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SSE Generation Ireland Limited

Campile, New Ross, Co Wexford

Industrial Emissions Licence Review
BAT Assessment

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1. BAT Conclusion 1

Great Island is registered to ISO 14001:2015, this standard meets the requirements of the BAT 1. Its scope and nature is appropriate to the Great Island installation and its range of environmental impacts. Main certificate: GB 17/873624.01

Table 1: Environmental Management Systems

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
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: (i) commitment of the management, including senior management;	Yes	In place
(ii)definition, by the management, of an environmental policy that includes the continuous improvement of the environmental performance of the installation;	Yes	In place
(iii)planning and establishing the necessary procedures, objectives and targets, in conjunction with financial planning and investment;	Yes	In place
(iv) implementation of procedures paying particular attention to: (a) structure and responsibility (b) recruitment, training, awareness and competence (c) communication (d) employee involvement (e) documentation (f) effective process control (g) planned regular maintenance programmes (h) emergency preparedness and response (i) safeguarding compliance with environmental legislation;	Yes	In place
(v) checking performance and taking corrective action, paying particular attention to: (a) monitoring and measurement (b) corrective and preventive action (c) maintenance of records (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;	Yes	In place
(vi) review, by senior management, of the EMS and its continuing suitability, adequacy and effectiveness;	Yes	In place
(vii) following the development of cleaner technologies;	Yes	In place

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
(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 including; (a) avoiding underground structures (b) incorporating features that facilitate dismantling (c) choosing surface finishes that are easily decontaminated (d) using an equipment configuration that minimises trapped chemicals and facilitates drainage or cleaning (e) designing flexible, self-contained equipment that enables phased closure (f) using biodegradable and recyclable materials where possible;	Yes	In place
(ix) application of sectoral benchmarking on a regular basis.	Yes	In place
(x) quality assurance/quality control programmes to ensure that the characteristics of all fuels are fully determined and controlled (see BAT 9);	Yes	In place
(xi) a management plan in order to reduce emissions to air and/or to water during other than normal operating conditions, including start-up and shutdown periods (see BAT 10 and BAT 11);	Yes	In place
(xii) a waste management plan to ensure that waste is avoided, prepared for reuse, recycled or otherwise recovered, including the use of techniques given in BAT 16;	Yes	In place
(xiii) a systematic method to identify and deal with potential uncontrolled and/or unplanned emissions to the environment, in particular: (a) emissions to soil and groundwater from the handling and storage of fuels, additives, by-products and wastes (b) emissions associated with self-heating and/or self-ignition of fuel in the storage and handling activities;	Yes	In place
(xiv) a dust management plan to prevent or, where that is not practicable, to reduce diffuse emissions from loading, unloading, storage and/or handling of fuels, residues and additives;	Yes	In place - No dust emitting materials in use on site
(xv) a noise management plan where a noise nuisance at sensitive receptors is expected or sustained, including; (a) a protocol for conducting noise monitoring at the plant boundary (b) a noise reduction programme (c) a protocol for response to noise incidents containing appropriate actions and timelines (d) a review of historic noise incidents, corrective actions and dissemination of noise incident knowledge to the affected parties;	Yes	In place – no noise issues therefore reduction plans and incidents are not applicable
(xvi) For the combustion, gasification or co-incineration of malodourous substances, an odour management plan including: (a) a protocol for conducting odour monitoring (b) where necessary, an odour elimination programme to identify and eliminate or reduce the odour emissions (c) a protocol to record odour incidents and the appropriate actions and timelines (d) a review of historic odour incidents, corrective actions and the dissemination of odour incident knowledge to the affected parties.	Yes	Not applicable

Figure 1: ISO 14001 Certificate

Certificate GB17/873624.01

The management system of

Great Island Power Station, SSE plc

Campile, New Ross, Co.Wexford, Ireland

has been assessed and certified as meeting the requirements of

ISO 14001:2015

For the following activities

The generation of electricity.

