Emissions Management & Monitoring Plan

University of Liverpool Energy Centres

Report produced for **University of Liverpool Energy Company Limited**

Provided by Walker Resource Management Ltd (WRM)

Document Title	Emissions Management & Monitoring Plan
Revision	v1.0
Date	19/07/2022
Document Reference	EPR-B04 Emissions Management & Monitoring Plan
Project Reference	PR1120/W04
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Reviewer	Martin Ropka

Version No.	Date	Description of change
0.1	20/04/2022	Initial draft
0.2	29/04/2022	Internal review
1.0	19/07/2022	First issue

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1.0 INTRODUCTION

This document sets out plans to manage and monitor emissions associated with three natural gas fired boilers and three natural gas fired combined heat and power (CHP) engines, operated by the University of Liverpool Energy Company Ltd (hereon referred to as ULEC), which provide heat and power to nearby University of Liverpool campus buildings. This plan reviews the potential emissions, management approaches for potential emissions, and the monitoring for emissions. It has been prepared in accordance with the following documents:

- The Environmental Permitting (England and Wales) Regulations 2016
- The Industrial Emissions Directive 2010

The CHP and boilers supply heat and electricity to the main campus buildings of the University of Liverpool. The CHP engines produce electricity via the combustion of gas which in turn generates heat as a by-product. This heat will be harnessed and transferred into useable energy for hot water which is then piped across the campus via plate heat exchangers. The operation of the boilers and CHP plant will follow demand to some extent and as such, the CHP plants will be operating at full load in times of high demand e.g. winter and reduced loads in periods of low demand e.g. summer. One of the boilers runs more often than the others, providing additional heat where required. The remaining two boilers are back-up for use in times of plant failure or in the extreme scenario that more heat is demanded than can be provided by the CHP engines and other boiler. Energy Centre 1 (NEC 1) is the most southerly of the two Energy Centres and houses the CHP engine which has a net thermal input rating of 11MW and the three boilers. This Energy Centre is a modern purpose-built building. The CHP engine and boiler plant in this building emit their exhaust gases through individual chimney stacks that are 48m high. Energy Centre 2 (NEC 2) houses the two CHP engines with net thermal input ratings of 4.5MW. This Energy Centre is a former boiler house. Each appliance in this building emits their exhaust gases through individual chimney stacks that are 29m high.

The natural gas which is combusted in the boilers will be piped directly onto site from three gas mains via gas boosters.

2.0 EMISSIONS ASSESSMENT & MANAGEMENT

The technological details of the boilers and CHPs are presented in Table 1 and Table 2 below.

Table 1 – Danstoker fired boiler

Boiler Technical Information	
Make	Danstoker
Model	TVB-H-15-Combination/TVB-H-15
Max. Rate of Fuel Consumption	12,535 kwh/hr (Boiler 1) 56 kwh/hr (Boilers 2 and 3)
Control System	Rationtronic 6000 burner controller
Variable Heat Load	0-13MW (Boiler 1). 0-12MW (Boilers 2 and 3)
Stack Height	29m (NEC 1), 46m (NEC 2)

Table 2 - Jenbacher engine technical information

EngineTechnical Information	
Make	GE Jenbacher
Model	GE Jenbacher reciprocating engine - JMS-620
Heat Efficiency	44.56
Power Efficiency	27.61
Max. Rate of Fuel Consumption	8,536 kwh/hr
Control System	Jenbacher DIANE XT controller
Variable Heat Load	Up to 3.5MW
Stack Height	29m (NEC 1)

Table 3 - Edina engine technical information

EngineTechnical Information	
Make	Edina
Model	GS-N.I/ Edina reciprocating engine - 2020-E20
Heat Efficiency	44.56
Power Efficiency	27.61
Max. Rate of Fuel Consumption	5,297 kwh/hr (CHP2) 5,428 kwh/hr (CHP3)
Control System	TEM related with COMAP
Variable Heat Load	Up to 2MW
Stack Height	46m (NEC 2)

2.1 Point Source Emissions

Table 4 below details the Environmental Risk Assessment for point source emissions resulting from the CHPs and boilers at the University of Liverpool Energy Centre (taken from the *UoL3_Environmental_Risk_Assessment*). The Risk Assessment identifies possible emissions arising from the boilers and CHPs directly, such as via the chimney stack. For the purpose of this risk assessment, it is the cumulative emissions from three boilers combined and the three CHPS that are assessed. The magnitude of each risk is reviewed, and risk management activity is detailed, resulting in an assessment of residual risk rating.

