



# BAT Assessment

University of Liverpool Energy Company



# Report produced for University of Liverpool Energy Company Ltd

Provided by Walker Resource Management Ltd (WRM)

|                           |                        |
|---------------------------|------------------------|
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## 1.0 INTRODUCTION

WRM have been tasked by University of Liverpool Energy Company Limited (hereon referred to as "ULEC") with undertaking a Best Available Techniques Assessment (BAT) of the Ashton Street Energy Centre at Ashton Street, Liverpool, L69 7ZX. This forms part of ULEC's application for an environmental permit to operate an Energy Centre with the burning of fuel in an appliance with a rated thermal input of 50 or more megawatts. The new BAT standards contained within the Best Available Techniques (BAT) Reference Document for Large Combustion Plants 2017 (BREF) document have been consulted in order to ensure this BAT Assessment meets the requirements of legislation.

### 1.1 Legislative Background

The latest Best Available Techniques (BAT) Reference Document for Large Combustion Plants 2017 (BREF) previously underwent a review across the European Union before being published in 2017. All new and existing installations are required to meet the standards as stated by BAT.

The Environmental Permitting (England and Wales) Regulations 2016 (as amended) require that activities identified under Schedule 1 be subjected to an assessment to demonstrate that the technology/technique proposed can be considered to be the 'Best Available' at the time the permit application is being made.

In order to undertake this BAT Assessment, guidance from the Environment Agency (EA) has been consulted with, in conjunction with the BREF document to ensure the site meets the required standards of compliance. These documents are displayed below and have been produced by the EA from IPPC regulations to give guidance to site operators in accordance with the BREF document:

- *Best Available Techniques (BAT) Reference Document for Large Combustion Plants 2017 (BREF).*

### 1.2 Definition of Best Available Technique

The IED (Directive 2010/75/EU) define BAT as:

*"the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and where that is not practicable, generally reduce emission and the impact on the environment as a whole".*

Article 2 of the Integrated Pollution Prevention and Control Directive 2008 (as amended) and Article 3 of the IED further defines the component parts of BAT as:

- "Best" – means the most effective techniques for achieving a high level of protection of the environment as a whole.
- "Available" – means techniques developed on a scale which allows them to be used in the relevant industrial sector, under economically and technically viable conditions, taking into account the costs and advantages.
- "Techniques" – includes both the technology and the way the installation is designed, built, maintained, operated and decommissioned.

BAT may be demonstrated by either:

- Compliance with the sector-level, indicative BAT performance described in the Sector Guidance Notes (SGNs) produced by the Environment Agency and in the European Commission 'Reference Documents on BAT' (BREFs); or
- By conducting an installation-specific options appraisal of candidate techniques.

## 2.0 SITE DETAILS

### 2.1 Site Address

ULEC Energy Centres  
Ashton Street,  
Liverpool,  
L69 7ZX

### 2.2 Operational Location

Site Grid Reference: SJ 3577 9046

### 2.3 Site Description

The facility is within the University of Liverpool Campus on the east side of Liverpool city centre. Access to the site is via Ashton Street and the A5047. The area around the site is made up of several educational, cultural and industrial buildings, as well as some residential.

### 2.4 Plans

Reference Drawing: ULEC\_Site\_Location\_Plan  
ULEC\_Site\_Layout\_Plan

### 2.5 Permits and Licences

ULEC currently hold no environmental permits or licences for Part A(1) (a) activities at Ashton Street Energy Centres and are seeking to obtain a bespoke installation permit to operate the Energy Centres.

### 3.0 BAT REVIEW

The following sections shall review BAT guidance criteria produced by the EA for each phase of waste processing relevant to ULEC. Due to the nature of the guidance and the fact it covers solid, liquid and gaseous fuels, as well as the combustion of biomass, this document has been produced purely to analyse the information related to the ULEC site applicable processes. All non-site-specific information contained within the guidance has been scrutinised but is not mentioned within this document to eliminate any potential confusion.

Each table below compares information from BAT guidance with information from the relevant section of the management system or other site documents. The relevant section of the management system or other site documents is referenced in the right-hand column.

When compared against the guidance the phases applicable to ULEC are as follows:

- General Considerations
  - Environmental Management Systems
  - Monitoring
  - General environmental and combustion
  - Energy efficiency
  - Water usage and emissions to water
  - Waste management
  - Noise emissions
- Combustion of liquid fuels (Boilers)
  - Energy efficiency
  - NO<sub>x</sub> and CO emissions to air
  - SO<sub>x</sub>, HCl and HF emissions to air
  - Dust and particulate-bound metal emissions to air
- Combustion of liquid fuels (Engines)
  - Energy efficiency
  - NO<sub>x</sub>, CO and volatile organic compound emissions to air
  - SO<sub>x</sub>, HCl and HF emissions to air
  - Dust and particulate-bound metal emissions to air
- Combustion of gaseous fuels
  - Energy efficiency
  - NO<sub>x</sub>, CO, NMVOC and CH<sub>4</sub> emissions to air

The management system (Document Reference: EPR-B01) as well as other key documents forming the permit application have been consulted with in order to undertake this BAT Assessment.

## 4.0 ASSESSMENT

The first phase of the process is to assess site activities and the associated permit management system against general BAT conclusions. Following this, section 4.1.2, contains the assessment against BAT conclusions for the combustion of gaseous fuels. The following tables have been produced from the Annex contained within the Commission Implementing Decision (EU) 2017/1442. Areas which don't apply to the operations at the facility due to site specific reasons have been excluded from the table. Please note, as stated within the Commission Implementing Decision (EU) 2017/1442, the scope (e.g. level of detail) and nature of how the site addresses the BAT conclusions will generally be related to the nature, scale and complexity of the installation, and the range of environmental impacts it may have (determined also by the type and amount of wastes processed).

### 4.1.1 General BAT Conclusions

| Environmental Management Systems |  |   |
|----------------------------------|--|---|
| BAT Conclusion No                | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC   | ULEC Permit Documents   |
| 01                               | <p>In order to maintain a high level of environmental performance, BAT is to implement and adhere to an Environmental Management System (EMS) incorporating all of the following features (where applicable):</p> <ol style="list-style-type: none"> <li>I. commitment of the management, including senior management;</li> <li>II. definition, by the management, of an environmental policy that includes the continuous improvement of the environmental performance of the installation;</li> <li>III. planning and establishing the necessary procedures, objectives and targets, in conjunction with financial planning and investment;</li> <li>IV. implementation of procedures paying particular attention to: <ol style="list-style-type: none"> <li>(a) structure and responsibility,</li> <li>(b) recruitment, training, awareness and competence,</li> <li>(c) communication,</li> <li>(d) employee involvement,</li> <li>(e) documentation,</li> <li>(f) effective process control,</li> </ol> </li> </ol> | <p><b>Management Commitment</b><br/>ULEC operate in line with the University of Liverpool Policy and Code of Practice for Environmental Permitting and Pollution Prevention (EPAPP; document reference: EMS002). Section 4 <i>Responsibility and Duties</i> of the EPAPP details the responsibilities for management roles regarding environmental management within the University, including but not limited to:</p> <ul style="list-style-type: none"> <li>• Senior Executive Group</li> <li>• Senior Management Team</li> <li>• Professional Services Leadership Team</li> <li>• Senior Managers</li> <li>• Line Managers</li> </ul> <p>As part of their adherence to the EPAPP, ULEC management regularly review compliance with the EPAPP, as well and the Environmental Permit Management System (EMS, document reference: EPR-B01), through annual management review meetings. During such meetings several aspects of performance are reviewed, including the implementation of the EMS.</p> |



