Appendix: D

Alternatives Analysis and Identification / Assessment of BAT

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CONTENTS

1 BACKGROUND

This Appendix supports an application to vary the Environmental Permit (EPR/AP3732KC) for the Spalding Energy Expansion (SEE), and provides an alternatives analysis, and an identification and assessment of Best Available Techniques (BAT).

SEE will be located on West Marsh Road, in Spalding, Lincolnshire, in the UK. The SEE site is immediately to the south of the existing National Grid Spalding 400 kV substation and the existing Spading Combined Cycle Gas Turbine (CCGT) generating station site.

Within the application to vary the Environmental Permit (EPR/AP3732KC), SEE comprises an OCGT generating station (including a gas turbine and associated equipment) with a rated thermal input of approximately 749.9 MW and, based on an approximate electrical generation efficiency of 40 per cent (based on the Lower Heating Value (LHV) of the fuel), a rated electrical output of approximately 299.9 MW. Directly Associated Activities (DAA) will include: a Gas Reception Facility (GRF); an emergency 400 V diesel generator; seven gas engines (each with a rated thermal input of approximately 2.8 MW and, based on an approximate electrical generation efficiency of 39 per cent, a rated electrical output of approximately 1.1 MW which are operated in an emergency / black start mode and as a support surface); and, a surface water drainage system.

2 CONTEXT / REFERENCE STANDARDS

The Industrial Emissions Directive[1] (IED) (Article 1 (Subject Matter)): *"lays down rules on integrated pollution prevention and control arising from industrial activities. It also lays down rules designed to prevent or, where that is not practicable, to reduce emissions into air, water and land and to prevent the generation of waste, in order to achieve a high level of protection of the environment taken as a whole"*.

The IED is a key European Union (EU) instrument, and recast seven previously existing directives, in particular the Integrated Pollution Prevention and Control (IPPC) Directive[2] and the Large Combustion Plant Directive[3] (LCPD).

In order to achieve a high level of protection of the environment, as a whole, the IED requires the application of Best Available Techniques (BAT).

The IED (Article 3 (Definitions), (10)) defines 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 the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole:*

(a) 'techniques' includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;

(b) 'available techniques' means those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator;

(c) *'best' means most effective in achieving a high general level of protection of the environment as a whole"*.

BAT is generally established at EU level. Following an exchange of information between Member States, BAT reference documents are drawn up for a wide range of industrial sectors and include a description of the available techniques to be considered and provide associated BAT Conclusions.

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[1] Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control). Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0075&from=EN
[2] Directive 2008/1/EC concerning integrated pollution prevention and control. Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0001
[3] Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants. Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02001L0080-20070101

In order to take account of developments in available techniques, the IED (Article 13 (BAT Reference Documents and Exchange of Information)) requires the review and update of the BAT reference documents and associated BAT Conclusions.

As such, a review and update of the Large Combustion Plant BAT reference document[4] has recently been completed and:

- In June 2016, a final draft of the Large Combustion Plant BAT reference document[5] (2016 LCP BRef) was published;
- In April 2017, at a meeting of the IED Article 75 Committee, a positive vote was given to associated BAT Conclusions within the 2016 LCP BRef; and,
- On 31 July 2017, the associated BAT Conclusions[6] were published in the Official Journal of the European Union (OJEU).

Following publication, the IED (Article 14 (Permit Conditions), (3)) requires that the BAT Conclusions are used as the reference point for setting conditions within Environmental Permits.

The scope of the BAT Conclusions concerns a number of activities specified in the IED, including: "*Combustion of fuels in installations with a total rated thermal input of 50 MW or more, only when this activity takes place in combustion plants with a total rated thermal input of 50 MW or more*". In addition to covering the installation, the scope of the BAT Conclusions also concerns upstream and downstream directly associated activities.

The IED is implemented in England via the Environmental Permitting (England and Wales) Regulations 2016.

To assist in making applications for (and varying) Environmental Permits under these Regulations, the UK Government has published online guidance. In particular, regarding BAT, the online guidance[7] notes that when an application (or variation) is made, the application (or variation) should state whether BAT will be applied or whether alternative techniques will be applied.

Where BAT will be applied, the application (or variation) should explain how the technique:

- Is compliant with the BAT Conclusions; or,
- For techniques that are not included in the BAT Conclusions, is compliant with the relevant BAT reference document and / or the technical guidance.

With regards to the technical guidance, in addition to the published online guidance, the Environment Agency has produced a number of Environmental Permitting Guidance Notes. Of these Guidance Notes, tailored guidance is provided in Sector Technical Guidance Notes (STGN).

2.1 Key Reference Standards

The following key reference standards are considered applicable:

- The BAT Conclusions;
- The 2016 LCP BRef; and,
- The Combustion Activities STGN[8].

