# Environment Agency

# Review of an Environmental Permit for an Installation subject to Chapter II of the Industrial Emissions Directive under the Environmental Permitting (England & Wales) Regulations 2016

# Decision document recording our decision-making process following review of a permit

The Permit number is: EPR/BV3006IN
The Operator is: Seabank Power Limited
The Installation is: Seabank Power Station
This Variation Notice number is: EPR/BV3006IN/V005

## What this document is about

Article 21(3) of the Industrial Emissions Directive (IED) requires the Environment Agency to review conditions in permits that it has issued and to ensure that the permit delivers compliance with relevant standards, within four years of the publication of updated decisions on best available techniques (BAT) Conclusions.

We have reviewed the permit for this installation against the revised BAT Conclusions for large combustion plant (LCP) published on 17th August 2017. This is our decision document, which explains the reasoning for the consolidated variation notice that we are issuing.

It explains how we have reviewed and considered the techniques used by the Operator in the operation and control of the plant and activities of the installation. This review has been undertaken with reference to the decision made by the European Commission establishing BAT Conclusions ('BAT Conclusions') for LCP as detailed in document reference IEDC-7-1. It is our record of our decision-making process and shows how we have taken into account all relevant factors in reaching our position. It also provides a justification for the inclusion of any specific conditions in the permit that are in addition to those included in our generic permit template.

As well as considering the review of the operating techniques used by the Operator for the operation of the plant and activities of the installation, the consolidated variation notice takes into account and brings together in a single document all previous variations that relate to the original permit issued. It also modernises the entire permit to reflect the conditions contained in our current generic permit template.

The introduction of new template conditions makes the permit consistent with our current general approach and philosophy and with other permits issued to installations in this sector. Although the wording of some conditions has changed, while others have been removed because of the new regulatory approach, it does not reduce the level of environmental protection achieved by the permit in any way. In this document we therefore address only our determination of substantive issues relating to the new BAT Conclusions.

We try to explain our decision as accurately, comprehensively and plainly as possible. We would welcome any feedback as to how we might improve our decision documents in future. A lot of technical terms and acronyms are inevitable in a document of this nature: we provide a glossary of acronyms near the front of the document, for ease of reference.

## How this document is structured

# Glossary of acronyms used in this document

(Please note that this glossary is standard for our decision documents and therefore not all these acronyms are necessarily used in this document.)

| | |
|---|---|
| BAT | Best Available Technique(s) |
| BAT-AEEL | BAT Associated Energy Efficiency Level |
| BAT-AEL | BAT Associated Emission Level |
| BATc | BAT conclusion |
| BREF | Best available techniques reference document |
| CCGT | Combined Cycle Gas Turbine |
| CEM | Continuous emissions monitor |
| CHP | Combined heat and power |
| CV | Calorific value |
| DAA | Directly associated activity – Additional activities necessary to be carried out to allow the principal activity to be carried out |
| DLN | Dry Low NOx burners |
| DLN-E | Dry Low NOx effective |
| EIONET | European environment information and observation network is a partnership network of the European Environment Agency |
| ELV | Emission limit value derived under BAT or an emission limit value set out in IED |
| EMS | Environmental Management System |
| EPR | Environmental Permitting (England and Wales) Regulations 2016 (SI 2016 No. 1154) |
| EWC | European waste catalogue |
| FSA | Food Standards Agency |
| IC | Improvement Condition |
| IED | Industrial Emissions Directive (2010/75/EU) |
| IPPCD | Integrated Pollution Prevention and Control Directive (2008/1/EC) – now superseded by IED |
| LCP | Large Combustion Plant subject to Chapter III of IED |
| MSUL/MSDL | Minimum start up load/minimum shut-down load |
| NOx | Oxides of nitrogen (NO plus $NO_2$ expressed as $NO_2$) |
| NPV | Net Present Value |
| OCGT | Open Cycle Gas Turbine |
| PHE | Public Health England |
| SAC | Special Area of Conservation |
| SGN | Sector guidance note |
| TGN | Technical guidance note |
| WFD | Water Framework Directive (2000/60/EC) |

# 1 Our decision

We have decided to issue the consolidated variation notice to the Operator. This will allow them to continue to operate the installation, subject to the conditions in the consolidated variation notice.

We consider that, in reaching that decision, we have taken into account all relevant considerations and legal requirements and that the varied permit will ensure that a high level of protection is provided for the environment and human health.

The consolidated variation notice contains many conditions taken from our standard Environmental Permit template including the relevant Annexes. We developed these conditions in consultation with industry, having regard to the legal requirements of the Environmental Permitting Regulations and other relevant legislation. This document does not therefore include an explanation for these standard conditions. Where they are included in the Notice, we have considered the techniques identified by the Operator for the operation of their installation, and have accepted that the details are sufficient and satisfactory to make those standard conditions appropriate. This document does, however, provide an explanation of our use of “tailor-made” or installation-specific conditions, or where our permit template provides two or more options.

# 2 How we reached our decision

## 2.1 Requesting information to demonstrate compliance with BAT Conclusions for Large Combustion Plant

We issued a Notice under Regulation 61(1) of the Environmental Permitting (England and Wales) Regulations 2016 (a Regulation 61 Notice) on 1st May 2018 requiring the Operator to provide information to demonstrate how the operation of their installation currently meets, or will subsequently meet, the revised standards described in the LCP BAT Conclusions document. The Notice also required that where the revised standards are not currently met, the Operator should provide information that:

- Describes the techniques that will be implemented before 17th August 2021, which will then ensure that operations meet the revised standard, or
- Justifies why standards will not be met by 17th August 2021, and confirmation of the date when the operation of those processes will cease within the installation or an explanation of why the revised BAT standard is not applicable to those processes, or
- Justifies why an alternative technique will achieve the same level of environmental protection equivalent to the revised standard described in the BAT Conclusions.

Where the Operator proposed that they were not intending to meet a BAT standard that also included a BAT Associated Emission Level (BAT AEL) described in the BAT Conclusions Document, the Regulation 61 Notice requested that the Operator make a formal request for derogation from compliance with that AEL (as provisioned by Article 15(4) of IED). In this circumstance, the Notice identified that any such request for derogation must be supported and justified by sufficient technical and commercial information that would enable us to determine acceptability of the derogation request.

The Regulation 61 Notice response from the Operator was received on 30th October 2018.

### 2.2 Review of our own information in respect to the capability of the installation to meet revised standards included in the BAT Conclusions document

Based on our records and previous regulatory activities with the facility we have no reason to consider that the operator will not be able to comply with the conditions that we include in the permit.

# 3 The legal framework

The consolidated variation notice will be issued under Regulation 20 of the EPR. The Environmental Permitting regime is a legal vehicle which delivers most of the relevant legal requirements for activities falling within its scope. In particular, the regulated facility is:

- an *installation* as described by the IED;
- subject to aspects of other relevant legislation which also have to be addressed.

We consider that the consolidated variation notice will ensure that the operation of the Installation complies with all relevant legal requirements and that a high level of protection will be delivered for the environment and human health.

We explain how we have addressed specific statutory requirements more fully in the rest of this document.

# 4 The key issues

The key issues arising during this permit review are:

- Emissions to air and the emission limits applied to the plant.
- The energy efficiency levels associated with the Best Available Techniques (BAT-AEELs)
- The assessment of BAT for gas turbines operating <500 hours per year.

We therefore describe how we determined these issues in most detail in the relevant sections of this document.