| Environmental Management Systems |   |  |
|----------------------------------|---|--|
| BAT Conclusion No                | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC  | ULEC Permit Documents  |
|                                  | <p>(g) maintenance programmes,<br/>(h) emergency preparedness and response,<br/>(i) safeguarding compliance with environmental legislation;</p> <p>V. checking performance and taking corrective action, paying particular attention to:</p> <p>(a) monitoring and measurement (see also the JRC Reference Report on Monitoring of emissions to air and water from IED installations – ROM),<br/>(b) corrective and preventive action,<br/>(c) maintenance of records,<br/>(d) independent (where practicable) internal or external auditing in order to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained;</p> <p>VI. review, by senior management, of the EMS and its continuing suitability, adequacy and effectiveness;</p> <p>VII. following the development of cleaner technologies;</p> <p>VIII. consideration for the environmental impacts from the eventual decommissioning of the plant at the stage of designing a new plant, and throughout its operating life;</p> <p>IX. application of sectoral benchmarking on a regular basis;</p> <p>X. quality assurance/quality control programmes to ensure that the characteristics of all fuels are fully determined and controlled (see BAT 9);</p> <p>XI. a management plan in order to reduce emissions to air and/or to water during other than normal operating conditions, including start-up and shutdown periods (see BAT 10 and BAT 11);</p> <p>XII. a waste management plan to ensure that waste is avoided, prepared for reuse, recycled or otherwise recovered, including the use of techniques given in BAT 16;</p> | <p>The content of the University’s Environmental Code of Practice (COP) is reviewed in line with any regulatory change or new information at least every two years.</p> <p><b>Emissions Management and Monitoring Plan</b><br/>ULEC operate in line with an Emissions Management and Monitoring Plan (EMMP; document reference: EPR-B04). Aspects covered within the EMMP include:</p> <ul style="list-style-type: none"> <li>• An assessment of point source and fugitive emissions and potential environmental impacts</li> <li>• Management of identified emissions and impacts</li> <li>• Emissions monitoring regimes</li> <li>• Records and reporting</li> <li>• Corrective actions</li> <li>• Staff training</li> <li>• Maintenance</li> <li>• Complaints</li> </ul> <p>In line with the requirements of the EMMP, records of all inspections, tests and monitoring events shall be kept for a minimum of 6-years, with results from monitoring events sent to the Environment Agency following the completion of sampling. Any adverse results from monitoring shall be investigated as soon as data has been obtained and ULEC shall:</p> <ul style="list-style-type: none"> <li>• Identify the cause and take corrective action</li> <li>• Record the nature and extent of the problem, along with any remedial action taken</li> <li>• Re-test to demonstrate compliance at the earliest possible opportunity.</li> </ul> |

| Environmental Management Systems |  |   |
|----------------------------------|--|---|
| BAT Conclusion No                | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC   | ULEC Permit Documents   |
|                                  | <p>XIII. a systematic method to identify and deal with potential uncontrolled and/or unplanned emissions to the environment, in particular:</p> <ul style="list-style-type: none"> <li>a) emissions to soil and groundwater from the handling and storage of fuels, additives, by-products and wastes</li> <li>b) emissions associated with self-heating and/or self-ignition of fuel in the storage and handling activities;</li> </ul> <p>XIV. a dust management plan to prevent or, where that is not practicable, to reduce diffuse emissions from loading, unloading, storage and/or handling of fuels, residues and additives;</p> <p>XV. a noise management plan where a noise nuisance at sensitive receptors is expected or sustained, including:</p> <ul style="list-style-type: none"> <li>a) a protocol for conducting noise monitoring at the plant boundary</li> <li>b) a noise reduction programme</li> <li>c) a protocol for response to noise incidents containing appropriate actions and timelines</li> <li>d) a review of historic noise incidents, corrective actions and dissemination of noise incident knowledge to the affected parties;</li> </ul> <p>XVI. for the combustion, gasification or co-incineration of malodourous substances, an odour management plan including:</p> <ul style="list-style-type: none"> <li>a) a protocol for conducting odour monitoring</li> <li>b) where necessary, an odour elimination programme to identify and eliminate or reduce the odour emissions</li> <li>c) a protocol to record odour incidents and the appropriate actions and timelines</li> <li>d) a review of historic odour incidents, corrective actions and the dissemination of odour incident knowledge to the affected parties.</li> </ul> | <p><b>Organisational Structure, Training and Competency</b><br/>ULEC have a clearly defined organisational structure to maintain control over the EMS. Each procedure associated with the EMS features a distinct 'Roles and Responsibilities' section to define the key tasks that must be undertaken at different levels of the organisation. Section 3.3 (Staffing) of the EMS states the following:</p> <p><i>'ULEC shall ensure that there are sufficient employees who are suitably trained and have demonstrated competency present onsite to management and operate the Energy Centres. Manufacturer training is provided to staff where applicable.'</i></p> <p>The training that each staff member has undertaken is recorded in line with ULEC's Recording Procedure (document reference: EPR-OP03). Performance reviews are conducted on an annual basis to ensure that all ULEC staff are aware of their individual contribution towards maintaining effective levels of process control and upholding compliance obligations.</p> <p><b>Effective Process Control</b><br/>ULEC are able to maintain high levels of process control through the combination of various EMS procedures and monitoring of the TEM systems. The regular monitoring and measurement of site processes and any environmental impacts are recorded. ULEC also conduct and record daily site checks to assess a number of variables including within the environmental permit documents. The effectiveness of individual site procedures shall be regularly reviewed and evaluated through audits and management reviews.</p> |

| Environmental Management Systems |  |   |
|----------------------------------|--|---|
| BAT Conclusion No                | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC | ULEC Permit Documents   |
|                                  |  | <b>BC01 Status: Compliant</b> – It is the operator’s view that they are compliant with this BAT conclusion. |

| Monitoring        |   |   |
|-------------------|---|---|
| BAT Conclusion No | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC  | ULEC Permit Documents   |
| 02                | BAT is to determine the net electrical efficiency and/or the net total fuel utilisation and/or the net mechanical energy efficiency of the gasification, IGCC and/or combustion units by carrying out a performance test at full load (1), according to EN standards, after the commissioning of the unit and after each modification that could significantly affect the net electrical efficiency and/or the net total fuel utilisation and/or the net mechanical energy efficiency of the unit. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality. | <p>ULEC are certified to the UK Government’s Combined Heat and Power Quality Assurance programme (CHPQA). The CHPQA assesses CHP schemes based upon their energy efficiency and environmental performance via an annual certification process. To ensure compliance with the CHPQA, ULEC monitor all energy inputs and outputs for the energy centre to allow an assessment of efficiency to be calculated using the Quality Index (QI). The QI provides an indication of the energy efficiency and environmental performance of the energy centre and is submitted to the administrator of the CHPQA programme for determination. Parameters that are monitored and calculated as part of the CHPQA are:</p> <ul style="list-style-type: none"> <li>• Power Efficiency</li> <li>• Heat Efficiency</li> <li>• QI</li> <li>• Qualifying Power Capacity</li> <li>• Qualifying Heat Capacity</li> <li>• Qualifying Fuel Input</li> </ul> |