This certificate is valid from 28 June 2018 until 28 June 2021
and remains valid subject to satisfactory surveillance audits.
Re certification audit due before 28 March 2021
Issue 2. Certified since 16 October 2006

Multiple certificates have been issued for this scope
The main certificate is numbered GB17/873624.00

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2. BAT Conclusion 2

Table 2: Electrical Efficiency

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
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, 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.	Yes	In place - Performance tests are completed to the required EN/ISO standards as detailed within BAT 2. Performance tests were completed during commissioning of the LCP and after each modification which could significantly affect performance. Test report to attached last complete in February 2017. Corrected Net Efficiency LHV 57.8%

Figure 2: Baseload Analysis Certificates

sse engineering centre

Great Island CCGT
Baseload Performance Analysis
February 2017

Technical Note No: TN-GEN-AM-COMM-551-029

Prepared and Issued by:
Katy Burke, Process Engineer
Ronnie Glen, Process Engineer

Approved by:
Paul Kieran, Process Engineering Manager

Date Issued:
01/03/2017

Rev: 1.0

Information Classification: Confidential

	04/01/2017 RTS*	31/01/2017	Deviation vs. 04/01/17	27/02/2017	Deviation vs. 04/01/17
Corrected Net Output (MW)	461	457	-0.9%	461	0
Corrected Net Efficiency LHV (%)	57.8	57.8	0	57.7	-0.1%
Corrected Net Efficiency HHV (%)	52.2	52.2	0	52.1	-0.1%
GT Simple Cycle Efficiency** LHV (%)	40.0	39.7	NA	39.8	NA

3. BAT Conclusion 3

Table 3:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
BAT is to monitor key process parameters relevant for emissions to air and water including those given below	Yes	Flue gas flow is monitored by calculation of gas consumption on continuous basis Oxygen, temperature, pressure – continuous measurement is complete Water vapour – periodic determination is determined Wastewater flow, pH and temperature are not applicable to this site for flue gas treatment.

Figure 3: BAT Table

Stream	Parameter(s)	Monitoring
Flue-gas	Flow	Periodic or continuous determination
	Oxygen content, temperature, and pressure	Periodic or continuous measurement
	Water vapour content (2)	
Waste water from flue-gas treatment	Flow, pH, and temperature	Continuous measurement

4. BAT Conclusion 4

Table 4:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
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	Yes	NOx – Continuous – EN 14792 CO – Continuous – EN 15058 SO_2 – Continuous – EN14791 (on gas oil only) SO_2 – Continuous – EN13284-2 (on gas oil only) CH4 – not currently licensed to monitor this parameter – has been monitored for 2020 Dust – monitored annually on gas – continuous analyser in place for gas oil if required

Figure 4: BAT Requirements

Parameter	Combustion Plant	Plant Size	Standards	Monitoring Frequency	Associated with BAT
NH_3	Not applicable				
NO_x	Natural-gas-fired boilers, engines, and turbines / Gas-oil-fired gas turbines	All	Generic EN standards	Continuous	20, 24, 28, 32, 27, 41, 42, 43, 47, 48, 56, 64, 65, 73
N_2O	Not Applicable				
CO	Natural-gas-fired boilers, engines, and turbines / Gas-oil-fired gas turbines	All	Generic EN standards	Continuous	20, 24, 28, 33, 38, 44, 49, 56, 64, 65, 73
SO_2	Gas-oil-fired gas turbines	All	Generic EN standards and EN 14791	Continuous	21, 25, 29, 34, 39, 50, 57, 66, 67, 74
SO_3	Not Applicable				
Gaseous chlorides	Not Applicable				
HF	Not Applicable				
Dust	Gas-oil-fired gas turbines	All	Generic EN standards and EN 13284-1 and EN 13284-2	Continuous	22, 26, 30, 35, 39, 51, 58, 75
Metals	Not Applicable				
Mercury	Not Applicable				
TVOC	Not Applicable				
Formaldehyde	Not Applicable				
CH_4	Natural-gas-fired engines	All	EN ISO 25139	Once per year	45
PCDD/F	Not Applicable				

5. BAT Conclusion 5

Table 5:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
BAT is to monitor emissions to water from flue-gas treatment with at least the frequency given below and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality	Not applicable	Not applicable

Figure 5: BAT Requirements

Substance/Parameter		Standard(s)	Minimum monitoring frequency	Monitoring associated with
Total organic carbon (TOC)[26]		EN 1484	Once every month	BAT 15
Chemical oxygen demand (COD)[26]		No EN standard available		
Total suspended solids (TSS)		EN 872		
Fluoride (F^-)		EN ISO 10304-1		
Sulphate (SO_4^{2-})		EN ISO 10304-1		
Sulphide, easily released (S^{2-})		No EN standard available		
Sulphite (SO_3^{2-})		EN ISO 10304-3		
Metals and metalloids	As	Various EN standards available (e.g. EN ISO 11885 or EN ISO 17294-2)		
	Cd			
	Cr			
	Cu			
	Ni			
	Pb			
	Zn			
	Hg	Various EN standards available (e.g. EN ISO 12846 or EN ISO 17852)		
Chloride (Cl^-)		Various EN standards available (e.g. EN ISO 10304-1 or EN ISO 15682)		–
Total nitrogen		EN 12260		–