Pollutant Model			Judgement				Action	
Source	Pathway	Receptor	P	C	M	Justification of Magnitude	Risk Management	Residual Risk
Emissions – Air pollutants	Aerial dispersion	Staff, local residents.	Med	Med	Med	Med – results from combustion of natural gas. Each boiler has measures in place to limit release of NOx. Incomplete combustion causes risk of elevated emissions (eg. during start-up and shut down). CHP has Selective Catalytic Reduction (SCR) which is automatically controlled and monitored.	• Each boiler and stack shall be associated with written maintenance schedule and in accordance with the manufacturer's instructions. The boiler shall be serviced annually by a trained service engineer. • Detailed air quality monitoring has been undertaken as part of this permit application. The results can be seen in the air quality impact assessment submitted as part of this application. • The boiler and stack shall be associated with written maintenance schedule and in accordance with the manufacturer's instructions. The boiler shall be serviced annually by a trained service engineer. • Staff operating and maintaining the boiler shall receive appropriate training and instructions from the boiler manufacturer. • Staff shall be aware of how to identify and mitigate elevated or abnormal pollution emissions. • The pipes through which the fuel is transported to site shall be maintained to prevent the escape of unburnt natural gas. • Good quality feedwater to ensure impurities do not lead to sediment or corrosion, thereby reducing boiler efficiency.	Low

Pollutant Model			Judgement				Action	
Source	Pathway	Receptor	P	C	M	Justification of Magnitude	Risk Management	Residual Risk
							• The boiler stack height shall be sufficient to prevent emissions influencing ground-level air pollution concentrations.	
Emissions from boiler - dust	Aerial dispersion	Staff, local residents.	Low	Low	Low	Low – The boilers are fuelled by natural gas which contains trace amounts of particulates.	• Continuing use of natural gas as fuel. • Regular servicing of the boilers by a trained operative as per the manufacturer's instructions.	Low
Emissions from boiler – NO_x	Aerial dispersion	Staff and local residents	Med	Med	Med	Med – There is potential for workers to be regularly exposed to NOx. The energy from waste plant has an emission rate of 0.2397g/s for for NOx.	• Fuel/air mix will be set up at installation to ensure boiler operates efficiently and does not regularly cycle on and off. • NOx emissions shall be controlled engine control system. • Thermal store charged and discharged to allow boilers to operate continuously. • Regular servicing of the boilers by a trained operative as per the manufacturer's instructions. • An advanced combustion control system to minimise NOx production. • Appropriate stack height to allow for dispersion.	Low
Emissions from boiler – CO	Aerial dispersion	Staff and local residents	Low	Low	Low	Low – The biomass boiler on site operates efficiently.	• The boiler and stack shall be associated with written maintenance schedule and in accordance with the manufacturer's instructions. The boiler shall be serviced annually by a trained service engineer.	Low

Pollutant Model			Judgement				Action	
Source	Pathway	Receptor	P	C	M	Justification of Magnitude	Risk Management	Residual Risk
							• Thermal store charged and discharged to allow boilers to operate continuously. • Gas warning device which continuously monitors the radiated air in the engine room and warns against gases which are hazardous. • Appropriate stack height to allow for dispersion.	
Emissions from boilers – SO_2	Aerial dispersion	Staff, local residents.	Low	Low	Low	Low - The CHP operates efficiently. Low - The boilers are fuelled by natural gas which contains trace amounts of Thermal store charged and discharged to allow boilers to operate continuously.	• Regular servicing of the energy from waste system by a trained operative as per the manufacturer's instructions. • The CHP shall be associated with a written maintenance schedule in accordance with the manufacturer's instructions. The CHP shall be serviced annually by a trained service engineer. • Thermal store charged and discharged to allow boilers to operate continuously.	Low