## 4.1 Emissions to air and the emission limits applied to the plant

A number of general principles were applied during the permit review. These included:

- The upper value of the BAT AELs ranges specified were used unless use of the tighter limit was justified.
- The principle of no backsliding where if existing limits in the permit were already tighter than those specified in the BREF, the existing permit limits were retained.
- Where a limit was specified in both IED Annex V and the BAT Conclusions for a particular reference period, the tighter limit was applied and in the majority of cases this was from the BAT Conclusions.
- Where AELs are indicative in the BAT Conclusions, these were applied unless adequate justification was provided by the Operator to demonstrate that an alternative limit was more appropriate.
- For gas turbines where the IED specified that limits applied over 70% load and the BAT Conclusions specified that AELs applied when dry low NOx is effective (DLN-E), we have used DLN-E as a default across all monitoring requirements for NOx and CO.

Seabank Power Station is a combined cycle gas turbine (CCGT) plant fired on natural gas which is supplied via a 26 km dedicated gas line from the National Grid Gas Network. There are two modules on site.

The net thermal input of the LCPs is as follows:

LCP313 consists of one 657.861 MWth CCGT;

LCP314 consists of one 657.861 MWth CCGT;

LCP315 consists of one 672.714 MWth CCGT; and

LCP409 consists of one OCGT and its thermal input will be notified under existing pre operational condition PO 1.

Module 1 (LCP313, LCP314) has two gas turbines and two heat recovery steam generators with one steam turbine, this generates approximately 755 MW of electrical power.

Module 2 (LCP315) has one gas turbine, one heat recovery steam generator and one steam turbine, this generates approximately 385 MW of electrical power.

The combined thermal input of modules 1 and 2 is 1,988 MWth.

LCP313, LCP314 and LCP315 are also authorised to operate in open cycle mode for a maximum of 500 hours per year each. The plant emits to air via the same stack during open and combined cycle mode and therefore continuous monitoring is carried out when in both modes.

The plant was put into operation before IED came into force and therefore the limits in the permit are from Part 1 of IED Annex V applicable to existing plant.

The ELVs and AELs are based on the following operating regime:

- LCP314, LCP314, LCP315 - Unlimited hours for CCGT operation with <500 hours/year for OCGT operation via the same stacks.
- LCP409 - <500 hours/year emergency plant for OCGT not yet built.

The existing minimum start up and shut down loads do not specify % load. The operator has confirmed that they are equivalent to approximately 170 MW and 60% of rated power output which is below the 70% required by Annex V of IED.

The following tables outline the limits that have been incorporated into the permit for LCP313, LCP314 and LCP315, where these were derived from and the reference periods at which they apply. The emission limits refer to concentrations, expressed as mass of emitted substance per volume of flue-gas under the following standard conditions: dry gas at a temperature of 273.15 K, pressure of 101.3 kPa and 15% volume reference oxygen concentration in the flue gases. The emission limits and monitoring requirements have been incorporated into Schedule 3 of the permit.

The permit specified additional periodic hourly monitoring requirements for oxides of nitrogen and carbon monoxide to be carried out annually. We have removed these from the current and post 2021 monitoring requirements as consider the continuous emissions monitoring in place is adequate to demonstrate compliance against chapter III and the BREF.

An additional daily limit from start up/shut down to baseload has been added to the limits in table S3.1a. Although this is not a regulatory requirement, it was requested by the Emissions Methodology Working Group of the Joint Environmental Protocol to ensure consistency across the sites.

No changes have been made to the monitoring or reporting requirements for LCP409 as this is emergency only plant and the BAT Conclusions specify that the Associated Emission Limit values are not applicable to emergency only plant.

### LCP313, LCP314 and LCP315: natural gas fired Combined Cycle Gas Turbines

| NOx limits (mg/Nm$^3$) | | | | | | |
|---|---|---|---|---|---|---|
| **Averaging** | **IED (Annex V Part 1) – Existing** | **BREF (Table 24 BAT-C 44)** | **Expected permit limits** | **Basis** | **Limits apply** | **Monitoring** |
| **Annual** | None | 40 | 41.2 (LCP313, LCP314)<br>40.8 (LCP315)<br>Note 2 | BREF | DLN effective to baseload | Continuous |
| **Monthly** | 75 Note 1 | None | 75 | BREF | DLN effective to baseload | |
| **Daily** | 82 Note 1 | 50 | 51.5 (LCP313, LCP314)<br>51 (LCP315)<br>Note 2 | BREF | DLN effective to baseload | |
| **95$^{th}$ %ile of hr means** | 150 Note 1 | None | 150 | IED | DLN effective to baseload | |
| Note 1: ELVs from IED based on the higher values because the plant is greater than 55% efficient.<br>Note 2: Expected ELVs based on energy efficiency uplift set out in associated footnote to table 24. | | | | | | |

| CO limits (mg/Nm$^3$) | | | | | | |
|---|---|---|---|---|---|---|
| **Averaging** | **IED (Annex V Part 1) – Existing** | **BREF (Table 24 BAT-C 44)** | **Expected permit limits** | **Basis** | **Limits apply** | **Monitoring** |
| **Annual** | None | 30 | Note 1 | BREF | DLN effective to baseload | Continuous |
| **Monthly** | 100 | None | 90 | Existing permit | DLN effective to baseload | |
| **Daily** | 110 | None | 100 | Existing permit | DLN effective to baseload | |
| **95$^{th}$ %ile of hr means** | 200 | None | 180 | Existing permit | DLN effective to baseload | |
| Note 1: The yearly annual carbon monoxide AEL is indicative. Due to optimisation of the plant for meeting the relevant NOx limits, the operator has confirmed that emissions of CO have the potential to be higher than 30mg/m$^3$ annually. We have therefore specified an improvement condition requiring the operator to investigate this and propose an appropriate limit if appropriate. | | | | | | |

## 4.2 The energy efficiency levels associated with the Best Available Techniques Conclusions

An energy efficiency level associated with the best available techniques (BAT-AEEL) refers to the ratio between the combustion unit's net energy output(s) and the combustion unit's fuel/feedstock energy input at actual unit design. The net energy output(s) is determined at the combustion unit boundaries, including auxiliary systems (e.g. flue-gas treatment systems), and for the unit operated at full load.

The table below sets out the BAT-AEELs specified in the LCP BAT Conclusions for the LCP on the site and the energy efficiency levels confirmed through the Regulation 61 notice response.

The Operator confirmed that the CCGTs have been performance acceptance tested at full load by the OEM after commissioning to applicable ISO and ASME standards for Gas Turbine Acceptance Tests and Performance Test Code respectively.

LCP313 and LCP314 were further performance acceptance tested at full load in 2008 following a modification which significantly affected the net total fuel utilisation and the net electrical efficiency (improved). The net electrical efficiency was improved by this modification. The site also have an in-house thermodynamic model which calculates efficiency at full load corrected back to reference conditions. This is used daily to determine performance and has been independently reviewed.

| BAT AEELs (%) | | | Plant efficiency (%) | | |
|---|---|---|---|---|---|
| Net electrical efficiency | Net total fuel utilisation | Net mechanical efficiency | Net electrical efficiency | Net total fuel utilisation | Net mechanical efficiency |
| LCP313, LCP314 and LCP315: CCGT >600MWth | | | | | |
| 50 - 60 | None | None | >55% | NA | NA |

LCP409 has not yet been built so we have not considered this in further detail at this stage. The process monitoring requirement for energy efficiency in the permit would ensure that the efficiency of the plant would be reported within four months of commissioning.

## 4.3 The review and assessment of BAT for gas turbines operating <500 hours per year

The proposed <500 hours per year (LCP409) black start plant has not yet been built and therefore we have not assessed the application of BAT further in this document. There are pre operational conditions requiring a BAT demonstration of the plant to be provided to us if the plant is built.