| Monitoring                          |   |  |              |            |          |      |                                      |  |                                    |                          |                                     |                          |                        |   |
|-------------------------------------|---|--|--------------|------------|----------|------|--------------------------------------|--|------------------------------------|--------------------------|-------------------------------------|--------------------------|------------------------|---|
| BAT Conclusion No                   | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC  | ULEC Permit Documents  |              |            |          |      |                                      |  |                                    |                          |                                     |                          |                        |   |
|                                     |   | <ul style="list-style-type: none"> <li>Qualifying Power Output</li> <li>Qualifying Heat Output</li> </ul> <p><b>BCO2 Status: Compliant</b> – It is the operator’s view that they are compliant with this BAT conclusion.</p> |              |            |          |      |                                      |  |                                    |                          |                                     |                          |                        |   |
| 03                                  | <p>BAT is to monitor key process parameters relevant for emissions to air and water including those given below.</p> <table border="1"> <thead> <tr> <th>Stream</th> <th>Parameter(s)</th> <th>Monitoring</th> </tr> </thead> <tbody> <tr> <td rowspan="3">Flue-gas</td> <td>Flow</td> <td>Periodic or continuous determination</td> </tr> <tr> <td>Oxygen content, temperature and pressure</td> <td rowspan="2">Periodic or continuous measurement</td> </tr> <tr> <td>Water vapour content (1)</td> </tr> <tr> <td>Waste-water from flue-gas treatment</td> <td>Flow, pH and temperature</td> <td>Continuous measurement</td> </tr> </tbody> </table> <p>(1) The continuous measurement of the water vapour content of the flue-gas is not necessary if the sampled flue-gas is dried before analysis.</p> | Stream   | Parameter(s) | Monitoring | Flue-gas | Flow | Periodic or continuous determination | Oxygen content, temperature and pressure | Periodic or continuous measurement | Water vapour content (1) | Waste-water from flue-gas treatment | Flow, pH and temperature | Continuous measurement | <p>In line with section 3.1 (Point Source Emissions Monitoring) of the EMMP, Flow rate, oxygen content, temperature, pressure and water vapour content of the flue gas shall be continuously monitored for both the CHPs and the Boilers. The quality assurance of these automated measuring systems and the reference measurement methods to calibrate them shall be carried out according to CEN-standards. If CEN-standards are unavailable, ISO, national or other international standards which ensure the provision of data of an equivalent scientific quality shall apply. Automated measuring systems shall be subject to control by means of parallel measurement with the reference methods at least once per year.</p> <p>As per section 3.7 (Records and Reporting) of the EMMP, records of all monitoring shall be kept for a minimum of 3-years and shall be readily available to the local authority and Environment Agency upon request.</p> <p>For the two Edina CHP engines, the required parameters are monitored continuously via the TEM engine management system, with results recorded on the ULEC eSight system. The Clarke CHP engine is fitted with a Jenbacher DIA.NE XT control system and the boilers are monitored via the Boiler Management System.</p> |
| Stream                              | Parameter(s)  | Monitoring   |              |            |          |      |                                      |  |                                    |                          |                                     |                          |                        |   |
| Flue-gas                            | Flow  | Periodic or continuous determination   |              |            |          |      |                                      |  |                                    |                          |                                     |                          |                        |   |
|                                     | Oxygen content, temperature and pressure  | Periodic or continuous measurement   |              |            |          |      |                                      |  |                                    |                          |                                     |                          |                        |   |
|                                     | Water vapour content (1)  |  |              |            |          |      |                                      |  |                                    |                          |                                     |                          |                        |   |
| Waste-water from flue-gas treatment | Flow, pH and temperature  | Continuous measurement   |              |            |          |      |                                      |  |                                    |                          |                                     |                          |                        |   |

| Monitoring        |   |   |
|-------------------|---|---|
| BAT Conclusion No | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC  | ULEC Permit Documents   |
|                   |   | <b>BC03 Status: Compliant</b> – It is the operator’s view that they are compliant with this BAT conclusion.   |
| 04                | <p>BAT is to monitor emissions to air with at least the frequency given below and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.</p> <p>See section 1.2 of <i>Commission Implementing Decision (EU) 2017/1442</i> for full BAT conclusion 4 table containing frequency and standards and the waste treatment processes they are to be monitored against.</p> | <p>ULEC operate with an EMMP which details the full suite of monitoring that is to be undertaken at the energy centre. A monitoring schedule for the Energy Centres for point source emissions has been developed in accordance with Annex V of the Industrial Emissions Directive and is detailed within Section 3.1 (Point Source Emissions Monitoring) of the EMMP.</p> <p>All emissions monitoring shall be carried out by an MCERTS accredited company with MCERTS accredited staff and equipment who will carry out the monitoring following the Standard Reference Methods for each pollutant as per the Environment Agency’s guidance.</p> <p>Should any adverse results be recorded, corrective action shall be taken in line with section 3.8 (Adverse Monitoring Results and Corrective Action) of the EMMP. This includes:</p> <ul style="list-style-type: none"> <li>• Identify the cause and take corrective action;</li> <li>• Clearly record the nature and extent of the problem, along with remedial action taken; and,</li> <li>• Re-test to demonstrate compliance at the earliest possible opportunity and inform the local authority of the steps taken and the re-test results.</li> </ul> |

| Monitoring        |  |  |
|-------------------|--|--|
| BAT Conclusion No | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC | ULEC Permit Documents  |
|                   |  | <p><b>NOx</b><br/>NOx emissions from the two Edina CHP engines are monitored on a continuous basis through the TEM engine management system. Each engine is fitted with an emissions tester within the exhaust flue and the TEM system can control the temperatures of the cylinders within the engine to control the NOx emissions to ensure compliance with emission limit values (ELVs).</p> <p>The Clarke CHP engine is fitted with a DIA.NE engine management system. This provides a detailed analysis of the engine condition and allows the quick and effective diagnosis of any issues that may lead to increased emissions of NOx through combustion efficiency losses.</p> <p>The three Danstoker boilers are fitted with a controller that continually samples flue products of combustion to ensure effective combustion of the natural gas. The controller trims the burner in line with the results of the continuous sampling to maintain effective combustion and reduce NOx emissions</p> <p><b>CO</b><br/>CO emissions from the two Edina CHP engines are monitored on a continuous basis through the TEM engine management system. Each engine is fitted with an emissions tester within the exhaust flue to monitor CO emissions to ensure compliance with emission limit values (ELVs).</p> <p>The Clarke CHP engine is fitted with a DIA.NE engine management system. This provides a detailed analysis of the engine condition and allows the quick and effective diagnosis of any issues that may lead to increased emissions of CO through combustion efficiency losses.</p> |

| Monitoring        |  |   |
|-------------------|--|---|
| BAT Conclusion No | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC | ULEC Permit Documents   |
|                   |  | <p>The three Danstoker boilers are fitted with a controller that continually samples flue products of combustion to ensure effective combustion of the natural gas. The controller trims the burner in line with the results of the continuous sampling to maintain effective combustion and reduce CO emissions</p> <p><b>Records and Reporting</b><br/>Results of emissions monitoring shall be forwarded to the Environment Agency following completion of sampling. Records of all monitoring results shall be kept for at least 3-years and shall be made readily available for the Environment Agency to examine.</p> <p><b>BC04 Status: Compliant</b> – It is the operator’s view that they are compliant with this BAT conclusion</p> |

| Monitoring        |   |  |
|-------------------|---|--|
| BAT Conclusion No | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC  | ULEC Permit Documents  |
| 05                | <p>BAT is to monitor emissions to water from flue-gas treatment with at least the frequency given below and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.</p> <p>See section 1.2 of <i>Commission Implementing Decision (EU) 2017/1442</i> for full BAT conclusion 4 table containing frequency and standards and the waste treatment processes they are to be monitored against.</p> | <p>This BAT conclusion is not considered to be relevant as there are no emissions to water from flue-gas treatment systems.</p> <p><b>BC05 Status: N/A</b></p> |