[4] 'Integrated Pollution Prevention and Control Reference Document on Best Available Techniques for Large Combustion Plants' (July 2006). Available at:
http://eippcb.jrc.ec.europa.eu/reference/BREF/lcp_bref_0706.pdf
[5] 'Best Available Techniques (BAT) Reference Document for Large Combustion Plants' (June 2016). Available at:
http://eippcb.jrc.ec.europa.eu/reference/BREF/LCP_FinalDraft_06_2016.pdf
[6] Commission Implementing Decision 2017/1442 establishing Best Available Technique (BAT) Conclusions, under Directive 2010/75/EU, for Large Combustion Plant. Available at:
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017D1442&from=EN
[7] Available at:
https://www.gov.uk/guidance/best-available-techniques-environmental-permits
[8] 'How to Comply with Your Environmental Permit – Additional Guidance for: Combustion Activities (EPR 1.01)' (February 2009). Available at:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/297003/geho0209bpin-e-e.pdf

These key reference standards are presented in an assumed hierarchy of compliance with regards to the reference points for setting conditions within Environmental Permits.

3 OBJECTIVES AND METHODOLOGY

3.1 Objectives

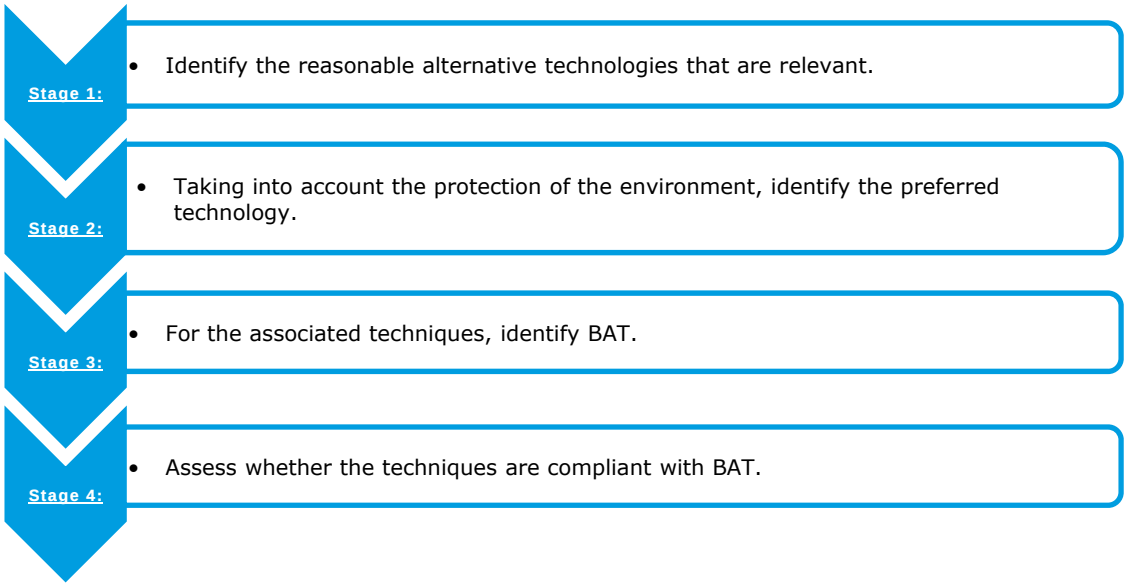
The objectives of this Appendix are to:

- Identify the reasonable alternative technologies that are relevant;
- Identify the preferred technology;
- For the associated techniques, identify BAT; and,
- Undertake an assessment of BAT.

3.2 Methodology

To meet the objectives of this Appendix, Insert D1 presents the methodology applied.

INSERT D1: METHODOLOGY



4 ALTERNATIVES ANALYSIS

This Section identifies the reasonable alternative technologies that are relevant.

4.1 Processes for Electricity Generation

In identifying the reasonable alternatives technologies for a generating station, consideration was given to processes for electricity generation. The processes comprised electricity generation from: sustainable fuels (e.g. biomass); renewables (e.g. solar / wind); nuclear fuels; and, fossil fuels.

4.1.1 Sustainable Fuels

Electricity generation from sustainable fuels covers a diverse range of fuels, including those derived from: timber; crops; and, agricultural / food wastes.

Specifically in terms of the environment, electricity generation from sustainable fuels:

- Generates a range of different emissions to air depending upon the specific fuel and technology used, which may require advanced emissions abatement equipment;
- Requires large areas of land for fuel storage; and,
- Requires a reliable and continuous fuel source.

Therefore, electricity generation from sustainable fuels is not considered appropriate or feasible at the SEE site.

4.1.2 Renewables

InterGen supports renewables, and believes electricity generation from renewables has an important role to play as the UK makes the transition to a low carbon economy. Whilst InterGen continues to consider investment in renewables, it has not yet identified a suitable opportunity in the UK.

Specifically in terms of the environment, electricity generation from renewables:

- Requires large areas of land; and,
- Requires a suitable solar / wind yield.

Therefore, electricity generation from renewables is not considered appropriate or feasible at the SEE site.

4.1.3 Nuclear Fuels

Electricity generation from nuclear fuels would require that the SEE site was considered by the UK Government as a potential site for a new nuclear generating station. The list of potential sites is included in NPS EN-6[9] which states (at paragraph 4.1.1) that: "*the following sites are those that the Government has determined are potentially suitable for the deployment of new nuclear power stations in England and Wales before the end of 2025:*

- *Bradwell;*
- *Hartlepool;*
- *Heysham;*
- *Hinkley Point;*
- *Oldbury;*
- *Sizewell;*
- *Sellafield; and*
- *Wylfa*".