# 5 Decision checklist regarding relevant BAT Conclusions

BAT Conclusions for LCP, were published by the European Commission on 17th August 2017. There are 75 BAT Conclusions. Only the BAT Conclusions relevant to the particular fuel type used on site have been replicated below.

This annex provides a record of decisions made in relation to each relevant BAT Conclusion applicable to the installation. This annex should be read in conjunction with the consolidated variation notice.

The conditions in the permit through which the relevant BAT Conclusions are implemented include but are not limited to the following:

| BAT Conclusion requirement topic | Permit condition(s) | Permit table(s) |
|---|---|---|
| Environmental Management System | 1.1.1 | S1.2 |
| BAT AELs | 3.1.1 and 3.5.1 | S3.1a |
| Monitoring | 2.3, 3.5 and 3.6 | S1.2, S1.3 S3.1a |
| Energy efficiency | 1.2 and 2.3 | S3.3 |
| Noise | 2.3 and 3.4 | S1.2 |
| Other operating techniques | 2.3 | S1.2 |

The overall status of compliance with the BAT Conclusion is indicated in the table as:

NA Not Applicable
CC Currently Compliant
FC Compliant in the future (within 4 years of publication of BAT conclusions)
NC Not Compliant
PC Partially Compliant

| BAT Concn. Number | Summary of BAT Conclusion requirement | Status NA/ CC / FC / NC | Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement |
|---|---|---|---|
| **General** | | | |
| 1 | **In order to improve the overall environmental performance, BAT is to implement and adhere to an environmental management system (EMS) that incorporates all of the following features:**<br>i. commitment of the management, including senior management;<br>ii. definition of an environmental policy that includes the continuous improvement of the installation by the management;<br>iii. planning and establishing the necessary procedures, objectives and targets, in conjunction with financial planning and investment;<br>iv. implementation of procedures<br>(a) Structure and responsibility<br>(b) Training<br>(c) Communication<br>(d) Employee involvement<br>(e) Documentation<br>(f) Efficient process control<br>(g) Maintenance programmes<br>(h) Emergency preparedness and response<br>(i) Safeguarding compliance with environmental legislation<br>v. checking performance and taking corrective action, paying particular attention to:<br>(a) monitoring and measurement (see also the Reference Document on the General Principles of Monitoring)<br>(b) corrective and preventive action<br>(c) maintenance of records<br>(d) independent (where practicable) internal and external auditing in order to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained;<br>vi. review of the EMS and its continuing suitability, adequacy and effectiveness by senior management;<br>vii. following the development of cleaner technologies;<br>viii. consideration for the environmental impacts from the eventual decommissioning of the installation at the stage of designing a new plant, and throughout its operating life;<br>viii. consideration for the environmental impacts from the eventual decommissioning of the installation at the stage of designing a new plant, and throughout its operating life;<br>ix. application of sectoral benchmarking on a regular basis.<br>Etc - see BAT Conclusions<br><br>**Applicability**. The scope (e.g. level of detail) and nature of the EMS (e.g. standardised or non-standardised) will | CC | The EMS is certified to ISO14001:2015 and includes the identification of the environmental Aspects and Impacts of the business and assigned Objectives and Targets to provide improvements in environmental performance. This is reviewed regularly. |

<table>
<tr><th>BAT Concn. Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th></tr>
<tr><td></td><td>generally be related to the nature, scale and complexity of the installation, and the range of environmental impacts it may have.</td><td></td><td></td></tr>
<tr><td>2</td><td>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.</td><td>CC</td><td>CCGTs have been performance acceptance tested – see key issues section above for more information on efficiency.</td></tr>
<tr><td>3</td><td>BAT is to monitor key process parameters relevant for emissions to air and water including those given below.
<table>
<tr><th>Stream</th><th>Parameter(s)</th><th>Monitoring</th></tr>
<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 (3)</td></tr>
<tr><td>Waste water from flue-gas treatment</td><td>Flow, pH, and temperature</td><td>Continuous measurement</td></tr>
</table></td><td>CC</td><td>The Distributed Control System continuously monitors and records the process parameters for air and water. These include calibrated instrument inputs from the Continuous Emissions Monitoring System (CEMS) for flue-gas parameters of air flow, temperature, pressure, water vapour and oxygen content as well as treated effluent discharge parameters of flow, pH and temperature. Flue gas emissions are not treated and do not go to water.</td></tr>
<tr><td>4</td><td>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.
<table>
<tr><th>Substance/Parameter</th><th>Fuel/Process/Type of combustion plant</th><th>Combustion plant total rated thermal input</th><th>Standard(s) (4)</th><th>Minimum monitoring frequency (5)</th><th>Monitoring associated with</th></tr>
<tr><td>$NH_3$</td><td>— When SCR and/or SNCR is used</td><td>All sizes</td><td>Generic EN standards</td><td>Continuous (6) (7)</td><td>BAT 7</td></tr>
<tr><td>$NO_X$</td><td>— Coal and/or lignite including waste co-</td><td>All sizes</td><td>Generic EN standards</td><td>Continuous (6) (8)</td><td>BAT 20<br>BAT 24</td></tr>
</table></td><td>CC</td><td>CEMS monitoring in place for gas turbines other than LCP409 as <500 hours. This is an MCERTS certified installation and includes continuous monitoring of $NO_x$ and CO. The site also calculates the annual tonnes of dust and $SO_2$.</td></tr>
</table>

| BAT Concn. Number | Summary of BAT Conclusion requirement | | | | | | Status NA/ CC / FC / NC | Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement |
|---|---|---|---|---|---|---|---|---|
| | | incineration<br>— Solid biomass and/or peat including waste co-incineration<br>— HFO- and/or gas-oil-fired boilers and engines<br>— Gas-oil-fired gas turbines<br>— Natural-gas-fired boilers, engines, and turbines<br>— Iron and steel process gases<br>— Process fuels from the chemical industry<br>— IGCC plants | | | | BAT 28<br>BAT 32<br>BAT 37<br>BAT 41<br>BAT 42<br>BAT 43<br>BAT 47<br>BAT 48<br>BAT 56<br>BAT 64<br>BAT 65<br>BAT 73 | | |
| | | — Combustion plants on offshore platforms | All sizes | EN 14792 | Once every year [9] | BAT 53 | | |
| | $N_2O$ | — Coal and/or lignite in circulating fluidised bed boilers<br>— Solid biomass and/or peat in circulating fluidised bed boilers | All sizes | EN 21258 | Once every year [10] | BAT 20<br>BAT 24 | | |
| | CO | — Coal and/or lignite including waste co-incineration<br>— Solid biomass and/or peat including waste co-incineration<br>— HFO- and/or gas-oil-fired boilers and engines<br>— Gas-oil-fired gas turbines<br>— Natural-gas-fired boilers, engines, and turbines<br>— Iron and steel process gases | All sizes | Generic EN standards | Continuous [6] [8] | BAT 20<br>BAT 24<br>BAT 28<br>BAT 33<br>BAT 38<br>BAT 44<br>BAT 49<br>BAT 56<br>BAT 64<br>BAT 65<br>BAT 73 | | |