| General Environmental and Combustion Performance |   |  |  |   |  |  |
|--|---|--|--|---|--|--|
| BAT Conclusion No                                | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC  |  |  | ULEC Permit Documents   |  |  |
| 06   | <p>In order to improve the general environmental performance of combustion plants and to reduce emissions to air of CO and unburnt substances, BAT is to ensure optimised combustion and to use an appropriate combination of the techniques given below.</p> |  |  |   | <p>As the Energy Centres contain natural gas fuelled boilers and engines, technique A is not seen to be applicable.</p> <p>B) With regards to technique B, ULEC operate in line with a Maintenance Schedule (document reference: EPR-OP01) that forms part of the wider EMS. The site operates a strict maintenance regime and equipment is of sufficient capacity to allow down time for routine maintenance and servicing as recommended by the manufacturer.</p> <p>An appropriate number of fully trained operatives shall conduct the planned preventative maintenance within the Energy Centres. Weekly Site Inspection checks shall also be undertaken by a competent person and any defect identified shall be resolved and overseen by the Maintenance and Engineering Hub Manager.</p> <p>C) With regards to technique C, The Clarke CHP engine (CHP 1) is fitted with a DIA.NE engine management system. This provides a detailed analysis of the engine condition and allows the quick and effective diagnosis of any issues that may lead to increased emissions of CO through combustion efficiency losses.</p> <p>The Edina CHP engines (CHP 2 &amp; CHP 3) are fitted with a TEM engine management system. This control the temperature of the cylinders and the wider engine system to ensure optimised combustion of natural gas. This also allows for efficient diagnosis of any issues that may lead to sub-optimal combustion, allowing effective maintenance to be undertaken in a timely manner.</p> <p>The three Danstoker boilers are fitted with a controller that continually samples flue products of combustion to ensure effective combustion of the natural gas. The controller trims the burner in</p> |  |
|  | Technique   | Description  | Applicability  |   |  |  |
|  | A   | Fuel blending and mixing                             | Ensure stable combustion conditions and/or reduce the emission of pollutants by mixing different qualities of the same fuel type | Generally applicable  |  |  |
|  | B   | Maintenance of the combustion system                 | Regular planned maintenance according to suppliers' recommendations  |   |  |  |
|  | C   | Advanced control system                              | See description in Section 10.8.1  | The applicability to old combustion plants may be constrained by the need to retrofit the combustion system and/or control command system |  |  |
| D  | Good design of the combustion equipment   | Good design of furnace, combustion chambers, burners | Generally applicable to new combustion plants  |   |  |  |

| General Environmental and Combustion Performance |  |             |  |   |
|--|--|-------------|--|---|
| BAT Conclusion No                                | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC |             |  | ULEC Permit Documents   |
|  |  |             | and associated devices   |   |
|  | E  | Fuel choice | Select or switch totally or partially to another fuel(s) with a better environmental profile (e.g. with low sulphur and/or mercury content) amongst the available fuels, including in start-up situations or when back-up fuels are used | <p>Applicable within the constraints associated with the availability of suitable types of fuel with a better environmental profile as a whole, which may be impacted by the energy policy of the Member State, or by the integrated site's fuel balance in the case of combustion of industrial process fuels. For existing combustion plants, the type of fuel chosen may be limited by the configuration and the design of the plant</p> <p>line with the results of the continuous sampling to maintain effective combustion and reduce CO emissions.</p> <p><b>BC06 Status: Compliant</b> – It is the operator’s view that they are compliant with this BAT conclusion</p> |

| General Environmental and Combustion Performance |   |  |
|--|---|--|
| BAT Conclusion No                                | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC  | ULEC Permit Documents  |
| 07   | In order to reduce emissions of ammonia to air from the use of selective catalytic reduction (SCR) and/or selective non-catalytic reduction (SNCR) for the abatement of NOX emissions, BAT is to optimise the design and/or operation of SCR and/or SNCR (e.g. optimised reagent to NOX ratio, homogeneous reagent distribution and optimum size of the reagent drops). | <p>This BAT conclusion is considered to not be applicable as SCR or SNCR abatement systems are not in use in the Energy Centres.</p> <p><b>BC07 Status: N/A</b></p>  |
| 08   | In order to prevent or reduce emissions to air during normal operating conditions, BAT is to ensure, by appropriate design, operation and maintenance, that the emission abatement systems are used at optimal capacity and availability.   | <p>ULEC abate emissions from the Energy Centre through the engine and boiler management and control systems. These systems (as described in the response to BAT 04 &amp; 06 above) ensure the efficient combustion of natural gas and efficient performance of the engines and boilers to reduce emissions.</p> <p>Should any adverse results be recorded during the periodic monitoring of emissions, corrective action shall be taken in line with section 3.8 (Adverse Monitoring Results and Corrective Action) of the EMMP. This includes:</p> <ul style="list-style-type: none"> <li>• Identify the cause and take corrective action;</li> <li>• Clearly record the nature and extent of the problem, along with remedial action taken; and,</li> <li>• Re-test to demonstrate compliance at the earliest possible opportunity and inform the local authority of the steps taken and the re-test results.</li> </ul> <p>ULEC operate in line with a Maintenance Schedule (document reference: EPR-OP01) that forms part of the wider EMS. The site operates a strict maintenance regime and equipment is of sufficient capacity to allow down time for routine maintenance and servicing as recommended by the manufacturer.</p> |

| General Environmental and Combustion Performance |   |   |
|--|---|---|
| BAT Conclusion No                                | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC  | ULEC Permit Documents   |
|  |   | <p>An appropriate number of fully trained operatives shall conduct the planned preventative maintenance within the Energy Centres. Weekly Site Inspection checks shall also be undertaken by a competent person and any defect identified shall be resolved and overseen by the Maintenance and Engineering Hub Manager.</p> <p><b>BC08 Status: Compliant</b> – It is the operator’s view that they are compliant with this BAT conclusion</p>                        |
| 09   | <p>In order to improve the general environmental performance of combustion and/or gasification plants and to reduce emissions to air, BAT is to include the following elements in the quality assurance/quality control programmes for all the fuels used, as part of the environmental management system (see BAT 1):</p> <ol style="list-style-type: none"> <li>i. Initial full characterisation of the fuel used including at least the parameters listed below and in accordance with EN standards. ISO, national or other international standards may be used provided they ensure the provision of data of an equivalent scientific quality;</li> <li>ii. Regular testing of the fuel quality to check that it is consistent with the initial characterisation and according to the plant design specifications. The frequency of testing and the parameters chosen from the table below are based on the variability of the fuel and an assessment of the relevance of pollutant releases (e.g. concentration in fuel, flue-gas treatment employed);</li> <li>iii. Subsequent adjustment of the plant settings as and when needed and practicable (e.g. integration of the fuel characterisation and control in the advanced control system (see description in Section 10.8.1)).</li> </ol> | <p>The ULEC Energy Centres utilises natural gas from the grid as fuel to power the CHPs and Boilers. As this is the case, testing of the fuel is not seen as applicable as the quality of the gas within the grid remains within set parameters. The TMS, DIA,NE and Boiler Management Systems also monitor the performance of the individual plant and adjust setting according to key process parameters to optimise efficiency.</p> <p><b>BC09 Status: N/A</b></p> |

| General Environmental and Combustion Performance |   |  |
|--|---|--|
| BAT Conclusion No                                | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC  | ULEC Permit Documents  |
| 10   | <p>In order to reduce emissions to air and/or to water during other than normal operating conditions (OTNOC), BAT is to set up and implement a management plan as part of the environmental management system (see BAT 1), commensurate with the relevance of potential pollutant releases, that includes the following elements:</p> <ul style="list-style-type: none"> <li>• appropriate design of the systems considered relevant in causing OTNOC that may have an impact on emissions to air, water and/or soil (e.g. low-load design concepts for reducing the minimum start-up and shutdown loads for stable generation in gas turbines);</li> <li>• set-up and implementation of a specific preventive maintenance plan for these relevant systems;</li> <li>• review and recording of emissions caused by OTNOC and associated circumstances and implementation of corrective actions if necessary;</li> <li>• periodic assessment of the overall emissions during OTNOC (e.g. frequency of events, duration, emissions quantification/estimation) and implementation of corrective actions if necessary.</li> </ul> | <p>ULEC operate in line 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 of the EMMP.</p> <p><b>BC10 Status: Compliant</b> – It is the operator’s view that they are compliant with this BAT conclusion</p> |
| 11   | <p>BAT is to appropriately monitor emissions to air and/or to water during OTNOC.</p>   | <p>The energy centre shall continue to comply with Emissions Limit Values (ELVs) during OTNOC periods and monitor emissions in line with section 3 of the EMMP.</p> <p>Should any adverse results be recorded during OTNOC, corrective action shall be taken in line with section 3.8 (Adverse Monitoring Results and Corrective Action) of the EMMP. This includes:</p> <ul style="list-style-type: none"> <li>• Identify the cause and take corrective action;</li> <li>• Clearly record the nature and extent of the problem, along with remedial action taken; and,</li> </ul>   |