The list of potential sites does not include the SEE site. Therefore, electricity generation from nuclear fuels it is not currently considered appropriate or feasible at the SEE site.

4.1.4 Fossil Fuels

Electricity generation from fossil fuels covers a range of fuels including: coal; oil; and, natural gas.

Specifically in terms of the environment, electricity generation from fossil fuels generates carbon dioxide (CO_2) emissions to air. The most significant greenhouse gas is CO_2, with other gases (such as methane (CH_4) quantified as an equivalent amount of CO_2. This is typically done by calculating their global warming potential relative to CO_2 over a specified timescale (e.g. 100 years).

The magnitude of CO_2 emissions to air (g/KWh) is dependent on the carbon content and heating value of fossil fuel burnt and the efficiency of the specific plant technology. Indeed, typically:

- Natural gas has a carbon content (by mass) of approximately 70 per cent and a lower heating value (LHV) of approximately 46,000 kJ/kg;
- Coal varies considerably, but a good quality black coal has a carbon content (by mass) or approximately 65 per cent and a LHV of approximately 25,000 kJ/kg;

[9] 'National Policy Statement for Nuclear Power Generation (NPS EN-6): Volume I of II' (July 2011). Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/47859/2009-nps-for-nuclear-volumeI.pdf

- Heavy fuel oil has a carbon content of approximately 85 per cent and a LHV of approximately 41,000 kJ/kg; and,
- Distillate fuel oil has a carbon content of approximately 87 per cent and an LHV of approximately 42,600 kJ/kg.

Table D1 provides a comparison of CO_2 emissions to air for a range of fossil fuels and plant technologies.

TABLE D1: COMPARISON OF CO_2 EMISSIONS TO AIR

Type of Plant	***CCGT***	***OCGT***	***Super-Critical***	***Ultra Super-Critical***	***Super-Critical***	***Recip-rocating Engine***	***Recip-rocating Engine***
Fuel	***Natural Gas***	***Natural Gas***	***Black Coal***	***Black Coal***	***Heavy Fuel Oil***	***Natural Gas***	***Distillate Fuel Oil***
Efficiency (%)	60%	40%	40%	45%	40%	50%	45%
Carbon Content in Fuel (% Mass)	70%	70%	60%	60%	85%	70%	87%
Carbon Density of Fuel (tonne/kJ Fuel)	0.0152	0.0152	0.0240	0.0240	0.0207	0.0152	0.0204
Fuel LHV (kJ/kg)	46,000	46,000	25,000	25,000	41,000	46,000	42,600
Fuel Mass Flow (kg/kWh)	0.130	0.196	0.360	0.320	0.220	0.157	0.188
Carbon Mass Flow (kg/kWh)	0.091	0.137	0.216	0.192	0.187	0.110	0.163
CO_2 Mass Flow (kg/kWh)	0.335	0.502	0.792	0.704	0.684	0.402	0.597

Further to Table D1, electricity generation from natural gas typically results in lower emissions to air (e.g. nitrogen oxides (NO_x), particulate matter (PM_{10}) and sulphur dioxide (SO_2)) compared to electricity generation from coal and oil.

In addition, electricity generation from natural gas does not produce material amounts of solid waste compared to electricity generation from coal.

Therefore, electricity generation from natural gas is preferred over electricity generation from coal / oil.

In support of this conclusion, in a speech delivered on 18 November 2015 concerning the direction of UK energy policy, the Secretary of State stated that:

> "*It cannot be satisfactory for an advanced economy like the UK to be relying on polluting, carbon intensive 50-year-old coal-fired power stations. Let me be clear: this is not the future. We need to build a new energy infrastructure, fit for the 21st century*".
>
> Therefore:
>
> "*In the next 10 years, it's imperative that we get new gas-fired power stations built*";
>
> And:
>
> "*Gas is central to our energy secure future*".

4.2 Electricity Generation from Natural Gas

Based on electricity generation from natural gas, there are a number of alternative technologies for a generating station, including: CCGT; OCGT; and, reciprocating gas engines.

To identify the preferred technology, and in addition to the protection of the environment, consideration was given to the electricity market needs. For a new generating station, it is considered that electricity market needs will influence both technical and economic feasibility.

For electricity generation from natural gas, electricity market needs are currently addressed through Capacity Market Auctions. Introduced in 2014 through the Electricity Market Reform, the auctions are a competitive process resulting in the award of Capacity Market Contract to successful units in order to achieve an overall target capacity in each prescribed delivery years. Successful units must delivery against their capacity obligation at any time of system stress during their prescribed delivery years, or face a financial penalty.

Table D2 provides a comparison of alternative technologies for a generating station.