<table>
<tr><th>BAT Concn. Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th></tr>
<tr><td></td><td>
<table>
<tr><td></td><td>— Process fuels from the chemical industry<br>— IGCC plants</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>— Combustion plants on offshore platforms</td><td>All sizes</td><td>EN 15058</td><td>Once every year (9)</td><td>BAT 54</td></tr>
<tr><td>$SO_2$</td><td>— Coal and/or lignite incl waste co-incineration<br>— Solid biomass and/or peat incl waste co-incineration<br>— HFO- and/or gas-oil-fired boilers<br>— HFO- and/or gas-oil-fired engines<br>— Gas-oil-fired gas turbines<br>— Iron and steel process gases<br>— Process fuels from the chemical industry in boilers<br>— IGCC plants</td><td>All sizes</td><td>Generic EN standards and EN 14791</td><td>Continuous (6) (11) (12)</td><td>BAT 21<br>BAT 25<br>BAT 29<br>BAT 34<br>BAT 39<br>BAT 50<br>BAT 57<br>BAT 66<br>BAT 67<br>BAT 74</td></tr>
<tr><td>$SO_3$</td><td>— When SCR is used</td><td>All sizes</td><td>No EN standard available</td><td>Once every year</td><td>—</td></tr>
</table>
</td><td></td><td></td></tr>
<tr><td>5</td><td>BAT is to monitor emissions to water from flue-gas treatment with at least the frequency given in BAT 5 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.</td><td>NA</td><td>No flue gas treatment.</td></tr>
<tr><td>6</td><td>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.
<table>
<tr><th colspan="2">Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>a.</td><td>Fuel blending and mixing</td><td>Ensure stable combustion conditions and/or reduce the emission of pollutants by mixing different qualities of the same fuel type</td><td rowspan="2">Generally applicable</td></tr>
<tr><td>b.</td><td>Maintenance of</td><td>Regular planned maintenance according to</td></tr>
</table>
</td><td>CC</td><td>The EMS includes Environmental Objectives. The Objectives have achievable targets for environmental improvements derived from sources such as external/internal audits, emergency exercises, suggestions, concerns and observations. These are all recorded and then reviewed by the</td></tr>
</table>

| BAT Concn. Number | Summary of BAT Conclusion requirement | Status NA/ CC / FC / NC | Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement |
|---|---|---|---|
| | <table><tr><td></td><td>the combustion system</td><td>suppliers' recommendations</td><td></td></tr><tr><td>c.</td><td>Advanced control system</td><td>See description in Section 8.1</td><td>The applicability to old combustion plants may be constrained by the need to retrofit the combustion system and/or control command system</td></tr><tr><td>d.</td><td>Good design of the combustion equipment</td><td>Good design of furnace, combustion chambers, burners and associated devices</td><td>Generally applicable to new combustion plants</td></tr><tr><td>e.</td><td>Fuel choice</td><td>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</td><td>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.<br>For existing combustion plants, the type of fuel chosen may be limited by the configuration and the design of the plant</td></tr></table> | | HSE Panel. Applicable improvements are given an action/response, action, due date and status. Their status is regularly reviewed until close out. Previously completed actions include combustion burner optimisation to further reduce $NO_x$, logic changes to the advanced control system to reduce time spent in start-up and shut down modes including allowing premix before synchronisation and minimising internal energy initiatives such as the shutting down of 1 x cooling water pump when applicable. In terms of fuel choice, although this type of gas turbine can be run on HFO, the plant is designed, built and commissioned to operate with only natural gas. The combustion equipment is operated and maintained in line with the OEM recommendations (who also provide the maintenance service) and continues to provide environmental improvements. |

| BAT Concn. Number | Summary of BAT Conclusion requirement | Status NA/ CC / FC / NC | Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement |
|---|---|---|---|
| 7 | 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 $NO_X$ emissions, BAT is to optimise the design and/or operation of SCR and/or SNCR (e.g. optimised reagent to $NO_X$ ratio, homogeneous reagent distribution and optimum size of the reagent drops).<br>**BAT-associated emission levels**<br>The BAT-associated emission level (BAT-AEL) for emissions of $NH_3$ to air from the use of SCR and/or SNCR is < 3–10 mg/$Nm^3$ as a yearly average or average over the sampling period. The lower end of the range can be achieved when using SCR and the upper end of the range can be achieved when using SNCR without wet abatement techniques. In the case of plants combusting biomass and operating at variable loads as well as in the case of engines combusting HFO and/or gas oil, the higher end of the BAT-AEL range is 15 mg/$Nm^3$. | NA | No SCR or SNCR in use. |
| 8 | 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. | CC | The Dry Low $NO_x$ (DLN) emissions abatement system is designed and built into the gas turbine combustion burners and is therefore active from premix mode which occurs prior to synchronisation. The burners were optimised in 2011 to further reduce $NO_x$. The start-up operation is optimised to minimise the amount of time in high $NO_x$ diffusion mode. The burner temperatures are monitored in real time and the $NO_x$ in mg/$Nm^3$/MW is reviewed regularly at the performance meeting to look for trends and developing patterns. |
| 9 | 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):<br>(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; | CC | We consider that for plants which burn natural gas from the National Grid as a fuel that it is not necessary for the Operator to replicate the testing carried out by the National Grid. However, for clarity we have included the |

<table>
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<tr><td></td><td>(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);<br>(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 8.1)).<br>Description<br>Initial characterisation and regular testing of the fuel can be performed by the operator and/or the fuel supplier. If performed by the supplier, the full results are provided to the operator in the form of a product (fuel) supplier specification and/or guarantee.
<table>
<tr><th>Fuel(s)</th><th>Substances/Parameters subject to characterisation</th></tr>
<tr><td>Natural gas</td><td>— LHV<br>— $CH_4$, $C_2H_6$, $C_3$, $C_4$+, $CO_2$, $N_2$, Wobbe index</td></tr>
</table></td><td></td><td>following text provided by the operator:<br><br>The site has a calibrated gas chromatograph which provides on line gas composition data including Lower Heating Value from the calorific value, the hydrocarbon content, nitrogen and Wobbe index. This can be used for quality control to compare the incoming gas quality against the specification to ensure the compositional elements are within tolerance.</td></tr>
<tr><td>10</td><td>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:<br>— 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),<br>— set-up and implementation of a specific preventive maintenance plan for these relevant systems,<br>— review and recording of emissions caused by OTNOC and associated circumstances and implementation of corrective actions if necessary,<br>— periodic assessment of the overall emissions during OTNOC (e.g. frequency of events, duration, emissions quantification/estimation) and implementation of corrective actions if necessary.</td><td>CC</td><td>The CCGTs are contracted to provide flexible generation and 2-shift operation frequently as determined by the Customer and the Grids requirements. As such they can spend time in OTNOC start-up and shut-down modes which generate more emissions than normal operation. The EMS Objective 'Reduce energy consumption/increase energy efficiency' has been and continues to be targeted by implementing improvements that reduce emissions in this OTNOC. These include, the optimisation of the gas turbine combustion burners in 2011 including the premix mode before synchronisation and the measuring, monitoring and</td></tr>
</table>