Pollutant Model			Judgement				Action	
Source	**Pathway**	**Receptor**	**P**	**C**	**M**	**Justification of Magnitude**	**Risk Management**	**Residual Risk**
Emissions – Air pollutants.	Aerial dispersion.	Staff, local residents and nearby protected sites.	Med	Med	Med	Med – results from combustion of natural gas. Each boiler has measures in place to limit release of NOx. The boilers have been converted to low-NOx burners. Incomplete combustion causes risk of elevated emissions (eg. during start-up and shut down). CHPs have engine management/control systems which control the temperatures of the cylinders which in turn	• Each appliance and stack shall be associated with a written maintenance schedule and operated in accordance with the manufacturer's instructions. The appliances shall be serviced annually by a trained service engineer. • Detailed air quality monitoring has been undertaken as part of this permit application. The results can be seen in the air quality impact assessment submitted as part of this application. • Staff operating and maintaining the boiler shall receive appropriate training and instructions from the boiler manufacturer. • Staff shall be aware of how to identify and mitigate elevated or abnormal pollution emissions. • The pipes through which the fuel is transported to site shall be maintained to prevent the escape of unburnt natural gas.	Low

Pollutant Model			Judgement				Action	
Source	Pathway	Receptor	P	C	M	Justification of Magnitude	Risk Management	Residual Risk
						controls the NOx emissions.	• Good quality feedwater to ensure impurities do not lead to sediment or corrosion, thereby reducing boiler efficiency. • The appliance stack heights are sufficient to prevent emissions influencing ground-level air pollution concentrations.	

Pollutant Model			Judgement				Action	
Source	**Pathway**	**Receptor**	**P**	**C**	**M**	**Justification of Magnitude**	**Risk Management**	**Residual Risk**
Emissions from boilers - dust	Aerial dispersion	Staff, local residents and nearby protected sites.	Low	Low	Low	Low – The boilers are fuelled by natural gas which contains trace amounts of particulates.	• Continuing use of natural gas as fuel. • Regular servicing of the appliances by a trained operative as per the manufacturer's instructions.	Low

Pollutant Model			Judgement				Action	
Source	**Pathway**	**Receptor**	**P**	**C**	**M**	**Justification of Magnitude**	**Risk Management**	**Residual Risk**
Emissions from boilers – NO_x	Aerial dispersion	Staff, local residents and nearby protected sites.	Med	Med	Med	Med – There is potential for workers to be regularly exposed to NOx.	• Fuel/air mix will be set up at installation to ensure boiler operates efficiently and does not regularly cycle on and off. • Boilers utilise Rationtronic 6000 burner controller which continually samples products of combustion and trims the burner as required. • Boilers have already been converted to low-NOx burners. • Boilers only operate at periods of high demand or as required when CHPs are not operational. • Regular servicing of the boilers by a trained operative as per the manufacturer's instructions. • Appropriate stack height to allow for dispersion.	Low

Pollutant Model			Judgement				Action	
Source	**Pathway**	**Receptor**	**P**	**C**	**M**	**Justification of Magnitude**	**Risk Management**	**Residual Risk**
Emissions from boilers – CO	Aerial dispersion	Staff, local residents and nearby protected sites.	Low	Low	Low	Low – The boiler operate efficiently.	• The boiler and stack are associated with a written maintenance schedule and in accordance with the manufacturer's instructions. The boiler shall be serviced annually by a trained service engineer. • Fuel/air mix will be set up at installation to ensure boiler operates efficiently and does not regularly cycle on and off. • Boilers utilise Rationtronic 6000 burner controller which continually samples products of combustion and trims the burner as required. • Boilers only operate at periods of high demand or as required when CHPs are not operational. • Appropriate stack height to allow for dispersion.	Low