TABLE D2: NATURAL GAS – COMPARISON OF ALTERNATIVE TECHNOLOGIES FOR A GENERATING STATION

	CCGT	***OCGT***	***Reciprocating Gas Engines***
Emissions to Air		Flue gases typically hotter than CCGTs, therefore are more buoyant. As a result, stack heights (and associated visual impacts) are smaller.	Due to the method in which fuel is combusted, there is typically a requirement for additional NO_x abatement. This would impose a larger footprint, and may also require additional chemicals (ammonia / urea) to operate.
Emissions to Water	Water required for process waters and cooling.	Minimal water requirements. Plant cooling is air-cooled via closed water circuits.	Similar to OCGT.
Technical Feasibility	In the short term, it is considered that current technical electricity market needs are related to the balancing of the electricity system against the intermittent nature of renewables (e.g. solar / wind). As such, technologies should be as flexible as possible capable of shorter start-up and shut-down periods, with fast ramp rates. For these technologies, with lower operating hours, efficiencies (and associated fuel costs) are not as important as the ability to cycle.		
	Whilst CCGTs have high efficiencies (between approximately 55 to 60 per cent), the start-up and shut-down periods are relatively long (between 30 to 180 minutes). In addition, keeping CCGTs warm (to allow shorter start-up periods) requires energy.	Whilst OCGTs have lower efficiencies than CCGTs, the start-up and shut-down periods are relatively short (between 10 to 20 to minutes, depending on the technology and capacity).	Reciprocating engines have the shortest start-up periods (less than 5 minutes; or less than 2 minutes if on 'hot stand-by').
Economic Feasibility	Compared to CCGT and reciprocating gas engines, OCGTs typically have lower CAPEX and OPEX costs per MW. This is largely because CCGT and reciprocating gas engines are more complex in their construction and operation, leading to their higher efficiencies. However, as noted above, OCGTs and reciprocating gas engines are considered to represent 'peaking plants', which typically generate electrical power for 1500 hours per year as a rolling average over a period of five years. Over this timescale, the benefits of higher efficiencies are very minimal.		

Further to Table D2, SEE (an OCGT generating station) secured a 15 year contract in the 2016 T-4 Capacity Market Auction, and is expected to commence construction in time to meet its commitments under this contract (principally to be in operations by 1 October 2020). This confirms that, considering current electricity market needs, the preferred technology is an OCGT generating station.

5 PREFERRED TECHNOLOGY

Based on Section 4 (Alternatives Analysis), this Section provides a summary description of the preferred technology.

SEE comprises an OCGT generating station (including a gas turbine and associated equipment) with a rated thermal input of approximately 749.9 MW and, based on an approximate electrical generation efficiency of 40 per cent (based on the LHV of the fuel), a rated electrical output of approximately 299.9 MW. DAA will include: a Gas Reception Facility (GRF); an emergency 400 V

diesel generator; seven gas engines (each with a rated thermal input of approximately 2.8 MW and, based on an approximate electrical generation efficiency of 39 per cent, a rated electrical output of approximately 1.1 MW which are operated in an emergency / black start mode and as a support service); and, a surface water drainage system. .

SEE will be designed to have an operational lifetime of approximately 30 years.

SEE will operate as a 'peaking plant', and will generate electrical power for 1500 hours per year as a rolling average over a period of five years (i.e. up to 7500 hours over five years). Peaking plants are combustion plants that are operated infrequently and at short notice to generate electrical power during periods of high ('peak') demand or when existing supplies into the electricity transmission and distribution system cease to generate. Whilst such periods are expected during the winter months, the ultimate operational regime of SEE is not predictable, and it could be required to start-up and shut-down at any point during the year, and at any point during the day or night. Typically, following start-up, SEE will operate for between one to three hours at a time.

Within the electricity generating process, natural gas will be burnt in the combustion chamber of the gas turbine from where the resulting hot gases will expand through the turbine section to generate sufficient power to drive the air compressor section and generator to produce electrical power. The flue gases from the gas turbine will be discharged via a dedicated 30 m high stack.

Due to the limited number of operating hours per year, there will be no permanent operational presence on site, and operations will be controlled and monitored remotely using a Distributed Control System (DCS) to be located within the adjacent existing Spalding CCGT generating station.

6 IDENTIFICATION AND ASSESSMENT OF BEST AVAILABLE TECHNIQUES

For the preferred technology, this Section identifies BAT and assesses whether the techniques are compliant with BAT.

Based on this identification and assessment, this Section also identifies any gaps.

The following definitions are applied:

- Y: The techniques are compliant with BAT, and there is no identified gap; and,
- N: The techniques are not compliant with BAT, and there is an identified gap.

6.1 General

Table D3 identifies general BAT and assesses whether the techniques are compliant with BAT.

TABLE D3: GENERAL BAT

BAT Reference	*Description of Identified BAT*	*Assessment*	*BAT*	
			Y	*N*
BAT 1	In order to improve the overall environmental performance, BAT is to implement and adhere to an Environmental Management System (EMS).	Spalding Energy Expansion Limited (SEEL) is committed to a high standard of Health, Safety and Environmental (HSE) Management throughout the construction, commissioning and operation of SEE. Due to the limited number of operating hours per year, there will be no permanent operational presence on the site, and operations will be controlled and monitored remotely using a DCS to be located within the adjacent existing Spalding CCGT generating station. At the existing Spalding CCGT generating station, the routine operation and maintenance of SEE will be sub-contracted to InterGen Operating Company (UK) Limited. Within the contract, specifically regarding environmental management, SEEL will require InterGen Operating Company UK) Limited to implement an appropriate Environmental Management System (EMS). Further information is provided in Section 3.6 (Environmental Management System).	✓	

6.2 Monitoring

Table D4 identifies monitoring BAT and assesses whether the techniques are compliant with BAT.