<table>
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<tr><td></td><td></td><td></td><td>reporting of mg/Nm$^3$($NO_x$) per MWe. Seabank have also actively reduced the MWs of internal energy required by reducing houseload requirements. Furthermore the time for a start-up and shut-down has been reduced through optimisation of the advanced control system logic including reduction of waiting times, warming times and incorporating OEM gas turbine fleet experience. Other OTNOCs such as trips and failed starts would be recorded as incidents/near misses and tracked through to the route cause.</td></tr>
<tr><td>11</td><td>BAT is to appropriately monitor emissions to air and/or to water during OTNOC.<br>Description<br>The monitoring can be carried out by direct measurement of emissions or by monitoring of surrogate parameters if this proves to be of equal or better scientific quality than the direct measurement of emissions. Emissions during start-up and shutdown (SU/SD) may be assessed based on a detailed emission measurement carried out for a typical SU/SD procedure at least once every year, and using the results of this measurement to estimate the emissions for each and every SU/SD throughout the year.</td><td>CC</td><td>CEMS continuously monitor the emission to air (in the flue-gas for LCP313, 314 and 315) for $NO_x$ and CO as well as the temperature, flow and pH of the treated effluent discharge. There is fortnightly sampling and analysis of the treated effluent discharge for biochemical oxygen demand (BOD), cadmium, sulphate and suspended solids. The mercury in the treated effluent is calculated and spot samples are taken to look for visible oil or grease.</td></tr>
<tr><td>12</td><td>In order to increase the energy efficiency of combustion, gasification and/or IGCC units operated ≥ 1 500 h/yr, BAT is to use an appropriate combination of the techniques given below.
<table>
<tr><th>Technique</th><th>Description</th><th>Applicability</th></tr>
</table></td><td>CC</td><td>Seabank currently operate the CCGT Power Station optimised for base load running using DLN designed burners to minimise $NO_x$.</td></tr>
</table>

| BAT Concn. Number | Summary of BAT Conclusion requirement | | | | Status NA/ CC / FC / NC | Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement |
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| | a. | Combustion optimisation | See description in Section 8.2.<br>Optimising the combustion minimises the content of unburnt substances in the flue-gases and in solid combustion residues | Generally applicable | | Energy consumption reduction measures have reduced the internal energy consumption. Studies and logic changes have reduced the time for less efficient start-up and shut-down modes. The control system provides the ability to influence the combustion parameters for ambient temperature related optimisation and stability. Fuel heating is used to avoid dew point issues due to the pressure drop from transfer to use. The anti-icing system bleeds off a proportion of the compressor air back into the compressor inlet to avoid ice formation during low ambient conditions. |
| | b. | Optimisation of the working medium conditions | Operate at the highest possible pressure and temperature of the working medium gas or steam, within the constraints associated with, for example, the control of $NO_X$ emissions or the characteristics of energy demanded | | | |
| | c. | Optimisation of the steam cycle | Operate with lower turbine exhaust pressure by utilisation of the lowest possible temperature of the condenser cooling water, within the design conditions | | | |
| | d. | Minimisation of energy consumption | Minimising the internal energy consumption (e.g. greater efficiency of the feed-water pump) | | | |
| | e. | Preheating of combustion air | Reuse of part of the heat recovered from the combustion flue-gas to preheat the air used in combustion | Generally applicable within the constraints related to the need to control $NO_X$ emissions | | |
| | f. | Fuel preheating | Preheating of fuel using recovered heat | Generally applicable within the constraints associated with the boiler design and the need to control $NO_X$emissions | | |
| | g. | Advanced control system | See description in Section 8.2.<br>Computerised control of the main combustion parameters enables the combustion efficiency to be improved | Generally applicable to new units. The applicability to old units may be constrained by the need to retrofit the combustion system and/or control command system | | |
| | h. | Feed-water preheating using recovered heat | Preheat water coming out of the steam condenser with recovered heat, before reusing it in the boiler | Only applicable to steam circuits and not to hot boilers.<br>Applicability to existing units may be limited due to constraints associated with the plant configuration and the amount of recoverable heat | | |
| | i. | Heat recovery by cogeneration (CHP) | Recovery of heat (mainly from the steam system) for producing hot water/steam to be used in industrial processes/activities or in a public network for district heating. Additional heat recovery is possible from: | Applicable within the constraints associated with the local heat and power demand.<br>The applicability may be limited in the case of gas compressors with an unpredictable operational heat profile | | |

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| | | — flue-gas<br>— grate cooling<br>— circulating fluidised bed | |
| j. | CHP readiness | See description in Section 8.2. | Only applicable to new units where there is a realistic potential for the future use of heat in the vicinity of the unit |
| k. | Flue-gas condenser | See description in Section 8.2. | Generally applicable to CHP units provided there is enough demand for low-temperature heat |
| l. | Heat accumulation | Heat accumulation storage in CHP mode | Only applicable to CHP plants.<br>The applicability may be limited in the case of low heat load demand |
| m. | Wet stack | See description in Section 8.2. | Generally applicable to new and existing units fitted with wet FGD |
| n. | Cooling tower discharge | The release of emissions to air through a cooling tower and not via a dedicated stack | Only applicable to units fitted with wet FGD where reheating of the flue-gas is necessary before release, and where the unit cooling system is a cooling tower |
| o. | Fuel pre-drying | The reduction of fuel moisture content before combustion to improve combustion conditions | Applicable to the combustion of biomass and/or peat within the constraints associated with spontaneous combustion risks (e.g. the moisture content of peat is kept above 40 % throughout the delivery chain).<br>The retrofit of existing plants may be restricted by the extra calorific value that can be obtained from the drying operation and by the limited retrofit possibilities offered by some boiler designs or plant configurations |
| p. | Minimisation of heat losses | Minimising residual heat losses, e.g. those that occur via the slag or those that can be reduced by insulating radiating sources | Only applicable to solid-fuel-fired combustion units and to gasification/IGCC units |
| q. | Advanced materials | Use of advanced materials proven to be capable of withstanding high operating temperatures and pressures and thus to achieve increased steam/combustion process efficiencies | Only applicable to new plants |

<table>
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<table>
<tr><td>r.</td><td>Steam turbine upgrades</td><td>This includes techniques such as increasing the temperature and pressure of medium-pressure steam, addition of a low-pressure turbine, and modifications to the geometry of the turbine rotor blades</td><td>The applicability may be restricted by demand, steam conditions and/or limited plant lifetime</td></tr>
<tr><td>s.</td><td>Supercritical and ultra-supercritical steam conditions</td><td>Use of a steam circuit, including steam reheating systems, in which steam can reach pressures above 220,6 bar and temperatures above 374 °C in the case of supercritical conditions, and above 250 – 300 bar and temperatures above 580 – 600 °C in the case of ultra-supercritical conditions</td><td>Only applicable to new units of ≥ 600 $MW_{th}$ operated > 4 000 h/yr.<br>Not applicable when the purpose of the unit is to produce low steam temperatures and/or pressures in process industries.<br>Not applicable to gas turbines and engines generating steam in CHP mode.<br>For units combusting biomass, the applicability may be constrained by high-temperature corrosion in the case of certain biomasses</td></tr>
</table>
</td><td></td><td></td></tr>
<tr><td>13</td><td>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.
<table>
<tr><th colspan="2">Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>a.</td><td>Water recycling</td><td>Residual aqueous streams, including run-off 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.</td><td>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.<br>There may be technical restrictions that prevent retrofitting to existing combustion plants</td></tr>
</table>
</td><td>CC</td><td>Water recycling is used. Firstly the cooling water used is treated effluent. Secondly it is circulated around the cooling circuits with an optimised amount of make-up and blow-down to maximise its use relative to the required quality. Boiler blow-down is reused in the cooling systems.</td></tr>
<tr><td>14</td><td>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.<br>Description<br>Waste water streams that are typically segregated and treated include surface run-off water, cooling water, and waste water from flue-gas treatment.<br>Applicability<br>The applicability may be restricted in the case of existing plants due to the configuration of the drainage systems.</td><td>CC</td><td>The segregated waste water streams are:<br>Surface run off collection is separately discharged to the Rhine via oil interceptors. Domestic waste water discharges via the sewage treatment plant (separating solids and reducing</td></tr>
</table>