6. BAT Conclusion 6

Table 6:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
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 in Figure 6.	Yes	Fuel Blending – Natural gas supply Maintenance of the combustion system – Regular planned maintenance carried out Advanced Control system – In place Good design of combustion equipment – In place Fuel Choice – almost constantly operated on natural gas with back up of gas oil.

Note 1: The site is a CCGT and utilises the combination of two or more thermodynamic cycles, e.g. a Brayton cycle (gas turbine/combustion engine) with a Rankine cycle (steam turbine/boiler), to convert heat loss from the flue-gas of the first cycle to useful energy by subsequent cycle(s). The combustion system is maintained according to original equipment manufacturers recommendations and fitted with an advanced computer based control system to control the combustion efficiency and support the prevention and/or reduction of emissions.

Maintenance of the Combustion System: Great Island has a programme of scheduled maintenance in accordance with the OEM's (MHPS) guidance. Operation of combustion turbines must include a planned programme of periodic inspection, with accompanying repair and replacement of parts to ensure maximum availability and reliability of unit. Operating factors which determine the maintenance requirement for a specific installation include fuel, starting frequency, load cycle and environment. These factors decide the scheduling of the various inspections: combustion inspection, hot gas path inspection and major inspections. Combustion inspections are the most frequent.

We utilise an OEM approved CPFM control system for controlling combustion emissions and stable combustion.

It makes adjustments to the air and pilot gas (or oil) ratio to optimise the combustion within the stability curve. Constant adjustments are made.

Figure 6: BAT Requirements

Technique		Description	Applicability
a.	Fuel blending and mixing	Ensure stable combustion conditions and/or reduce the emission of pollutants by mixing different qualities of the same fuel type	Generally applicable
b.	Maintenance of the combustion system	Regular planned maintenance according to suppliers' recommendations	
c.	Advanced control system	See description in Section 8.1	The applicability to old combustion plants may be constrained by the need to retrofit the combustion system and/or control command system
d.	Good design of the combustion equipment	Good design of furnace, combustion chambers, burners and associated devices	Generally applicable to new combustion plants
e.	Fuel choice	Select or switch totally or partially to another fuel(s) with a better environmental profile (e.g. with low sulphur and/or mercury content) amongst the available fuels, including in start-up situations or when back-up fuels are used	Applicable within the constraints associated with the availability of suitable types of fuel with a better environmental profile as a whole, which may be impacted by the energy policy of the Member State, or by the integrated site's fuel balance in the case of combustion of industrial process fuels. For existing combustion plants, the type of fuel chosen may be limited by the configuration and the design of the plant

7. BAT Conclusion 7

Table 7:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
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)	Not applicable	Not applicable – No SCR or SNCR

Figure 7: BAT Requirements

BAT-associated emission levels

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.

8. BAT Conclusion 8

Table 8:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
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	Not applicable	Not applicable – no abatement system employed

9. BAT Conclusion 9

Table 9:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
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: 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; 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); 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	Yes	In Place - The fuel gas supplied to the site has been assessed in accordance with technique (i) and is continuously monitored in accordance with technique (ii) Measurement of LHV, CH4, C2H6,C3, C4+, CO2 and Wobbe index is carried out continuously using an online gas chromatograph which carries out calculations in accordance with ISO6976. The gas chromatograph is calibrated annually in accordance with ISO17025. The data supplied from the gas monitoring system is used to assess the performance of the plant in accordance with technique (iii). The Gas Oil supplied to site is tested by the supplier and the results provided for Ash, N, C & S in the form of supplier specification Site gas oil consumption is low due to consistently firing on natural gas. There have been no recent deliveries of gas oil, last delivery March 2015 Analysis provided by supplier to include Ash, N, C & S to specification.