TABLE D4: MONITORING BAT

BAT Reference	*Description of Identified BAT*	*Assessment*	*BAT*	
			Y	*N*
BAT 2	BAT is to determine the net electrical efficiency of the combustion units by carrying out a performance test at full load, according to EN Standards, after the commissioning of the unit (and after any relevant modification). 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.	The net electrical efficiency of SEE will be determined via performance tests which will be carried out at full load during commissioning. Commissioning will be progressive from checks of final plant / equipment, to pre-commissioning and setting to work of individual component parts, through to the testing of overall plant / equipment. Reliability tests will demonstrate the fitness for purpose of SEE prior to commercial operation. Performance test will demonstrate that SEE complies with the performance guarantees. Availability and reliability will be demonstrated by operating SEE under commercial conditions without major repair to any item of plant / equipment. The performance tests will be carried out according to either ISO 2314: 2009 ('Gas Turbines – Acceptance Tests) or ASME PTC 22: 2014 ('Gas Turbines'). These are the two main standards for performance tests of gas turbines, and ensure the provision of data of an appropriate scientific quality.	✓	
BAT 3	BAT is to monitor key process parameters relevant for emissions to air, including: flow; oxygen content; temperature; pressure; and, water vapour content.	Monitoring will be undertaken in accordance with Part 3 (Emission Monitoring) of Annex V of the IED and the Environment Agency's Technical Guidance Notes (Monitoring) M1 ('Sampling Requirements for Stack Emission Monitoring') and M2 ('Monitoring of Stack Emissions to Air'). As appropriate, SEEL will also apply BS EN 14181: 2014 ('Stationary Source Emissions: Quality Assurance of Automated Measuring Systems') and the Environment Agency's Technical Guidance Notes (Monitoring) M20 ('Quality Assurance of Continuous Emission Monitoring Systems: Application of BS EN 14181 and BS EN 13284-2'). Further information is provided in Section 4.9 (Monitoring).	✓	

BAT Reference	***Description of Identified BAT***	***Assessment***	***BAT***	
			Y	***N***
BAT 4	With regards to natural gas-fired turbines, BAT is to monitor the following emissions to air: • NO_x (on a continuous basis, and in accordance with EN Standards); and, • CO (on a continuous basis, 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.	Monitoring will be undertaken in accordance with Part 3 (Emission Monitoring) of Annex V of the IED and the Environment Agency's Technical Guidance Notes (Monitoring) M1 ('Sampling Requirements for Stack Emission Monitoring') and M2 ('Monitoring of Stack Emissions to Air'). As appropriate, SEEL will also apply BS EN 14181: 2014 ('Stationary Source Emissions: Quality Assurance of Automated Measuring Systems') and the Environment Agency's Technical Guidance Notes (Monitoring) M20 ('Quality Assurance of Continuous Emission Monitoring Systems: Application of BS EN 14181 and BS EN 13284-2'). Further information is provided in Section 4.9 (Monitoring).	✓	

6.3 General Environmental / Combustion Performance

Table D5 identifies general environmental / combustion performance and assesses whether the techniques are compliant with BAT.

TABLE D5: GENERAL ENVIRONMENTAL / COMBUSTION PERFORMANCE BAT

BAT Reference	*Description of Identified BAT*		*Assessment*	*BAT*	
				Y	*N*
BAT 6	In order to improve the general environmental performance of combustion plants, and to reduce emissions of CO and unburnt substances, BAT is to ensure optimised combustion and to use a combination of:				
	(a)	Fuel blending and mixing.	N / A	-	-
	(b)	Maintenance of the combustion system.	SEEL will implement regular and planned maintenance of the combustion system in accordance with the Original Equipment Manufacturer (OEM) recommendations.	✓	
	(c)	Advanced control system.	SEEL will implement a computer-based advanced control system to automatically control and optimise the combustion efficiency, and support the prevention and reduction of emissions. The system will include associated high-performance monitoring.	✓	
	(d)	Good design of the combustion system.	SEE represents a well-designed combustion system.	✓	
	(e)	Fuel choice.	SEE will burn natural gas only. Natural gas will be used when SEE is run as normal, is started-up and is shut-down. Natural gas is an inherently clean fuel and does not produce emissions of particulate matter (PM_{10}) and sulphur dioxide (SO_2) typically associated with the burning of other fossil fuels. As a result, emissions of PM_{10} and SO_2 will be negligible.	✓	
BAT 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.		N / A. All emissions to air will be controlled at source, and no emissions abatement systems are required.	-	-
BAT 9	In order to improve general environmental performance of combustion plants and to reduce emissions to air, BAT is to include the following elements in the fuel quality assurance / fuel quality control programme:				

