)[2]
Llwyn	SAC	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	not sensitive	n/a
Alyn Valley	SAC	Tilio-Acerion forests of slopes, screes and ravines	Unmanaged Broadleafed/Coniferous Woodland	MinCLminN:0.142 MinCLMaxS:1.721 MinCLmaxN: 1.863

1: most sensitive habitat feature and Critical Load range noted for the site, where feature is sensitive to nutrient nitrogen impacts on broad habitat; feature may not be present within area of impacts.

2: Critical Loads are dependent on aspects of habitat including the nature of the surface and sensitivity of the habitat to changing deposition rates; information presented for minimum Critical Loads

3.3.6. The predicted acid deposition due to nitrogen at the modelled receptor points are as follows:

Table 3.8: Calculated total N acid deposition

	PC[1]		BC[2]	
	total N[3]	total S	N	S
	keq/ha/y			
E1	*habitat not sensitive; no further assessment*			
E2	1.31E-04	n/a	2.20E+00	4.00E-01
E3	9.46E-05	n/a	2.20E+00	4.00E-01

1: Background data provided on APIS for the site of interest; required in use of Critical Load Function Tool

2: Calculated using conversions provided in EA guidance AQTAG06

3: assumes 70% modelled values

3.3.7. As above the assessment has initially considered the combined PCs arising from both the existing and the proposed stack emissions. The Critical Load Function Tool on the APIS website has been used to calculate the exceedances and deposition as a proportion of the Critical Load for acid deposition.

Table 3.9: Results and Exceedances – Acidification

	PC	PEC
	% of lower CL function	% of Lower Critical Load function
E1	*habitat not sensitive; no further assessment*	
E2	0	*PC insignificant; PC≤1% AQAL*
E3	0	*PC insignificant; PC≤1% AQAL*

Notes: calculated using the APIS Critical Load Function Tool

3.3.8. All combined PCs modelled in the closest parts of the nature conservation sites are ≤1% of the most sensitive Critical Load rages and are insignificant irrespective of background concentrations. No further assessment is required

3.4. Summary and Conclusions

3.4.1. In accordance with previous information requests from NRW a review has been undertaken of international nature conservation sites located within 5-10km of the application site. The screening assessment identified the Llwyn SAC and Alyn Valley Woods SAC within the screening radii. Data provided on the APIS website indicates the Alyn Valley Woods SAC is potentially sensitive to ambient NO_x and nitrogen and acid deposition. The Llwyn SAC is not identified on APIS as being sensitive to ambient NO_x, nitrogen deposition or acid deposition. However, NRW has previously advised that habitat features are present at the Llwyn SAC that are sensitive to nitrogen deposition. In, addition, NRW has advised a more sensitive Critical Load for nitrogen deposition should be referred to for the Alyn Valley Woods SAC. This Addendum to the original

2018 AQA has therefore been produced to include additional assessment of potential ambient NO_x and dry deposition rates at the closest parts of these sites to the application site.

3.4.2. The resulting long-term and short-term NO_x concentrations and nitrogen and acid deposition rates resulting from the facility are well below the relevant screening thresholds (≤1% of the relevant Critical Level and Critical Loads). Further assessment is not deemed necessary.

Prepared on behalf of Smith Grant LLP by:

Name:	**Signature:**	**Date:**
K. Hawkins, Partner BSc MSc MIAQM MEnvSci CEnv		14 February 2020

APPENDIX A

Nature Conservation Sites:
Background Information

Appendix A: Summary of International Nature Conservation Sites within 5-10km of Facility and Background Information

Site[1]	Site Interest Feature[2]	Sensitivity / Habitat / Class[2]	Critical Level / Load[2]	Background[2, 3]
Ambient NOx				
Llwyn SAC	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) *[APIS information]*	not sensitive	n/a	n/a
	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) *[NRW information]*	NRW advises is sensitive to nitrogen deposition	annual mean: NOx 30 ug/m3; daily mean: NOx 75 ug/m3	Maximum: 7.47 Minimum: 6.22 Average: 6.96
Alyn Valley Woods SAC	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia)	habitat is sensitive	annual mean: NOx 30 ug/m3; daily mean: NOx 75 ug/m3	Maximum: 7.47 Minimum: 6.22 Average: 6.96
Nitrification				
Llwyn SAC	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) *[APIS information]*	not senstitive	n/a	n/a
	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) *[NRW information]*	Carex paniculata woodland, Urtica dioica woodland, Lysimachia nemorum woodland	10-20 kgN/ha/yr	Maximum: 29 Minimum: 29 Average: 29
		Mercurialis perennis woodland	15-20 kgN/ha/yr	Maximum: 29 Minimum: 29 Average: 29
Alyn Valley Woods SAC	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)		10-20 kgN/ha/yr	Maximum: 31.4 Minimum: 30 Average: 30.3
	Tilio-Acerion forests of slopes, screes and ravines	Meso- and eutrophic Quercus woodland	15-20 N/ha/yr	Maximum: 31.4 Minimum: 30 Average: 30.3
Acidification				
Llwyn SAC	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	not sensitive	n/a	n/a
Alyn Valley Woods SAC	Tilio-Acerion forests of slopes, screes and ravines	Unmanaged Broadleafed/Coniferous Woodland	MinCLminN: 0.142 | MaxCLminN: 0.142 MinCLMaxS: 1.721 | MaxCLMaxS: 6.036 MinCLMaxN: 1.863 | MaxCLMaxN: 6.178	Maximum N|S : 2.2 | 0.4 Minimum N|S: 2.1 | 0.4 Average N|S: 2.2 | 0.4

1: Information obtained from MAGIC website (www.magic.defra.gov.uk) *(14th February 2020)*

2: Information obtained from APIS website (www.apis.ac.uk) and/or NRW *(14th February 2020)*

3: refers to the background for feature of interest across the site

Appendix G

MCP / Generator Checklist

MCP / Generator Checklist

Table A below summarises the information to be provided to the competent authority for each MCP and generator.

MCP Checklist (to be provided for each MCP)	
MCP Specific Identifier	Newbridge Energy Limited 2885
12-digit grid reference	SJ 359022
Rated thermal input (MW) of the MCP	5.2 MW_{th}
Type of MCP (diesel engine, gas turbine, other engine or MCP)	Biomass CHP Plant
Type of fuels used: gas oil (diesel), natural gas, gaseous fuels, other than natural gas	Biomass (virgin wood)
Date when MCP first put into operation	24.11.20
Sector of activity of the MCP or the facility in which it is applied (NACE code)	D.35.11 (Production of Electricity)
Expected number of operating hours of the MCP and average load in use	8,000 hours per annum
Where the option of exemption under Article 6(8) is used the operator (as identified on Form A) should sign a declaration here that the MCP will not be operated more than the number of hours referred to in this paragraph	n/a
Generator Checklist (to be provided for each generator which comprises the Specified Generator) *(excluded generators not to be included)*	
The rated thermal input in MW thermal	5.2 MW_{th}
Details of any capacity agreement(s) or balancing service agreement(s) for each individual generator, for example if they are Tranche A or Tranche B generators	n/a
The total rated thermal input of all generators on site	5.2 MW_{th}
Will the operating hours for each individual Tranche A generator be restricted to 50 hours or less per year?	n/a – not a Tranche A generator
Will the aggregated operating hours for all Tranche A generators be restricted to 50 hours or less per year?	n/a
Will the NOx emissions of any individual Tranche A generator be greater than 500 mg/Nm^3 (STP, 15% O2)	n/a