Figure 8: BAT Requirements

Fuel(s)	Substances/Parameters subject to characterisation
Biomass/peat	— LHV — moisture
	— Ash — C, Cl, F, N, S, K, Na — Metals and metalloids (As, Cd, Cr, Cu, Hg, Pb, Zn)
Coal/lignite	— LHV — Moisture — Volatiles, ash, fixed carbon, C, H, N, O, S
	— Br, Cl, F
	— Metals and metalloids (As, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, Sb, Tl, V, Zn)
HFO	— Ash — C, S, N, Ni, V
Gas oil	— Ash — N, C, S
Natural gas	— LHV — CH_4, C_2H_6, C_3, C_4+, CO_2, N_2, Wobbe index
Process fuels from the chemical industry (27)	— Br, C, Cl, F, H, N, O, S — Metals and metalloids (As, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, Sb, Tl, V, Zn)
Iron and steel process gases	— LHV, CH_4 (for COG), C_XH_Y (for COG), CO_2, H_2, N_2, total sulphur, dust, Wobbe index
Waste (28)	— LHV — Moisture — Volatiles, ash, Br, C, Cl, F, H, N, O, S — Metals and metalloids (As, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, Sb, Tl, V, Zn)

10. BAT Conclusion 10

Table 10:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
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: i) 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); ii) set-up and implementation of a specific preventive maintenance plan for these relevant systems, iii) review and recording of emissions caused by OTNOC and associated circumstances and implementation of corrective actions if necessary, iv) periodic assessment of the overall emissions during OTNOC (e.g. frequency of events, duration, emissions quantification/estimation) and implementation of corrective actions if necessary. Defined OTNOC conditions that exclude compliance assessment; • Start Up and Shut Down periods • Malfunction and Breakdown • Gas turbine tuning activities • Aborted runs of short of short-duration • Exceptional conditions	Yes	In place - Sites do not have a specific OTNOC management plan, however the EMS incorporates many of the key aspects of BAT 10 & 11. The site operates a risk based review with the EMS (Aspects and impacts) which includes a review of potential impacts of OTNOC. A) Gas turbine starts are optimised based on plant condition (i.e. warmth category) along with advanced control systems (Auto tune and LVE) which enable DLN in the early stages of the firing sequence to minimise emissions during start-up. B) All plant components are included within the site specific preventative maintenance programmes, the frequency of maintenance is dependent on operation of the site. BAT 11: Emissions during start-up and shutdown operations are monitored and reviewed to identify if corrective actions are required. Emissions to atmosphere are assessed as part of the annual environmental performance review carried out by sites. In the event of an accident or environmental incident, we would review the emissions, cause etc. as part of our incident investigation process and ensure any relevant corrective and / or preventive action is implemented. Start-up emissions are atypical during plant commissioning since there is a requirement to deviate from normal gas turbine load and/or exhaust temperature profiles in order to complete essential testing and/or control system tuning activities. In such cases, commissions plans are arranged to minimise additional emissions so far as is reasonable practicable.

11. BAT Conclusion 11

Table 11:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
BAT is to appropriately monitor emissions to air and/or to water during OTNOC	Yes	In place - The site monitors CO, SO_2, Dust and NO_X as required by BAT 4 and IE Licence for duel fired turbines. Monitoring is carried out continuously in accordance with EN14181. Emissions to water are continuously monitored as per licence requirements.

12. BAT Conclusion 12

Table 12:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
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	Yes	In Place
Combustion optimisation	Yes	Measures taken to maximise the efficiency of energy conversion, e.g. in the boiler, while minimising emissions (in particular of CO). This is achieved by a combination of techniques including good design of the combustion equipment, optimisation of the temperature (e.g. efficient mixing of the fuel and combustion air) and residence time in the combustion zone, and use of an advanced control system. CPFM system used to stabilise combustion by recording pressure fluctuations. It regulates Gas and/or Air mix to do so. Optimised GT combustion hardware also used using Dry Low NOx combustion technique. (a) Also maintenance / inspection carried out of combustion parts.
Optimisation of the working medium conditions	Yes	The thermal output from the gas turbine is optimised to control the efficiency and pinch points for optimal performance of the HRSG. Output of the GT provides optimum temperatures to the HRSG to optimise the Rankin cycle. Operating temperatures & pressures vary with unit load.
Optimisation of the steam cycle	Yes	Cooling Water flows are adjusted to meet the steam turbine design conditions by varying the number of cooling pumps running and valve positions. Specially designed L-0 (non erosion) blades on the ST allows a lower Condenser Pressure to be pulled to produce more MW output on the machine. The condenser cooling water passes are cleaned when fouled to improve efficiency. Engineers record the TTD or thermal temperature difference which is a guide to the condenser efficiency.
Minimisation of energy consumption	Yes	Minimum flow and reliability help in minimising the internal energy consumption.
Preheating of combustion air	Yes	Not applicable. There is no preheating of air required for the CCGT.
Fuel preheating		SSE don't use recovered heat but use IP feed water to heat the gas.
Advanced control system	Yes	Gas Turbines are fitted with an advanced computer based control system to control the combustion efficiency and support the prevention and/or reduction of emissions. Redundancy and Protection Systems in Place.