Pollutant Model			Judgement				Action	
Source	**Pathway**	**Receptor**	**P**	**C**	**M**	**Justification of Magnitude**	**Risk Management**	**Residual Risk**
Emissions from boilers– SO_2	Aerial dispersion	Staff, local residents and nearby protected sites.	Low	Low	Low	Low - The boilers are fuelled by natural gas which contains trace amounts of sulphur.	• The boiler and stack are associated with a written maintenance schedule and in accordance with the manufacturer's instructions. The boiler shall be serviced annually by a trained service engineer. • Fuel/air mix will be set up at installation to ensure boiler operates efficiently and does not regularly cycle on and off. • Boilers utilise Rationtronic 6000 burner controller which continually samples products of combustion and trims the burner as required. • Boilers only operate at periods of high demand or as required when CHPs are not operational. • Appropriate stack height to allow for dispersion.	Low
Emissions from CHPs – NO_x	Aerial dispersion	Staff, local residents and nearby protected sites.	Med	Med	Med	Med – There is potential for workers to be regularly exposed to NOx.	• NOx emissions from engines controlled by engine management system which controls the temperatures of the cylinders which in turn control the NOx emissions.	Low

Pollutant Model			Judgement				Action	
Source	Pathway	Receptor	P	C	M	Justification of Magnitude	Risk Management	Residual Risk
							• This control system notifies the operators on site in the event of a fault or out of range values and shuts the appliance down. • The CHP and stack are associated with a written maintenance schedule and in accordance with the manufacturer's instructions. The boiler shall be serviced annually by a trained service engineer.	
Emissions from CHPs – CO	Aerial dispersion	Staff, local residents and nearby protected sites.	Low	Low	Low	Low – The CHPs operate efficiently.	• CO emissions from engines controlled by engine management system which controls the temperatures of the cylinders • This control system notifies the operators on site in the event of a fault or out of range values and shuts the appliance down. • The CHP and stack are associated with a written maintenance schedule and in accordance with the manufacturer's instructions. The boiler shall be serviced annually by a trained service engineer.	Low
P = Possibility C = Consequence M = Magnitude								

The point source emission Environmental Risk Assessment identifies three possible sources of Medium-magnitude risks:

- Emissions – Air Pollutants
- Emissions from boilers – NOx
- Emissions from CHPs – NOx

Risk abatement actions have been identified for the three sources detailed. With these mitigation measures in place the residual risk ratings for both sources are reduced to Low risk.

The point source emission Environmental Risk Assessment identifies three possible sources of Low-magnitude risks:

- Emissions from boiler - dust
- Emissions from boilers – SO2
- Emissions from boilers – CO
- Emissions from CHPs – CO

Risk abatement actions have been identified to ensure that these sources of emissions remain at Low Risk.

2.2 Fugitive Emissions

No risk of fugitive emissions has been identified.

2.3 Potential Environmental Impacts

An air quality impact assessment (AQIA) has been conducted to model the potential impacts of emissions from the Energy Centres. See accompanying document: *EPR-A03 Air Quality Impact Assessment.*

3.0 MONITORING

The following approach is detailed for emissions monitoring based on the Industrial Emissions Directive (2010).

3.1 Point Source Emissions Monitoring

A monitoring schedule for point source emissions has been developed in accordance with Part 2 of Annex V of the Industrial Emissions Directive. Tables 4 and 5 detail the monitoring approach for the boilers and CHPs respectively.

Table 4 - Point source emissions monitoring plan for the boilers

Substance	Emission Limit Value (expressed at 273.15K, 101.3kPa, Dry and at 3% O2)	Monitoring Type	Monitoring Frequency
Sulphur Dioxide (SO_2)	35 mg/m^3	Periodic	6-monthly
Oxides of Nitrogen (NOx)	100 mg/m^3	Periodic	6-monthly
Carbon Monoxide	100 mg/m^3	Periodic	6-monthly
Dust	5 mg/m^3	Periodic	6-monthly