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<tr><td></td><td></td><td></td><td>BOD) before being discharged to the Avonmouth sewage treatment works (STW) pipe. Plant area drains are collected via oil interceptors and discharged to the off-site Avonmouth STW discharge pipe (beyond the Seabank site boundary). Neutralised effluent (salt water pH 6-9) from the water treatment plant is discharged to the off-site Avonmouth STW discharge pipe (beyond the site boundary).</td></tr>
<tr><td>15</td><td>In order to reduce emissions to water from flue-gas treatment, BAT is to use an appropriate combination of the techniques given in BAT 15, and to use secondary techniques as close as possible to the source in order to avoid dilution.</td><td>NA</td><td>No flue gas treatment.</td></tr>
<tr><td>16</td><td>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:<br>(a) waste prevention, e.g. maximise the proportion of residues which arise as by-products;<br>(b) waste preparation for reuse, e.g. according to the specific requested quality criteria;<br>(c) waste recycling;<br>(d) other waste recovery (e.g. energy recovery),<br>by implementing an appropriate combination of techniques such as:
<table>
<tr><th colspan="2">Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>a.</td><td>Generation of gypsum as a by-product</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 limestone used in the wet FGD influences the purity of the gypsum produced</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>
<tr><td>b.</td><td>Recycling or recovery of residues</td><td>Recycling or recovery of residues (e.g. from semi-dry desulphurisation processes, fly ash, bottom ash) as a</td><td>Generally applicable within the constraints associated with the required material</td></tr>
</table></td><td>CC</td><td>Specific waste from the combustion of natural gas in the gas turbines is minimal. The waste hierarchy is applied (prevention, reuse, recycling, other recovery or disposal) to segregate all wastes into waste streams (i.e. separate, metal, wood, cardboard etc.). Reductions in the consumption of water, associated chemicals and other raw materials are environmental objectives tracked through the EMS. Waste reporting via EWC codes is done annually.</td></tr>
</table>

<table>
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<tr><td></td><td>
<table>
<tr><td></td><td>in the construction sector</td><td>construction material (e.g. in road building, to replace sand in concrete production, or in the cement industry)</td><td>quality (e.g. physical properties, content of harmful substances) associated to each specific use, and by the market conditions</td></tr>
<tr><td>c.</td><td>Energy recovery by using waste in the fuel mix</td><td>The residual energy content of carbon-rich ash and sludges generated by the combustion of coal, lignite, heavy fuel oil, peat or biomass can be recovered for example by mixing with the fuel</td><td>Generally applicable where plants can accept waste in the fuel mix and are technically able to feed the fuels into the combustion chamber</td></tr>
<tr><td>d.</td><td>Preparation of spent catalyst for reuse</td><td>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</td><td>The applicability may be limited by the mechanical condition of the catalyst and the required performance with respect to controlling $NO_X$ and $NH_3$ emissions</td></tr>
</table>
</td><td></td><td></td></tr>
<tr><td>17</td><td>In order to reduce noise emissions, BAT is to use one or a combination of the techniques given below.
<table>
<tr><th colspan="2">Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>a.</td><td>Operational measures</td><td>These include:<br>— improved inspection and maintenance of equipment<br>— closing of doors and windows of enclosed areas, if possible<br>— equipment operated by experienced staff<br>— avoidance of noisy activities at night, if possible<br>— provisions for noise control during maintenance activities</td><td>Generally applicable</td></tr>
<tr><td>b.</td><td>Low-noise equipment</td><td>This potentially includes compressors, pumps and disks</td><td>Generally applicable when the equipment is new or replaced</td></tr>
<tr><td>c.</td><td>Noise attenuation</td><td>Noise propagation can be reduced by inserting obstacles between the emitter and the receiver. Appropriate obstacles include protection walls, embankments and buildings</td><td>Generally applicable to new plants. In the case of existing plants, the insertion of obstacles may be restricted by lack of space</td></tr>
<tr><td>d.</td><td>Noise-control equipment</td><td>This includes:<br>— noise-reducers<br>— equipment insulation</td><td>The applicability may be restricted by lack of space</td></tr>
</table>
</td><td>CC</td><td>The Power Station is located away from residential areas.<br>Noise attenuation matting is fitted to the cooling towers to reduce splash noise emissions.<br>The gas turbines and the boiler feed pumps are installed within acoustic enclosures and also within plant buildings to reduce noise emissions.<br>Silencers are fitted to the steam by pass stacks and the emergency diesel generators exhausts.<br>Noise levels surveys are regularly undertaken.<br>Seabank monitor and maintain the plant to ensure it is operating effectively.</td></tr>
</table>

<table>
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<tr><td></td><td>
<table>
<tr><td></td><td></td><td>— enclosure of noisy equipment<br>— soundproofing of buildings</td><td></td></tr>
<tr><td>e.</td><td>Appropriate location of equipment and buildings</td><td>Noise levels can be reduced by increasing the distance between the emitter and the receiver and by using buildings as noise screens</td><td>Generally applicable to new plant</td></tr>
</table>
</td><td></td><td></td></tr>
<tr><td colspan="4">Combustion of liquid fuels</td></tr>
<tr><td></td><td>BAT-associated energy efficiency levels (BAT-AEELs) for HFO and/or gas oil combustion in boilers
<table>
<tr><th rowspan="3">Type of combustion unit</th><th colspan="4">BAT-AEELs [99] [100]</th></tr>
<tr><th colspan="2">Net electrical efficiency (%)</th><th colspan="2">Net total fuel utilisation (%) [101]</th></tr>
<tr><th>New unit</th><th>Existing unit</th><th>New unit</th><th>Existing unit</th></tr>
<tr><td>HFO- and/or gas-oil-fired boiler</td><td>> 36,4</td><td>35,6–37,4</td><td>80–96</td><td>80–96</td></tr>
</table>
</td><td>NA</td><td>Seabanks oil fired boiler is <15MWth and is therefore not included in this assessment.</td></tr>
<tr><td colspan="4">Combustion of gaseous fuels</td></tr>
<tr><td>40</td><td>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.
<table>
<tr><th colspan="2">Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>a.</td><td>Combined cycle</td><td>See description in Section 8.2</td><td>Generally applicable to new gas turbines and engines except when operated < 1 500 h/yr.<br>Applicable to existing gas turbines and engines within the constraints associated with the steam cycle design and the space availability.<br>Not applicable to existing gas turbines and engines operated < 1 500 h/yr.<br>Not applicable to mechanical drive gas turbines operated in discontinuous mode with extended load variations and frequent start-ups and shutdowns.<br>Not applicable to boilers</td></tr>
</table>
BAT-associated energy efficiency levels (BAT-AEELs) for the combustion of natural gas
<table>
<tr><th rowspan="3">Type of combustion unit</th><th colspan="4">BAT-AEELs [136] [137]</th></tr>
<tr><th colspan="2">Net electrical efficiency (%)</th><th rowspan="2">Net total fuel utilisation (%) [138] [139]</th><th colspan="2">Net mechanical energy efficiency (%) [139] [140]</th></tr>
<tr><th>New</th><th>Existing</th><th>New unit</th><th>Existing unit</th></tr>
</table>
</td><td>CC</td><td>All three LCPs (313,314,315) are operated within a combined cycle. This is not applicable to the auxiliary boiler as it is a boiler and is <15 MWth.<br>A thermodynamic model is used in conjunction with the OEM correction curves to calculate the CCGT efficiencies at reference (ISO) conditions.<br>This model has been independently reviewed.<br>The thermodynamic model demonstrates that the CCGT full load net efficiencies corrected to reference conditions for Module 1(LCP313/314) and Module 2</td></tr>
</table>