Feed-water preheating using recovered heat	Yes	SSE send condensate through the Gland Steam Condensers which condenses the steam but also heats the condensate water before sending this water to the HRSG/Boiler. SSE also used the hot air from the GT Compressor to heat the HP feed water in the TCA while cooling the combustion air.
Heat recovery by cogeneration (CHP)	Not applicable	Not applicable – LCP is not a CHP
CHP readiness	Not applicable	Not applicable – LCP is not a CHP
Flue-gas condenser	Not applicable	Not applicable – LCP is not a CHP
Heat accumulation	Not applicable	Not applicable – LCP is not a CHP
Wet stack	Not applicable	Not applicable – Not a new site and no wet FGD fitted
Cooling tower discharge	Not applicable	Not applicable – No wet FGD fitted
Fuel pre-drying	Not applicable	Not applicable – Natural gas used – no combustion of biomass or peat
Minimisation of heat losses	Not applicable	Insulation installed on all hot components, GT/ST/Pipe-work and hence optimising the cycle
Advanced materials	Not applicable	Not applicable – Not a new plant. Reliability Upgrades decided with MHPSE prior to each outage can be some material changes, but we are using a state of the art F4 turbine from MHPS with design features to optimise performance on the Inlet, Compressor, Combustor, Turbine and Exhaust sections.
Steam turbine upgrades	The applicability may be restricted by demand, steam conditions and/or limited plant lifetime	This is a 6 year old plant, has already got HP, IP and LP Steam Turbines. Reliability Upgrades are produced and suggested each time. Only look at works on the ST during a Major Inspection (next scheduled in 2022).
Supercritical and ultra-supercritical steam conditions	Not applicable	Not applicable – not a new plant

Figure 9: BAT Requirements

	Technique	Description	Applicability
a.	Combustion optimisation	See description in Section 8.2. Optimising the combustion minimises the content of unburnt substances in the flue-gases and in solid combustion residues	Generally applicable
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. 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. 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: — flue-gas — grate cooling — circulating fluidised bed	Applicable within the constraints associated with the local heat and power demand. The applicability may be limited in the case of gas compressors with an unpredictable operational heat profile
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. 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). 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
r.	Steam turbine upgrades	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	The applicability may be restricted by demand, steam conditions and/or limited plant lifetime
s.	Supercritical and ultra-supercritical steam conditions	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	Only applicable to new units of ≥ 600 MW_{th} operated > 4 000 h/yr. Not applicable when the purpose of the unit is to produce low steam temperatures and/or pressures in process industries. Not applicable to gas turbines and engines generating steam in CHP mode. For units combusting biomass, the applicability may be constrained by high-temperature corrosion in the case of certain biomasses

13. BAT Conclusion 13

Table 13:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
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	Yes	In place - Water usage is optimised and minimised where plant design allows. The site is fitted with a once through cooling system resulting in excellent condenser efficiency and minimal water usage (losses). The water used within the cooling water system is not of suitable quality to be re-used in other processes on site. All water is returned to the estuary. Process water usage including boiler feed water is optimised through minimisation of blowdown from the water steam cycle.

Figure 10: BAT Requirements

Technique		Description	Applicability
a.	Water recycling	Residual aqueous streams, including runoff water, from the plant are reused for other purposes. The degree of recycling is limited by the quality requirements of the recipient water stream and the water balance of the plant	Not applicable to waste water from cooling systems when water treatment chemicals and/or high concentrations of salts from seawater are present
b.	Dry bottom ash handling	Dry, hot bottom ash falls from the furnace onto a mechanical conveyor system and is cooled down by ambient air. No water is used in the process.	Only applicable to plants combusting solid fuels. There may be technical restrictions that prevent retrofitting to existing combustion plants