BAT Reference	*Description of Identified BAT*		*Assessment*	*BAT*	
				Y	*N*
	-	According to EN Standards, initial full characterisation of: LHV; CH_4; C_2H_6; C_3; C_4+; CO_2; N_2; and, Wobbe Index. 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.	N / A. The characteristics and quality of the natural gas will be controlled by National Grid, through the National Gas Transmission System (and therefore at a national level). As such, the characteristics and quality of the natural gas arriving at SEE site will be within the agreed tolerances agreed with National Grid. As such, no specific fuel quality assurance / fuel quality control programme is required. Nevertheless, a system will be in place to monitor certain characteristics of the natural gas for use in overall performance monitoring.	-	-
	-	Regular testing of the fuel quality to check that it is consistent with the initial characterisation and the plant design specifications.			
	-	Subsequent adjustment of the combustion plant as and when needed.			
BAT 10	In order to reduce emissions during Other Than Normal Operating Conditions (OTNOC), BAT is to include the following elements in a Management Plan (commensurate with the relevant of potential pollutant releases):				
	-	Appropriate design of the systems relevant in causing OTNOC that may have an impact on emissions to air, water and / or land.	SEEL is committed to a high standard of HSE Management throughout the construction, commissioning and operation of SEE. The EMS will include a plan / procedure to reduce emissions to air and / or water during OTNOC (including start-up and shut-down periods).	✓	
	-	A specific preventative maintenance plan.			
	-	Review and recording of emissions caused by OTNOC (and associated circumstances) and, if necessary, implementation of corrective actions.			
	-	Periodic assessment of the overall emissions during OTNOC and, if necessary, implementation of corrective actions.			
BAT 11	BAT is to appropriately monitor emissions to air and / or to water during OTNOC.		Monitoring will be undertaken in accordance with Part 3 (Emission Monitoring) of Annex V of the IED and the Environment Agency's Technical Guidance Notes (Monitoring) M1 ('Sampling Requirements for Stack Emission Monitoring') and M2 ('Monitoring of Stack Emissions to Air'). As appropriate, SEEL will also apply BS EN 14181: 2014 ('Stationary Source Emissions: Quality Assurance of Automated Measuring Systems') and the Environment Agency's Technical Guidance Notes (Monitoring) M20 ('Quality Assurance of Continuous Emission Monitoring Systems: Application of BS EN 14181 and BS EN 13284-2'). Further information is provided in Section 4.9 (Monitoring).	✓	

6.4 Energy Efficiency

Table D6 identifies energy efficiency BAT and assesses whether the techniques are compliant with BAT.

TABLE D6: ENERGY EFFICIENCY BAT

BAT Reference	*Description of Identified BAT*		*Assessment*	*BAT*	
				Y	*N*
BAT 12	In order to increase the energy efficiency of combustion plants operated ≥1500 hours per year, BAT is to use an appropriate combination of:				
	(a)	Combustion optimisation.	SEEL will implement a computer-based advanced control system to automatically control and optimise the combustion efficiency, and support the prevention and reduction of emissions. The system will include associated high-performance monitoring.	✓	
	(b)	Optimisation of the working medium conditions.	SEEL will implement a computer-based advanced control system to automatically optimise the working medium (gas) conditions to support the prevention and reduction of emissions.	✓	
	(c)	Optimisation of the steam cycle.	N / A	-	-
	(d)	Minimisation of energy consumption.	SEE represents a well-designed combustion system. Throughout the design process, to ensure energy efficiency, consideration has been given to the minimisation of internal energy consumption.	✓	
	(e)	Preheating of combustion air.	N / A. Under normal operating conditions, the preheating of combustion air lowers the energy efficiency of gas turbines.	-	-
	(f)	Fuel preheating.	N / A. Fuel preheating is only applicable to gas turbines in combined cycle.	-	-
	(g)	Advanced control system.	SEEL will implement a computer-based advanced control system to automatically control and optimise the combustion efficiency, and support the prevention and reduction of emissions. The system will include associated high-performance monitoring.	✓	
	(h)	Feed-water preheating using recovered heat.	N / A	-	-

BAT Reference	*Description of Identified BAT*		*Assessment*	*BAT*	
				Y	*N*
	(i)	Heat recovery by cogeneration.	N / A. Further information is provided in Section 4.7 (Resource Efficiency and Climate Change).	-	-
	(j)	CHP-Readiness.	N / A. Further information is provided in Section 4.7 (Resource Efficiency and Climate Change).	-	-
	(k)	Flue-gas condenser.	N / A	-	-
	(l)	Heat accumulation.	N / A	-	-
	(m)	Wet stack.	N / A	-	-
	(n)	Cooling water discharge.	N / A	-	-
	(o)	Fuel pre-drying.	N / A	-	-
	(p)	Minimisation of heat losses.	N / A	-	-
	(q)	Advanced materials.	SEE will be constructed from advanced materials proven to be capable of withstanding the high operating temperatures and pressures necessary to achieve the required BAT Associated Energy Efficiency Level (BAT-AEEL).	✓	
	(r)	Steam turbine upgrades.	N / A	-	-
	(s)	Supercritical and ultra-supercritical steam conditions.	N / A	-	-
BAT 40	In order to increase the energy efficiency of natural gas combustion, BAT is to use an appropriate combination of BAT 12 and:				
	(a)	Combined cycle.	N / A This is applicable to gas turbines operated ≥1500 hours per year. SEE will operate as a 'peaking plant', and will generate electrical power for 1500 hours per year as a rolling average over a period of five years. Over this timescale, the benefits of higher efficiencies associated with a combined cycle are very minimal.	-	-