<table>
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<tr><td></td><td>
<table>
<tr><td></td><td>unit</td><td>unit</td><td></td><td colspan="2"></td></tr>
<tr><td>Gas engine</td><td>39,5–44 (141)</td><td>35–44 (141)</td><td>56–85 (141)</td><td colspan="2">No BAT-AEEL.</td></tr>
<tr><td>Gas-fired boiler</td><td>39–42,5</td><td>38–40</td><td>78–95</td><td colspan="2">No BAT-AEEL.</td></tr>
<tr><td>Open cycle gas turbine, ≥ 50 MWth</td><td>36–41,5</td><td>33–41,5</td><td>No BAT-AEEL</td><td>36,5–41</td><td>33,5–41</td></tr>
<tr><td colspan="6">Combined cycle gas turbine (CCGT)</td></tr>
<tr><td>CCGT, 50–600 $MW_{th}$</td><td>53–58,5</td><td>46–54</td><td>No BAT-AEEL</td><td colspan="2">No BAT-AEEL</td></tr>
<tr><td>CCGT, ≥ 600 $MW_{th}$</td><td>57–60,5</td><td>50–60</td><td>No BAT-AEEL</td><td colspan="2">No BAT-AEEL</td></tr>
<tr><td>CHP CCGT, 50–600 $MW_{th}$</td><td>53–58,5</td><td>46–54</td><td>65–95</td><td colspan="2">No BAT-AEEL</td></tr>
<tr><td>CHP CCGT, ≥ 600 $MW_{th}$</td><td>57–60,5</td><td>50–60</td><td>65–95</td><td colspan="2">No BAT-AEEL</td></tr>
</table>
</td><td></td><td>(LCP315) are both >55%.<br>For information the auxiliary boiler (fired on gas) has a rated net total fuel utilisation specified efficiency is 88%.</td></tr>
<tr><td>41</td><td>In order to prevent or reduce $NO_X$ emissions to air from the combustion of natural gas in boilers, BAT is to use one or a combination of the techniques given in BAT 41.</td><td>NA</td><td>No LCP boilers on site.</td></tr>
<tr><td>42</td><td>In order to prevent or reduce $NO_X$ 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.
<table>
<tr><th colspan="2">Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>a.</td><td>Advanced control system</td><td>See description in Section 8.3.<br>This technique is often used in combination with other techniques or may be used alone for combustion plants operated < 500 h/yr</td><td>The applicability to old combustion plants may be constrained by the need to retrofit the combustion system and/or control command system</td></tr>
<tr><td>b.</td><td>Water/steam addition</td><td rowspan="2">See description in Section 8.3</td><td>The applicability may be limited due to water availability</td></tr>
<tr><td>c.</td><td>Dry low-$NO_X$ burners (DLN)</td><td>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</td></tr>
<tr><td>d.</td><td>Low-load design concept</td><td>Adaptation of the process control 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</td><td>The applicability may be limited by the gas turbine design</td></tr>
<tr><td>e.</td><td>Low-$NO_X$ burners</td><td>See description in Section 8.3</td><td>Generally applicable to supplementary</td></tr>
</table>
</td><td>CC</td><td>The CCGTs have an advanced control system which is optimised to minimise time for start-up and shut-down modes and the control logic has been modified to enter premix mode before electrical synchronisation which lowers the NOx emissions associated with a start. DLN burners are used to reduce NOx emissions to below the permit limits, and within the BAT-AEL. The DLN burners are effective from premix mode which is before synchronisation on LCP313,314 and 315 so therefore are effective from 1 MWe to full load MWe. The control system incorporates real-time NOx emissions data input from the</td></tr>
</table>

| BAT Concn. Number | Summary of BAT Conclusion requirement | Status NA/ CC / FC / NC | Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement |
|---|---|---|---|
| | (LNB) — firing for heat recovery steam generators (HRSGs) in the case of combined-cycle gas turbine (CCGT) combustion plants<br>f. Selective catalytic reduction (SCR) — Not applicable in the case of combustion plants operated < 500 h/yr. Not generally applicable to existing combustion plants of < 100 $MW_{th}$. 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 | | MCERTs certified CEMS system including alarms if limits are approached so Operators can intervene appropriately. |
| 43 | In order to prevent or reduce $NO_X$ emissions to air from the combustion of natural gas in engines, BAT is to use one or a combination of the techniques given in BAT 43. | NA | No LCP gas engines on site. |
| 44 | 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.<br>***Description* - See descriptions in Section 8.3.**<br>**BAT-associated emission levels (BAT-AELs) for $NO_X$ emissions to air from the combustion of natural gas in gas turbines** | FC | Optimised combustion and minimisation of CO release by short start-up and shut-down periods (when the highest concentration of CO is generated).<br><br>Improvement condition IC12 included to establish appropriate yearly AEL for carbon monoxide due to potentially higher levels than indicative AEL due to optimisation of NOx levels. |

| Type of combustion plant | Combustion plant total rated thermal input ($MW_{th}$) | BAT-AELs ($mg/Nm^3$) (142) (143) | |
|---|---|---|---|
| | | Yearly average (144) (145) | Daily average or average over the sampling period |
| **Open-cycle gas turbines (OCGTs) (146) (147)** | | | |
| New OCGT | ≥ 50 | 15–35 | 25–50 |
| Existing OCGT (excluding turbines for mechanical drive applications) — All but plants operated < 500 h/yr | ≥ 50 | 15–50 | 25–55 (148) |
| **Combined-cycle gas turbines (CCGTs) (146) (149)** | | | |
| New CCGT | ≥ 50 | 10–30 | 15–40 |
| Existing CCGT with a net total fuel utilisation of | ≥ 600 | 10–40 | 18–50 |

| BAT Concn. Number | Summary of BAT Conclusion requirement | Status NA/ CC / FC / NC | Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement |
|---|---|---|---|

| | | | |
|---|---|---|---|
| < 75 % | | | |
| Existing CCGT with a net total fuel utilisation of ≥ 75 % | ≥ 600 | 10–50 | 18–55 ([150]) |
| Existing CCGT with a net total fuel utilisation of < 75 % | 50–600 | 10–45 | 35–55 |
| Existing CCGT with a net total fuel utilisation of ≥ 75 % | 50–600 | 25–50 ([151]) | 35–55 ([152]) |

**Open- and combined-cycle gas turbines**

| | | | |
|---|---|---|---|
| Gas turbine put into operation no later than 27 November 2003, or existing gas turbine for emergency use and operated < 500 h/yr | ≥ 50 | No BAT-AEL | 60–140 ([153]) ([154]) |
| Existing gas turbine for mechanical drive applications — All but plants operated < 500 h/yr | ≥ 50 | 15–50 ([155]) | 25–55 ([156]) |

As an indication, the yearly average CO emission levels for each type of existing combustion plant operated ≥ 1 500 h/yr and for each type of new combustion plant will generally be as follows:

- New OCGT of ≥ 50 $MW_{th}$: < 5–40 mg/$Nm^3$. For plants with a net electrical efficiency (EE) greater than 39 %, a correction factor may be applied to the higher end of this range, corresponding to [higher end] × EE/39, where EE is the net electrical energy efficiency or net mechanical energy efficiency of the plant determined at ISO baseload conditions.
- Existing OCGT of ≥ 50 $MW_{th}$ (excluding turbines for mechanical drive applications): < 5–40 mg/$Nm^3$. The higher end of this range will generally be 80 mg/$Nm^3$ in the case of existing plants that cannot be fitted with dry techniques for $NO_X$ reduction, or 50 mg/$Nm^3$ for plants that operate at low load.
- New CCGT of ≥ 50 $MW_{th}$: < 5–30 mg/$Nm^3$. For plants with a net electrical efficiency (EE) greater than 55 %, a correction factor may be applied to the higher end of the range, corresponding to [higher end] × EE/55, where EE is the net electrical energy efficiency of the plant determined at ISO baseload conditions.
- Existing CCGT of ≥ 50 $MW_{th}$: < 5–30 mg/$Nm^3$. The higher end of this range will generally be 50 mg/$Nm^3$ for plants that operate at low load.
- Existing gas turbines of ≥ 50 $MW_{th}$ for mechanical drive applications: < 5–40 mg/$Nm^3$. The higher end of the range will generally be 50 mg/$Nm^3$ when plants operate at low load.