| General Environmental and Combustion Performance |  |   |
|--|--|---|
| BAT Conclusion No                                | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC | ULEC Permit Documents   |
|  |  | <ul style="list-style-type: none"> <li>Re-test to demonstrate compliance at the earliest possible opportunity and inform the local authority of the steps taken and the re-test results.</li> </ul> <p><b>BC11 Status: Compliant</b> – It is the operator’s view that they are compliant with this BAT conclusion</p> |

| Energy Efficiency |   |  |
|-------------------|---|--|
| BAT Conclusion No | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442)/ Information that needs to be provided by ULEC  | ULEC Permit Documents  |
| 12                | <p>In order to increase the energy efficiency of combustion, gasification and/or IGCC units operated <math>\geq 1\,500</math> h/yr, BAT is to use an appropriate combination of the techniques given.</p> <p>See section 1.4 of <i>Commission Implementing Decision (EU) 2017/1442</i> for full BAT conclusion 12 table containing full list of techniques.</p> | <p>A) With regards to technique A, ULEC utilise the engine and boiler management systems described above to ensure optimisation of the combustion process within the three CHP engines and three boilers. Within the CHPs, the TEM and DIA.NE engine management systems control the temperatures of the cylinders within the engines to control combustion efficiency and reduce emissions. Within the boilers the controller continually samples the flue products of combustion and trims the burner accordingly to ensure efficient combustion that reduces emissions.</p> <p>ULEC operate in line with a Maintenance Schedule (document reference: EPR-OP01) that forms part of the wider EMS. The site operates a strict maintenance regime and equipment is of sufficient capacity to allow down time for routine maintenance and servicing as recommended by the manufacturer.</p> <p>An appropriate number of fully trained operatives shall conduct the planned preventative maintenance within the Energy Centres.</p> |

| Energy Efficiency |  |  |
|-------------------|--|--|
| BAT Conclusion No | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442)/ Information that needs to be provided by ULEC | ULEC Permit Documents  |
|                   |  | <p>Weekly Site Inspection checks shall also be undertaken by a competent person and any defect identified shall be resolved and overseen by the Maintenance and Engineering Hub Manager. This ensures that reliability issues do not lead to reductions in the efficacy of the combustion process within both the CHPs and the Boilers.</p> <p>C) With regards to technique C, The Clarke CHP engine (CHP 1) is fitted with a DIA.NE engine management system. This provides a detailed analysis of the engine condition and allows the quick and effective diagnosis of any issues that may lead to increased emissions through combustion efficiency losses.</p> <p>The Edina CHP engines (CHP 2 &amp; CHP 3) are fitted with a TEM engine management system. This control the temperature of the cylinders and the wider engine system to ensure optimised combustion of natural gas. This also allows for efficient diagnosis of any issues that may lead to sub-optimal combustion, allowing effective maintenance to be undertaken in a timely manner.</p> <p>The three Danstoker boilers are fitted with a controller that continually samples flue products of combustion to ensure effective combustion of the natural gas. The controller trims the burner in line with the results of the continuous sampling to maintain effective combustion and reduce CO emissions.</p> <p><b>BC12 Status: Compliant</b> – It is the operator’s view that they are compliant with this BAT conclusion</p> |

| Water Usage and Emissions to Water |  |   |   |           |             |               |                    |   |   |                            |  |   |   |
|------------------------------------|--|---|---|-----------|-------------|---------------|--------------------|---|---|----------------------------|--|---|---|
| BAT Conclusion No                  | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC   |   | ULEC Permit Documents   |           |             |               |                    |   |   |                            |  |   |   |
| 13                                 | <p>In order to reduce water usage and the volume of contaminated waste water discharged, BAT is to use one or both of the techniques given below.</p> <table border="1"> <thead> <tr> <th>Technique</th> <th>Description</th> <th>Applicability</th> </tr> </thead> <tbody> <tr> <td>a. Water recycling</td> <td>Residual aqueous streams, including runoff water, from the plant are reused for other purposes. The degree of recycling is limited by the quality requirements of the recipient water stream and the water balance of the plant</td> <td>Not applicable to waste water from cooling systems when water treatment chemicals and/or high concentrations of salts from seawater are present</td> </tr> <tr> <td>b. Dry bottom ash handling</td> <td>Dry, hot bottom ash falls from the furnace onto a mechanical conveyor system and is cooled down by ambient air. No water is used in the process.</td> <td>Only applicable to plants combusting solid fuels. There may be technical restrictions that prevent retrofitting to existing combustion plants</td> </tr> </tbody> </table> |   |   | Technique | Description | Applicability | a. Water recycling | Residual aqueous streams, including runoff water, from the plant are reused for other purposes. The degree of recycling is limited by the quality requirements of the recipient water stream and the water balance of the plant | Not applicable to waste water from cooling systems when water treatment chemicals and/or high concentrations of salts from seawater are present | b. Dry bottom ash handling | Dry, hot bottom ash falls from the furnace onto a mechanical conveyor system and is cooled down by ambient air. No water is used in the process. | Only applicable to plants combusting solid fuels. There may be technical restrictions that prevent retrofitting to existing combustion plants | <p>Water usage is reviewed by ULEC on a monthly basis (AMR daily reads) via ADSM contracted services. This enables ULEC to identify any periods in which a higher than expected volume of water has been used which will lead to an investigation being carried out.</p> <p>There is no regular waste water produced in the Energy Centres.</p> <p><b>BC12 Status: Compliant</b> – It is the operator’s view that they are compliant with this BAT conclusion</p> |
|                                    | Technique  | Description   | Applicability   |           |             |               |                    |   |   |                            |  |   |   |
|                                    | a. Water recycling   | Residual aqueous streams, including runoff water, from the plant are reused for other purposes. The degree of recycling is limited by the quality requirements of the recipient water stream and the water balance of the plant | Not applicable to waste water from cooling systems when water treatment chemicals and/or high concentrations of salts from seawater are present |           |             |               |                    |   |   |                            |  |   |   |
| b. Dry bottom ash handling         | Dry, hot bottom ash falls from the furnace onto a mechanical conveyor system and is cooled down by ambient air. No water is used in the process.   | Only applicable to plants combusting solid fuels. There may be technical restrictions that prevent retrofitting to existing combustion plants   |   |           |             |               |                    |   |   |                            |  |   |   |



| Water Usage and Emissions to Water |   |  |  |   |
|------------------------------------|---|--|--|---|
| BAT Conclusion No                  | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC  |  | ULEC Permit Documents  |   |
| 14                                 | In order to prevent the contamination of uncontaminated waste water and to reduce emissions to water, BAT is to segregate waste water streams and to treat them separately, depending on the pollutant content.                       |  | It is considered that this BAT Conclusion is not applicable as there is no regular waste water produced in the Energy Centres. |   |
| 15                                 | In order to reduce emissions to water from flue-gas treatment, BAT is to use an appropriate combination of the techniques given below, and to use secondary techniques as close as possible to the source in order to avoid dilution. |  |  | It is considered that this BAT Conclusion is not applicable as there is no regular waste water produced in the Energy Centres.<br><br><b>BC15 Status: N/A</b> |
|                                    | <b>Technique</b>  |  | <b>Typical pollutants targeted</b>   |   |
|                                    |   |  | <b>Applicability</b>   |   |
|                                    | <i>Preliminary and primary treatment, e.g.,</i>   |  |  |   |
|                                    | a.  | Optimised combustion (see BAT 6) and flue-gas treatment systems (e.g. SCR/SNCR, see BAT 7) | Organic compounds, ammonia (NH3)   |   |
| <i>Secondary Techniques</i>        |   |  |  |   |
| b.                                 | Adsorption on activated carbon  | Organic compounds, mercury (Hg)  | Generally applicable.  |   |
| c.                                 | Aerobic biological treatment  | Biodegradable organic  | Generally applicable for   |   |