BAT Reference	*Description of Identified BAT*		*Assessment*	*BAT*	
				Y	*N*
STGN 1.1	The Combustion Activities STGN states that indicative BAT for gas turbines is to:				
	(8)	Consider measures to increase the energy efficiency of the gas turbine including: • Increasing the combustion air temperature, balanced against excess air requirements and NO_x emissions to air; • Using concentric shafts to connect different stages of compression and expansion; and, • Intercooling between stages of compression and reheating.	SEEL will implement a computer-based advanced control system to automatically optimise the working medium (gas) conditions to support the prevention and reduction of emissions.	✓	
	(9)	Consider heat recovery by co-generation / CHP-Readiness.	N / A. Further information is provided in Section 4.7 (Resource Efficiency and Climate Change).	-	-

Table D7 identifies the BAT-Associated Energy Efficiency Levels (BAT-AEELs) and assesses whether the techniques are compliant with the BAT-AEELs.

TABLE D7: BAT-AEELs

BAT Reference	*BAT-AEELs*	*Assessment*	*BAT*	
			Y	*N*
Table 23	For a new Open Cycle Gas Turbine (OCGT) Unit with a rated thermal input ≥50 MW, the net electrical efficiency should be between 36 to 41.5 per cent.	SEE will have an electrical generation efficiency above 36 per cent, based on the LHV of the fuel.	✓	

6.5 Emissions to Air

Table D8 identifies emissions to air BAT and assesses whether the techniques are compliant with BAT. Further information is also provided in Appendix G (Air Quality Impact Assessment).

TABLE D8: EMISSIONS TO AIR BAT

BAT Reference	*Description of Identified BAT*		*Assessment*	*BAT*	
				Y	*N*
BAT 42	In order to prevent or reduce NO_x emissions to air from the combustion of natural gas in gas turbines, BAT is to use an appropriate combination of:				
	(a)	Advanced control system.	SEEL will implement a computer-based advanced control system to automatically control and optimise the combustion efficiency, and support the prevention and reduction of emissions. The system will include associated high-performance monitoring.	✓	
	(b)	Water / steam addition.	N / A	-	-
	(c)	Dry low-NO_x burners.	The gas turbine will be fitted with dry low-NO_x burners.	✓	
	(d)	Low-load design concept.	SEEL will implement a computer-based control advanced control system to automatically control and optimise combustion efficiency, and support the prevention and reduction of emissions over a range of loads. Following commissioning, SEEL will confirm the associated 'Minimum Start-Up Load' and 'Minimum Shut-Down Load'.	✓	
	(e)	Low-NO_x burners.	N / A	-	-
	(f)	Selective Catalytic Reduction.	N / A	-	-
BAT 44	In order to prevent or reduce CO emissions to air from the combustion of natural gas, BAT is to ensure combustion optimisation.		SEEL will implement a computer-based advanced control system to automatically control and optimise the combustion efficiency, and support the prevention and reduction of emissions. The system will include associated high-performance monitoring.	✓	

BAT Reference	*Description of Identified BAT*	*Assessment*	*BAT*	
			Y	*N*
STGN 3.2	The Combustion Activities STGN states that indicative BAT to prevent or reduce NO_x emissions to air is to:			
	(1) Control NO_x emissions to air by a combination of: • Combustion optimisation; • Advanced control systems; and, • Other measures as appropriate.	SEEL will implement a computer-based advanced control system to automatically control and optimise the combustion efficiency, and support the prevention and reduction of emissions. The system will include associated high-performance monitoring. The gas turbine will be fitted with dry low-NO_x burners.	✓	
	(4) Use of water / steam addition or dry low-NO_x burners.	The gas turbine will be fitted with dry low-NO_x burners.	✓	
STGN 3.2	The Combustion Activities STGN states that indicative BAT to prevent or reduce SO_2 emissions to air is to:			
	(1) Use low sulphur fuels.	SEE will burn natural gas only. Natural gas will be used when SEE is run as normal, is started-up and is shut-down. Natural gas is an inherently clean fuel and does not produce emissions of SO_2 typically associated with the burning of other fossil fuels. As a result, emissions of SO_2 will be negligible.	✓	

Table D9 identifies the BAT-Associated Emission Levels (BAT-AELs) and assesses whether the techniques are compliant with BAT-AELs.

TABLE D9: BAT-AELs

BAT Reference	*BAT-AELs*	*Assessment*	*BAT*	
			Y	*N*
Table 24	For a new Open Cycle Gas Turbine (OCGT) Unit with a rated thermal input ≥50 MW, NO_x emissions to air from the combustion of natural gas in gas turbines should be:			
	Between 25 to 50 mg/Nm^3 on a daily average.	NO_x emissions to air will be limited to a daily average of 50 mg/Nm^3.	✓	
	Between 15 to 35 mg/Nm^3 on a yearly average.	N / A. For new OCGT units operated 1500 hours per year as a rolling average over a period of five years, the Environment Agency has advised (during pre-application discussions) that a yearly average will not be enforced.	-	-

BAT Reference	*BAT-AELs*	*Assessment*	*BAT*	
			Y	*N*
-	For a new Open Cycle Gas Turbine (OCGT) Unit with a rated thermal input ≥50 MW, CO emissions to air from the combustion of natural gas should be:			
	Between 5 to 40 mg/Nm^3.	N / A. This is applicable to new OCGT units operated ≥1500 hours per year. SEE will operate as a 'peaking plant', and will generate electrical power for 1500 hours per year as a rolling average over a period of five years.	-	-

6.6 Water Usage / Emissions to Water

Table D10 identifies water usage / emissions to water BAT and assesses whether the techniques are compliant with BAT.