Table 5 - Point source emissions monitoring plan for the engines

Substance	Emission Limit Value (expressed at 273.15K, 101.3kPa, Dry and at 15% O2)	Monitoring Type	Monitoring Frequency
Oxides of Nitrogen (NOx)	75 mg/m^3	Periodic	6-monthly
Carbon Monoxide	100 mg/m^3	Periodic	6-monthly

Monitoring equipment, techniques, personnel and organisations employed for the emissions monitoring programme shall have either MCERTS certification or MCERTS accreditation (as appropriate), where available, unless otherwise agreed in writing by the Environment Agency. As such, sampling shall be carried out in accordance with CEN standards. IF CEN standards are not available, then ISO, national or other international standards which ensue the provision of data of an equivalent scientific quality shall apply.

3.2 Emissions Monitoring Locations

Each boiler and CHP has a dedicated emissions monitoring access port located on the appliance exhaust flue. These are located in a straight, vertical section of the duct with a constant cross sectional area, at least five hydraulic diameters from the top of the stack, at least two hydraulic diameters upstream from any bend or obstruction and at least five hydraulic diameters downstream of any bend or obstruction.

Access to the sampling ports is in the form of a temporary/permanent platform with sufficient working area to allow the monitoring team to work safely with their equipment throughout the duration of the test.

3.3 Assessment of Compliance with Emission Limit Values

The emission limit values for air shall be regarded as being complied with if the results of each of the series of measurements as prescribed in Tables 4 and 5 above do not exceed the emission limit values.

3.4 Visible Emissions

With the exception of condensed water vapour, all other releases to air should be free from persistent visible emissions and free from droplets.

If a persistent problem with visible emissions is identified through inspections, ULEC Ltd shall perform visual checks of the emissions daily, recording the time, location, weather conditions and the observations of emissions made during the check. Once the source of the emissions has been determined, ULEC Ltd shall take corrective action without delay.

3.5 Records & Reporting

Records shall be kept of all inspections, tests and monitoring. Records shall be kept by ULEC Ltd for at least six years and will be readily available for the Environment Agency to examine.

Results of emissions monitoring shall be forwarded to the Environment Agency following completion of the sampling.

3.6 Adverse Monitoring Results & Corrective Action

Any adverse results from monitoring activity shall be investigated by ULEC Ltd as soon as the monitoring data has been obtained. ULEC Ltd shall:

- Identify the cause and take corrective action;
- Clearly record the nature and extent of the problem, along with remedial action taken; and,
- Re-test to demonstrate compliance at the earliest possible opportunity and inform the Environment Agency of the steps taken and the re-test results.

3.7 Staff Training

All boiler and CHP operatives shall receive training to mitigate release of emissions.

3.8 Boiler and CHP Plant Maintenance

ULEC Ltd shall maintain the boilers, CHPs and associated plant at the frequencies suggested by the technology suppliers to mitigate the release of point source emissions appointed.

3.9 Other Than Normal Operating Conditions (OTNOC)

ULEC operate with a maintenance schedule that ensures sufficient downtime and regular inspections of each appliance to limit the probability of abnormal operating conditions. Should OTNOC occur, ULEC shall ensure that there is capacity within the system, via the use of the boilers, to shutdown any affected appliances whilst repair or maintenance works are carried out to bring the site back to normal operating conditions. During such conditions, ULEC will maintain the monitoring requirements set out within section 3.

4.0 EMISISON COMPLAINTS

ULEC shall implement any necessary action in response to any complaints or concerns expressed by interested parties, including operatives, customers, clients and regulatory authorities regarding emissions or other negative externalities relating to boiler and CHP operations. ULEC shall record the following:

- Name and contact details of the person who expressed concern or made a complaint;
- Specific subject(s) of the concern or complaint;
- The source / location of where the complaint comes from;
- Date and time communicated to the producer and name of the person to whom it was communicated;
- Nature and date(s) of any actions and checks and who carried them out;
- Nature and date of any response to the person who expressed a concern or made the complaint; and
- Name of the person who communicated the response.

Records of complaints shall be retained and made readily available to the Environment Agency.

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