| Water Usage and Emissions to Water |  |   |  |   |                       |
|------------------------------------|--|---|--|---|-----------------------|
| BAT Conclusion No                  | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC |   |  |   | ULEC Permit Documents |
|                                    |  |   | compounds, ammonium (NH <sub>4</sub> )   | the treatment of organic compounds. Aerobic biological treatment of ammonium (NH <sub>4</sub> <sup>+</sup> ) may not be applicable in the case of high chloride concentrations (i.e. around 10 g/l) |                       |
|                                    | d.   | Anoxic/anaerobic biological treatment                               | Mercury (Hg), nitrate (NO <sub>3</sub> <sup>-</sup> ), nitrite (NO <sub>2</sub> <sup>-</sup> ) | Generally Applicable  |                       |
|                                    | e.   | Coagulation and flocculation  | Suspended solids   |   |                       |
|                                    | f.   | Crystallisation   | Metals and metalloids, sulphate (SO <sub>4</sub> <sup>2-</sup> ), fluoride (F <sup>-</sup> )   |   |                       |
|                                    | g.   | filtration (e.g. sand filtration, microfiltration, ultrafiltration) | Suspended solids, metals   |   |                       |

| Water Usage and Emissions to Water |   |                |  |                       |
|------------------------------------|---|----------------|--|-----------------------|
| BAT Conclusion No                  | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC  |                |  | ULEC Permit Documents |
|                                    | h.  | Flotation      | Suspended solids, free oil   |                       |
|                                    | i.  | Ion exchange   | Metals   |                       |
|                                    | j.  | Neutralisation | Acids, alkalis   |                       |
|                                    | k.  | Oxidation      | Sulphide (S <sup>2-</sup> ), sulphite (SO <sub>3</sub> <sup>2-</sup> )                       |                       |
|                                    | l.  | Precipitation  | Metals and metalloids, sulphate (SO <sub>4</sub> <sup>2-</sup> ), fluoride (F <sup>-</sup> ) |                       |
|                                    | m.  | Sedimentation  | Suspended solids   |                       |
|                                    | n.  | Stripping      | Ammonia (NH <sub>3</sub> )   |                       |
|                                    | <p>The BAT-AELs refer to direct discharges to a receiving water body at the point where the emission leaves the installation. See table 10.1 of BREF document for full table of BAT-AELs.</p> |                |  |                       |

| Waste Management                    |   |   |  |           |             |               |                                     |
|-------------------------------------|---|---|--|-----------|-------------|---------------|-------------------------------------|
| BAT Conclusion No                   | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC  |   | ULEC Permit Documents  |           |             |               |                                     |
| 16                                  | <p>In order to reduce the quantity of waste sent for disposal from the combustion and/or gasification process and abatement techniques, BAT is to organise operations so as to maximise, in order of priority and taking into account life-cycle thinking:</p> <ul style="list-style-type: none"> <li>a. waste prevention, e.g. maximise the proportion of residues which arise as byproducts;</li> <li>b. waste preparation for reuse, e.g. according to the specific requested quality criteria;</li> <li>c. waste recycling;</li> <li>d. other waste recovery (e.g. energy recovery), by implementing an appropriate combination of techniques such as:</li> </ul> |   | <p>ULEC utilise natural gas as the fuel for the Energy Centre, therefore the combustion process does not lead to the production of waste. It is therefore determined that BAT 16 is not applicable.</p> <p><b>BC16 Status: N/A</b></p> |           |             |               |                                     |
|                                     | A   | <table border="1"> <thead> <tr> <th>Technique</th> <th>Description</th> <th>Applicability</th> </tr> </thead> <tbody> <tr> <td>Generation of gypsum as a byproduct</td> <td>Quality optimisation of the calcium-based reaction residues generated by the wet FGD so that they can be used as a substitute for mined gypsum (e.g. as raw material in the plasterboard industry). The quality of</td> <td>Generally applicable within the constraints associated with the required gypsum quality, the health requirements associated to each specific use, and by the market conditions</td> </tr> </tbody> </table> |  | Technique | Description | Applicability | Generation of gypsum as a byproduct |
| Technique                           | Description   | Applicability   |  |           |             |               |                                     |
| Generation of gypsum as a byproduct | Quality optimisation of the calcium-based reaction residues generated by the wet FGD so that they can be used as a substitute for mined gypsum (e.g. as raw material in the plasterboard industry). The quality of  | Generally applicable within the constraints associated with the required gypsum quality, the health requirements associated to each specific use, and by the market conditions  |  |           |             |               |                                     |

| Waste Management  |  |  |  |   |                       |
|-------------------|--|--|--|---|-----------------------|
| BAT Conclusion No | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC |  |  |   | ULEC Permit Documents |
|                   |  |  | limestone used in the wet FGD influences the purity of the gypsum produced   |   |                       |
|                   | B  | Recycling or recovery of residues in the construction sector | Recycling or recovery of residues (e.g. from semi-dry desulphurisation processes, fly ash, bottom ash) as a construction material (e.g. in road building, to replace sand in concrete production, or in the cement industry) | Generally applicable within the constraints associated with the required material quality (e.g. physical properties, content of harmful substances) associated to each specific use, and by the market conditions |                       |
|                   | C  | Energy recovery by using waste in the fuel mix               | The residual energy content of carbon-rich ash and sludges generated by the combustion of coal, lignite, heavy fuel oil, peat or biomass can   | Generally applicable where plants can accept waste in the fuel mix and are technically able to feed the fuels into the combustion chamber   |                       |

| Waste Management  |  |   |  |   |                       |
|-------------------|--|---|--|---|-----------------------|
| BAT Conclusion No | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC |   |  |   | ULEC Permit Documents |
|                   |  |   | be recovered for example by mixing with the fuel   |   |                       |
|                   | D  | Preparation of spent catalyst for reuse | Preparation of catalyst for reuse (e.g. up to four times for SCR catalysts) restores some or all of the original performance, extending the service life of the catalyst to several decades. Preparation of spent catalyst for reuse is integrated in a catalyst management scheme | The applicability may be limited by the mechanical condition of the catalyst and the required performance with respect to controlling NOX and NH3 emissions |                       |

| Noise Emissions  |   |  |   |                       |
|--|---|--|---|-----------------------|
| BAT Conclusion No  | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442/ Information that needs to be provided by ULEC |  |   | ULEC Permit Documents |
| 17   | In order to reduce noise emissions, BAT is to use one or a combination of the techniques given below.         |  |   |                       |
|  |   | Technique  | Description   | Applicability         |
|  | A   | Operational measures                                   | <p>These include:</p> <ul style="list-style-type: none"> <li>improved inspection and maintenance of equipment</li> <li>closing of doors and windows of enclosed areas, if possible</li> <li>equipment operated by experienced staff</li> <li>avoidance of noisy activities at night, if possible</li> <li>provisions for noise control during maintenance activities</li> </ul> | Generally applicable  |
| B  | Low-noise equipment   | This potentially includes compressors, pumps and disks | Generally applicable when the   |                       |
| <p>A) With regards to technique A, ULEC utilise operational measures to reduce noise emissions from the Energy Centres. As per the conditions of the planning permission for the Energy Centre (City of Liverpool, Application 08F/0688), the rating level of the noise emitted from any plant on site shall not exceed the existing background noise level. ULEC therefore carry out noise measurements and assessments in accordance with BS4142:1997 to ensure continued compliance with the planning consent.</p> <p>To ensure reduced noise emissions, ULEC operate with a Maintenance Schedule (EPR-OP01) as part of the operator's wider EMS. The site operates a strict maintenance regime and equipment is of sufficient capacity to allow down time for routine maintenance and servicing as recommended by the manufacturer.</p> <p>An appropriate number of fully trained operatives shall conduct the planned preventative maintenance within the Energy Centre. Weekly Site Inspection checks shall also be undertaken by a competent person and any defect identified that may lead to increased noise emissions shall be resolved and overseen by the Maintenance and Engineering Hub Manager. The Maintenance Schedule details all of the site infrastructure, inspection schedules and maintenance, service and calibration schedules.</p> <p>C) With regards to technique C, all plant within the Energy Centres is situated within enclosed buildings to further attenuate noise emissions. All windows and doors shall remain closed during operations to ensure appropriate screening and reduction of noise.</p> <p><b>BC17 Status: Compliant</b> - It is the operator's view that they are compliant with this BAT conclusion.</p> |   |  |   |                       |