In the case of a gas turbine equipped with DLN burners, these indicative levels correspond to when the DLN operation is effective.

| | | | |
|---|---|---|---|
| 45 | In order to reduce non-methane volatile organic compounds (NMVOC) and methane ($CH_4$) emissions to air from the combustion of natural gas in spark-ignited lean-burn gas engines, BAT is to ensure optimised combustion | NA | No LCP gas engines on site. |

<table>
<tr><th>BAT Concn. Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th></tr>
<tr><td></td><td>and/or to use oxidation catalysts.<br>Description<br>See descriptions in Section 8.3. Oxidation catalysts are not effective at reducing the emissions of saturated hydrocarbons containing less than four carbon atoms.<br>BAT-associated emission levels (BAT-AELs) for formaldehyde and $CH_4$ emissions to air from the combustion of natural gas in a spark-ignited lean-burn gas engine
<table>
<tr><th rowspan="4">Combustion plant total rated thermal input ($MW_{th}$)</th><th colspan="3">BAT-AELs ($mg/Nm^3$)</th></tr>
<tr><th>Formaldehyde</th><th colspan="2">$CH_4$</th></tr>
<tr><th colspan="3">Average over the sampling period</th></tr>
<tr><th>New or existing plant</th><th>New plant</th><th>Existing plant</th></tr>
<tr><td>≥ 50</td><td>5–15 (162)</td><td>215–500 (163)</td><td>215–560 (162) (163)</td></tr>
</table></td><td></td><td></td></tr>
</table>

# 6 Review and assessment of derogation requests made by the Operator in relation to BAT Conclusions which include an associated emission level (AEL) value

The IED enables a competent authority to allow derogations from BAT AELs stated in BAT Conclusions under specific circumstances as detailed under Article 15(4):

By way of derogation from paragraph 3, and without prejudice to Article 18, the competent authority may, in specific cases, set less strict emission limit values. Such a derogation may apply only where an assessment shows that the achievement of emission levels associated with the best available techniques as described in BAT Conclusions would lead to disproportionately higher costs compared to the environmental benefits due to:

> *(a) the geographical location or the local environmental conditions of the installation concerned; or*
>
> *(b) the technical characteristics of the installation concerned.*

As part of their Regulation 61 Note response, the Operator has not requested a derogation from compliance with any AEL values.

# 7 Emissions to Water

The consolidated permit incorporates a discharge to controlled waters identified as W1.

There are no BAT AELs specified in the BAT Conclusions for this type of plant. There are also no additional treatment options identified as BAT for the installation. We have therefore not carried out any additional assessment of the emissions to water as part of this review.

## 8. Additional IED Chapter II requirements:

**Black start**

In the event of a black out National Grid would call on combustion plant to operate and may require them to do so outside their permitted conditions. We have dedicated black start plant and they are permitted to run as such but this scenario is relevant to the rest of the LCP which could be called depending on the circumstances.

A risk assessment will be carried out by Energy UK/Joint Environmental Programme on behalf of LCP connected to the National Transmission System. Air emissions modelling will be based on generic black start scenarios to establish whether they have the potential to have local impact on the environment or not (on a national basis). If the modelling demonstrates that no significant impacts are likely, the plant can operate under condition a specific permit condition. This conditions allows the hourly ELVs for plants operating under a black start instruction to be discounted for the purpose of reporting. We would also require there to be a procedure in place for minimisation of emissions in the case of a black start event and for reporting in the event of a black start. This modelling and the procedures have not been agreed in advance of the issue of the permit review and therefore a condition linking back to an improvement condition has been included in the permit.

# 9 Review and assessment of changes that are not part of the BAT Conclusions derived permit review.

This document should be read in conjunction with the application, supporting information and notice.

| Aspect considered | Decision |
|---|---|
| **Receipt of application** | |
| Confidential information | A claim for commercial or industrial confidentiality has not been made. |
| Identifying confidential information | We have not identified information provided as part of the application that we consider to be confidential. |
| **The site** | |
| Biodiversity, heritage, landscape and nature conservation | The application is within the relevant distance criteria of a site of heritage, landscape or nature conservation, and/or protected species or habitat.<br><br>A full assessment of the application and its potential to affect the site(s)/species/habitat has not been carried out as part of the permit review process. We consider that the review will not affect the features of the site(s)/species/habitat as the conditions will provide at least the same level of protection as those in the previous permit and in some cases will provide a higher level of protection to those in the previous permit.<br><br>We have not consulted Natural England on the application. The decision was taken in accordance with our guidance. |
| **Operating techniques** | |
| General operating techniques | We have reviewed the techniques used by the Operator where they are relevant to the BAT Conclusions and compared these with the relevant guidance notes.<br><br>The permit conditions ensure compliance with the relevant BREF, BAT Conclusions. The ELVs deliver compliance with the BAT-AELs. |
| **Permit conditions** | |
| Updating permit conditions during consolidation | We have updated permit conditions to those in the current generic permit template as part of permit consolidation. The conditions will provide at least the same level of protection as those in the previous permit and in some cases will provide a higher level of protection to those in the previous permit. |

| Aspect considered | Decision |
|---|---|
| Changes to the permit conditions due to an Environment Agency initiated variation | We have varied the permit as stated in the variation notice. |
| Emission limits | We have decided that emission limits should be set for the parameters listed in the permit.<br>These are described in the relevant BAT Conclusions in Section 5 of this document.<br>It is considered that the ELVs described above will ensure that significant pollution of the environment is prevented and a high level of protection for the environment is secured. |
| Monitoring | We have decided that monitoring should be carried out for the parameters listed in the permit, using the methods detailed and to the frequencies specified.<br>These are described in the relevant BAT Conclusions in Section 5 of this document.<br>Table S3.3 Process monitoring requirements was amended to include the requirement to monitor energy efficiency after overhauls on site in line with BAT Conclusion 2.<br>Based on the information in the application we are satisfied that the Operator's techniques, personnel and equipment have either MCERTS certification or MCERTS accreditation as appropriate. |
| Reporting | We have specified reporting in the permit.<br>These are described in the relevant BAT Conclusions in Section 5 of this document. |
| **Operator competence** | |
| Management system | There is no known reason to consider that the Operator will not have the management system to enable it to comply with the permit conditions. |
| **Growth Duty** | |
| Section 108 Deregulation Act 2015 – Growth duty | We have considered our duty to have regard to the desirability of promoting economic growth set out in section 108(1) of the Deregulation Act 2015 and the guidance issued under section 110 of that Act in deciding whether to grant this permit.<br>Paragraph 1.3 of the guidance says:<br>"The primary role of regulators, in delivering regulation, is to achieve the regulatory outcomes for which they are responsible. For a number of regulators, these regulatory outcomes include an explicit reference to development or growth. The growth duty establishes economic growth as a factor that all specified regulators should have regard to, alongside the delivery of the |

| Aspect considered | Decision |
|---|---|
| | protections set out in the relevant legislation."<br><br>We have addressed the legislative requirements and environmental standards to be set for this operation in the body of the decision document above. The guidance is clear at paragraph 1.5 that the growth duty does not legitimise non-compliance and its purpose is not to achieve or pursue economic growth at the expense of necessary protections.<br><br>We consider the requirements and standards we have set in this permit are reasonable and necessary to avoid a risk of an unacceptable level of pollution. This also promotes growth amongst legitimate operators because the standards applied to the operator are consistent across businesses in this sector and have been set to achieve the required legislative standards. |