TABLE D10: WATER USAGE / EMISSIONS TO WATER BAT

BAT Reference	*Description of Identified BAT*		*Assessment*	*BAT*	
				Y	*N*
BAT 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.		There will be segregation of waste water streams according to their source and pollutant content. Regarding emissions to water: • There will be no point source emissions to sewers or effluent treatment plants (as there are no process waters); • There will be transfers off-site associated with the offline washing of the gas turbine; and, • There will be point source emissions to other waters (the River Welland) associated with the discharge of collected surface waters.	✓	
STGN 3.1	The Combustion Activities STGN states that indicative BAT for site drainage is to:				
	(12)	Use an efficient oil / water separation and interception system, noting that further treatment may be required to remove dissolved hydrocarbons.	Surface water from impermeable areas of the SEE site will be collected via drains. These drains will combine and connect into a catch-basin located in the south east corner of the existing Spalding CCGT generating station site. From the catch-basin, the surface water will flow towards the existing attenuation pond located in the north east corner of the existing Spalding CCGT generating station site, passing through an existing oil / water separator. As and when necessary, surface water collected in the attenuation pond will be pumped into the River Welland.	✓	
	(13)	Only directly discharge to controlled waters where the discharge will meet the requirements under all conditions.			

BAT Reference	*Description of Identified BAT*		*Assessment*	*BAT*	
				Y	*N*
STGN 3.1	The Combustion Activities STGN states that indicative BAT for cleaning fluids is to:				
	(10)	Neutralise or treat wash waters / cleaning out solutions to produce an acceptable waste before discharge / disposal.	Occasionally it will be necessary to wash the blades of the air compressor section of the gas turbine to remove debris that has penetrated the air inlet filters and lodged on the air compressor blades. Offline washing will be done at times when the performance of the gas turbines has degraded. During offline washing, the air compressor blades will be rotated slowly through a detergent solution. Following offline washing, approximately 15 m^3 of waste water (containing the used detergent) will be collected and retained at the site in a storage tank, and subsequently removed from site by a licensed contractor for disposal at a suitability licensed facility. The frequency of offline washing will be dependent upon the operational hours of the gas turbine and the ambient air quality in the vicinity of the site. As all waste water will be collected and retained, and subsequently removed from site, there will be no effects on the surrounding environment.	✓	

6.7 Waste Management / Emissions to Land

Table D11 identifies waste management / emissions to land BAT and assesses whether the techniques are compliant with BAT.

TABLE D11: WASTE MANAGEMENT / EMISSIONS TO LAND BAT

BAT Reference	*Description of Identified BAT*		*Assessment*	*BAT*	
				Y	*N*
BAT 16	In order to reduce the quantity of waste sent for disposal from the combustion process (and associated abatement techniques), BAT is to organise operations so as to maximise (in order of priority and taking account of life-cycle thinking): • Waste prevention; • Waste preparation for re-use; • Waste recycling; and, • Other waste recovery.		SEEL is committed to a high standard of HSE Management throughout the construction, commissioning and operation of SEE. The EMS will include a plan relating to waste management.	✓	
STGN 1.2	The Combustion Activities STGN states that indicative BAT for the avoidance, recovery and disposal of wastes is to:				
	(1)	Store, handle and transport all waste streams to prevent the release of waste.	SEEL is committed to a high standard of HSE Management throughout the construction, commissioning and operation of SEE. The EMS will include a plan relating to waste management.	✓	
	(5)	Recycle materials back into the process whenever possible.			
	(6)	Where recycling and re-use is not possible, consider regeneration of materials or return of material to the manufacturer.			

6.8 Emissions of Noise

Table D12 identifies emissions of noise BAT and assesses whether the techniques are compliant with BAT. Further information is also provided in (Noise Impact Assessment).

TABLE D12: EMISSIONS OF NOISE BAT

BAT Reference	*Description of Identified BAT*		*Assessment*	*BAT*	
				Y	*N*
BAT 17	In order to reduce emissions of noise, BAT is to use an appropriate combination of:				
	(a)	Operational measures.	SEEL is committed to a high standard of HSE Management throughout the construction, commissioning and operation of SEE. The EMS will ensure that SEE operates within the parameters of its associated consents and permits.	✓	
	(b)	Low-noise equipment.	SEEL will ensure that SEE incorporates plant / equipment with emissions of noise within the parameters of the Noise Impact Assessment. Where necessary, this will include: low-noise equipment; noise attenuation; and, noise-control equipment.	✓	
	(c)	Noise attenuation.			
	(d)	Noise-control equipment.			
	(e)	Appropriate location of equipment and buildings.	SEEL has appropriately located equipment and buildings to ensure that SEE operates within the parameters of the Noise Impact Assessment. Further information is provided in Appendix H (Noise Impact Assessment).	✓	