| Noise Emissions   |   |   |   |  |                       |
|-------------------|---|---|---|--|-----------------------|
| BAT Conclusion No | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442/ Information that needs to be provided by ULEC |   |   |  | ULEC Permit Documents |
|                   |   |   |   | equipment is new or replaced   |                       |
|                   | C   | Noise attenuation                               | Noise propagation can be reduced by inserting obstacles between the emitter and the receiver. Appropriate obstacles include protection walls, embankments and buildings                         | Generally applicable to new plants. In the case of existing plants, the insertion of obstacles may be restricted by lack of space      |                       |
|                   | D   | Noise-control equipment                         | This includes: <ul style="list-style-type: none"> <li>• noise-reducers</li> <li>• equipment insulation</li> <li>• enclosure of noisy equipment</li> <li>• soundproofing of buildings</li> </ul> | The applicability may be restricted by lack of space   |                       |
|                   | E   | Appropriate location of equipment and buildings | Noise levels can be reduced by increasing the distance between the emitter and the receiver and by using buildings as noise screens   | Generally applicable to new plants. In the case of existing plants, the relocation of equipment and production units may be restricted |                       |



| Noise Emissions   |  |  |  |                       |
|-------------------|--|--|--|-----------------------|
| BAT Conclusion No | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442/<br>Information that needs to be provided by ULEC |  |  | ULEC Permit Documents |
|                   |  |  | by lack of space or<br>by excessive<br>costs |                       |

4.1.2 BAT Conclusions for the Combustion of Natural Gas

| Energy Efficiency |   |  |                       |             |               |                |                            |  |
|-------------------|---|--|-----------------------|-------------|---------------|----------------|----------------------------|--|
| BAT Conclusion No | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC  |  | ULEC Permit Documents |             |               |                |                            |  |
| 40                | In order to increase the energy efficiency of natural gas combustion, BAT is to use an appropriate combination of the techniques given in BAT 12 and below. |  |                       |             |               |                |                            |  |
|                   | A   | <table border="1"> <thead> <tr> <th>Technique</th> <th>Description</th> <th>Applicability</th> </tr> </thead> <tbody> <tr> <td>Combined cycle</td> <td>See descriptions in 10.8.2</td> <td>Generally applicable to new gas turbines and engines except when operated &lt; 1 500 h/yr. Applicable to existing gas turbines and engines within the constraints associated with the steam cycle design and the space availability. Not applicable to existing gas turbines and engines operated &lt; 1 500 h/yr.</td> </tr> </tbody> </table> | Technique             | Description | Applicability | Combined cycle | See descriptions in 10.8.2 | Generally applicable to new gas turbines and engines except when operated < 1 500 h/yr. Applicable to existing gas turbines and engines within the constraints associated with the steam cycle design and the space availability. Not applicable to existing gas turbines and engines operated < 1 500 h/yr. |
| Technique         | Description   | Applicability  |                       |             |               |                |                            |  |
| Combined cycle    | See descriptions in 10.8.2  | Generally applicable to new gas turbines and engines except when operated < 1 500 h/yr. Applicable to existing gas turbines and engines within the constraints associated with the steam cycle design and the space availability. Not applicable to existing gas turbines and engines operated < 1 500 h/yr.   |                       |             |               |                |                            |  |

| Energy Efficiency   |  |  |  |                       |
|---|--|--|--|-----------------------|
| BAT Conclusion No   | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC |  |  | ULEC Permit Documents |
|   |  |  | Not applicable to mechanical drive gas turbines operated in discontinuous mode with extended load variations and frequent start-ups and shutdowns. Not applicable to boilers |                       |
| Please see table 10.23 of the BREF document for BAT-associated emission levels (BAT-AEELs) for the combustion of natural gas. |  |  |  |                       |

| NO <sub>x</sub> , CO, NMVOC and CH <sub>4</sub> emissions to air |   |   |                      |                       |             |               |   |                         |   |                      |  |
|--|---|---|----------------------|-----------------------|-------------|---------------|---|-------------------------|---|----------------------|--|
| BAT Conclusion No  | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC  |   |                      | ULEC Permit Documents |             |               |   |                         |   |                      |  |
| 41   | <p>In order to prevent or reduce NO<sub>x</sub> emissions to air from the combustion of natural gas in boilers, BAT is to use one or a combination of the techniques given below.</p> <table border="1"> <thead> <tr> <th>Technique</th> <th>Description</th> <th>Applicability</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>Air and/or fuel staging</td> <td>See descriptions in Section 10.8.3. Air staging is often associated</td> <td>Generally applicable</td> </tr> </tbody> </table> |   |                      | Technique             | Description | Applicability | A | Air and/or fuel staging | See descriptions in Section 10.8.3. Air staging is often associated | Generally applicable | <p>C) With regards to technique C, the Danstoker boilers are fitted with low-NO<sub>x</sub> burners to control air and fuel mixing, reducing NO<sub>x</sub> emissions.</p> <p>D) With regards to technique D, the three Danstoker boilers are fitted with a controller and Boiler Management System that continually samples flue products of combustion to ensure effective combustion of the natural gas. The controller trims the burner in line with the results of the continuous sampling to maintain effective combustion and limit NO<sub>x</sub> emissions.</p> |
| Technique  | Description   | Applicability   |                      |                       |             |               |   |                         |   |                      |  |
| A  | Air and/or fuel staging   | See descriptions in Section 10.8.3. Air staging is often associated | Generally applicable |                       |             |               |   |                         |   |                      |  |

| NOx, CO, NMVOC and CH4 emissions to air |  |   |   |   |  |
|---|--|---|---|---|--|
| BAT Conclusion No                       | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC |   |   |   | ULEC Permit Documents  |
|   |  |   | with low-NOX burners  |   | <p><b>BC41 Status: Compliant</b> - It is the operator's view that they are compliant with this BAT conclusion.</p> |
|   | B  | Flue-gas recirculation                      | See description in Section 10.8.3   | Generally applicable  |  |
|   | C  | Low-NOX burners (LNB)                       |   | Generally applicable  |  |
|   | D  | Advanced control system                     | See description in Section 10.8.3. This technique is often used in combination with other techniques or may be used alone for combustion plants operated < 500 h/yr | The applicability to old combustion plants may be constrained by the need to retrofit the combustion system and/or control command system |  |
|   | E  | Reduction of the combustion air temperature | See description in Section 10.8.3   | Generally applicable within the constraints associated with the process needs   |  |
|   | F  | Selective non-catalytic reduction (SNCR)    |   | Not applicable to combustion plants operated < 500 h/yr with highly variable boiler loads.  |  |

| NOx, CO, NMVOC and CH4 emissions to air |  |                                     |  |                       |
|---|--|-------------------------------------|--|-----------------------|
| BAT Conclusion No                       | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC |                                     |  | ULEC Permit Documents |
|   |  |                                     | <p>The applicability may be limited in the case of combustion plants operated between 500 h/yr and 1 500 h/yr with highly variable boiler loads</p>  |                       |
|   | G  | Selective catalytic reduction (SCR) | <p>Not applicable to combustion plants operated &lt; 500 h/yr.<br/>Not generally applicable to combustion plants of &lt; 100 MWth.<br/>There may be technical and economic restrictions for retrofitting existing combustion plants operated between 500 h/yr and 1 500 h/yr</p> |                       |

| NOx, CO, NMVOC and CH4 emissions to air  |  |                                   |   |   |
|--|--|-----------------------------------|---|---|
| BAT Conclusion No  | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC   |                                   |   | ULEC Permit Documents   |
| 42   | In order to prevent or reduce NOx emissions to air from the combustion of natural gas in gas turbines, BAT is to use one or a combination of the techniques given below. |                                   |   |   |
|  | Technique  |                                   | Description   | Applicability   |
|  | A  | Advanced control system           | See description in Section 10.8.3. This technique is often used in combination with other techniques or may be used alone for combustion plants operated < 500 h/yr | The applicability to old combustion plants may be constrained by the need to retrofit the combustion system and/or control command system             |
|  | B  | Water/steam addition              | See description in Section 10.8.3   | The applicability may be limited due to water availability  |
|  | C  | Dry Low-NOX burners (DLN)         |   | The applicability may be limited in the case of turbines where a retrofit package is not available or when water/steam addition systems are installed |
| D  | Low-load design concept  | Adaptation of the process control | The applicability may be limited by   |   |
| <p>ULEC Energy Centre utilises CHP engines and boilers for the combustion of natural gas. It is therefore determined that BC42 is not applicable to the site.</p> <p><b>BC42 Status: N/A</b></p> |  |                                   |   |   |

| NOx, CO, NMVOC and CH4 emissions to air |  |                                     |   |  |                       |
|---|--|-------------------------------------|---|--|-----------------------|
| BAT Conclusion No                       | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC |                                     |   |  | ULEC Permit Documents |
|   |  |                                     | and related equipment to maintain good combustion efficiency when the demand in energy varies, e.g. by improving the inlet airflow control capability or by splitting the combustion process into decoupled combustion stages | the gas turbine design   |                       |
|   | E  | Low-NOx burners (LNB)               | See description in Section 10.8.3   | Generally applicable to supplementary firing for heat recovery steam generators (HRSGs) in the case of combined-cycle gas turbine (CCGT) combustion plants |                       |
|   | F  | Selective catalytic reduction (SCR) |   | Not applicable in the case of combustion plants operated < 500 h/yr.   |                       |

| NOx, CO, NMVOC and CH4 emissions to air |   |  |   |                       |             |               |   |                         |  |   |
|---|---|--|---|-----------------------|-------------|---------------|---|-------------------------|--|---|
| BAT Conclusion No                       | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC  |  |   | ULEC Permit Documents |             |               |   |                         |  |   |
|   |   |  | Not generally applicable to existing combustion plants of < 100 MWth. Retrofitting existing combustion plants may be constrained by the availability of sufficient space. There may be technical and economic restrictions for retrofitting existing combustion plants operated between 500 h/yr and 1 500 h/yr |                       |             |               |   |                         |  |   |
| 43                                      | <p>In order to prevent or reduce NOx emissions to air from the combustion of natural gas in engines, BAT is to use one or a combination of the techniques given below.</p> <table border="1"> <thead> <tr> <th>Technique</th> <th>Description</th> <th>Applicability</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>Advanced control system</td> <td>See description in Section 10.8.3. This technique is often used in</td> </tr> </tbody> </table> |  |   | Technique             | Description | Applicability | A | Advanced control system | See description in Section 10.8.3. This technique is often used in | <p>A) With regards to technique A, the Clarke CHP engine (CHP 1) is fitted with a DIA.NE engine management system. This provides a detailed analysis of the engine condition and allows the quick and effective diagnosis of any issues that may lead to increased emissions of NOx through combustion efficiency losses. This same system also controls the temperature within the engine to control the level of NOx emissions.</p> |
| Technique                               | Description   | Applicability  |   |                       |             |               |   |                         |  |   |
| A                                       | Advanced control system   | See description in Section 10.8.3. This technique is often used in |   |                       |             |               |   |                         |  |   |



| NOx, CO, NMVOC and CH4 emissions to air |  |                                     |  |  |   |
|---|--|-------------------------------------|--|--|---|
| BAT Conclusion No                       | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC |                                     |  |  | ULEC Permit Documents   |
|   |  |                                     | combination with other techniques or may be used alone for combustion plants operated < 500 h/yr | the need to retrofit the combustion system and/or control command system   | <p>The Edina CHP engines (CHP 2 &amp; CHP 3) are fitted with a TEM engine management system with COMAP. This controls the temperature of the cylinders and the wider engine system to ensure optimised combustion of natural gas and control NOx emissions. This also allows for efficient diagnosis of any issues that may lead to sub-optimal combustion, allowing effective maintenance to be undertaken in a timely manner.</p> <p>The Clarke CHP engine (CHP1) controls NOx emissions through the DIA.NE engine control system.</p> <p><b>BC43 Status: Compliant</b> - It is the operator's view that they are compliant with this BAT conclusion.</p> |
|   | B  | Lean-burn concept                   | See description in Section 10.8.3. Generally used in combination with SCR                        | Only applicable to new gas-fired engines   |   |
|   | C  | Advanced lean-burn concept          | See descriptions in Section 10.8.3   | Only applicable to new spark plug ignited engines  |   |
|   | D  | Selective catalytic reduction (SCR) |  | Retrofitting existing combustion plants may be constrained by the availability of sufficient space. Not applicable to combustion plants operated < 500 h/yr. There may be technical and economic restrictions for retrofitting existing combustion |   |

| NOx, CO, NMVOC and CH4 emissions to air |  |  |   |   |
|---|--|--|---|---|
| BAT Conclusion No                       | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC   |  |   | ULEC Permit Documents   |
|   |  |  | plants operated between 500 h/yr and 1 500 h/yr |   |
| 44                                      | <p>In order to prevent or reduce CO emissions to air from the combustion of natural gas, BAT is to ensure optimised combustion and/or to use oxidation catalysts.</p> <p>Please see table 10.24 of the BREF document for BAT-associated emission levels (BAT-AELs) for NOx emissions to air from the combustion of natural gas.</p> <p>Please see table 10.25 of the BREF document for BAT-associated emission levels (BAT-AELs) for NOx emissions to air from the combustion of natural gas in boilers and engines.</p> |  |   | <p><b>Optimised Combustion</b><br/>ULEC utilise the engine and boiler management systems described above to ensure optimisation of the combustion process within the three CHP engines and three boilers.</p> <p>The Clarke CHP engine (CHP 1) is fitted with a DIA.NE engine management system. This provides a detailed analysis of the engine condition and allows the quick and effective diagnosis of any issues that may lead to increased emissions of CO through combustion efficiency losses.</p> <p>The Edina CHP engines (CHP 2 &amp; CHP 3) are fitted with a TEM engine management system. This control the temperature of the cylinders and the wider engine system to ensure optimised combustion of natural gas. This also allows for efficient diagnosis of any issues that may lead to sub-optimal combustion and increased CO emissions, allowing effective maintenance to be undertaken in a timely manner.</p> <p>The three Danstoker boilers are fitted with a controller that continually samples flue products of combustion to ensure effective combustion of the natural gas. The controller trims the burner in line with the results of the continuous sampling to maintain effective combustion and reduce CO emissions.</p> |

| NO <sub>x</sub> , CO, NMVOC and CH <sub>4</sub> emissions to air |  |  |
|--|--|--|
| BAT Conclusion No  | BAT Guidance (Adapted from Annex I of Directive (EU) 2017/1442 / Information that needs to be provided by ULEC   | ULEC Permit Documents  |
|  |  | <b>BC44 Status: Compliant</b> - It is the operator's view that they are compliant with this BAT conclusion.  |
| 45   | <p>In order to reduce non-methane volatile organic compounds (NMVOC) and methane (CH<sub>4</sub>) emissions to air from the combustion of natural gas in spark-ignited lean-burn gas engines, BAT is to ensure optimised combustion and/or to use oxidation catalysts.</p> <p>Please see table 10.26 of the BREF document for BAT-associated emission levels (BAT-AELs) for formaldehyde and CH<sub>4</sub> emissions to air from the combustion of natural gas in a spark-ignited lean-burn gas engine.</p> | <p>ULEC Energy Centre utilises CHP engines and boilers for the combustion of natural gas. It is therefore determined that BC45 is not applicable to the site.</p> <p><b>BC45 Status: N/A</b></p> |

## 5.0 CONCLUSION

University of Liverpool Energy Company Ltd operate Energy Centres at their site on Ashton Street, Liverpool which meets the Best Available Technique as described in the Best Available Techniques (BAT) Reference Document for Large Combustion Plants 2017 (BREF) document, as well as the *Commission Implementing Decision (EU) 2017/1442*.



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