14. BAT Conclusion 14

Table 14:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
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	Yes	In place - Storm water and process water streams are segregated on site. Drains are colour coded to prevent contamination. Oil / silt interceptors are installed where appropriate. Water Treatment Plant effluent - All waste water flows from the water treatment plant are collected in a neutralisation basin. Here the effluent is mixed in a basin and the pH adjusted through chemical addition. The contents are air blown through the basin to ensure the contents are mixed and the site licence discharge pH limits are achieved. It is then that the contents are pumped to the returned cooling water and discharged to the estuary. Internal & external drains - The flow from all internal building drains and those external areas where there is potential for oil contamination (e.g. car park, plant) is discharged through a site oil interceptor. Sewage effluent - Site sewage is treated on-site in a waste treatment plant. Site storm water is collected via the surface water drains, a number of interceptors have been installed to protect against potential residual oil.

15. BAT Conclusion 15

Table 15:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
In order to reduce emissions to water from flue-gas treatment, BAT is to use an appropriate combination of the techniques given below, and to use secondary techniques as close as possible to the source in order to avoid dilution	Not applicable	Not applicable – the LCP does not operate a flue gas treatment system

Figure 11: BAT Requirements

Technique		Typical pollutants prevented/abated	Applicability
Primary techniques			
a.	Optimised combustion (see BAT 6) and flue-gas treatment systems (e.g. SCR/SNCR, see BAT 7)	Organic compounds, ammonia (NH_3)	Generally applicable
Secondary techniques [22]			
b.	Adsorption on activated carbon	Organic compounds, mercury (Hg)	Generally applicable
c.	Aerobic biological treatment	Biodegradable organic compounds, ammonium (NH_4^+)	Generally applicable for the treatment of organic compounds. Aerobic biological treatment of ammonium (NH_4^+) may not be applicable in the case of high chloride concentrations (i.e. around 10 g/l)
d.	Anoxic/anaerobic biological treatment	Mercury (Hg), nitrate (NO_3^-), nitrite (NO_2^-)	Generally applicable
e.	Coagulation and flocculation	Suspended solids	Generally applicable
f.	Crystallisation	Metals and metalloids, sulphate (SO_4^{2-}), fluoride (F^-)	Generally applicable
g.	Filtration (e.g. sand filtration, microfiltration, ultrafiltration)	Suspended solids, metals	Generally applicable
h.	Flotation	Suspended solids, free oil	Generally applicable
i.	Ion exchange	Metals	Generally applicable
j.	Neutralisation	Acids, alkalis	Generally applicable
k.	Oxidation	Sulphide (S^{2-}), sulphite (SO_3^{2-})	Generally applicable
l.	Precipitation	Metals and metalloids, sulphate (SO_4^{2-}), fluoride (F^-)	Generally applicable
m.	Sedimentation	Suspended solids	Generally applicable
n.	Stripping	Ammonia (NH_3)	Generally applicable

16. BAT Conclusion 16

Table 16:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
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: (a) waste prevention, e.g. maximise the proportion of residues which arise as by-product; (b) Waste prevention, e.g. maximise the proportion of residues which arise as by-product; (c) waste recycling; (d) other waste recovery (e.g. energy recovery), by implementing an appropriate combination of techniques such as those listed in the BAT table below	Yes	In Place - The BAT techniques detailed within BAT 16 are not directly applicable. However, the site follows the principles of the waste hierarchy; Reduce, Reuse, Recycle, Recover and finally deposal for all waste generated at the site. The process for waste disposal is detailed within a local approved procedure.

Figure 11: BAT Requirements

Technique		Description	Applicability
a.	Generation of gypsum as a by-product	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	Generally applicable within the constraints associated with the required gypsum quality, the health requirements associated to each specific use, and by the market conditions
b.	Recycling or recovery of residues in the construction sector	Recycling or recovery of residues (e.g. from semi-dry desulphurisation processes, fly ash, bottom ash) as a construction material (e.g. in road building, to replace sand in concrete production, or in the cement industry)	Generally applicable within the constraints associated with the required material quality (e.g. physical properties, content of harmful substances) associated to each specific use, and by the market conditions
c.	Energy recovery by using waste in the fuel mix	The residual energy content of carbon-rich ash and sludges generated by the combustion of coal, lignite, heavy fuel oil, peat or biomass can be recovered for example by mixing with the fuel	Generally applicable where plants can accept waste in the fuel mix and are technically able to feed the fuels into the combustion chamber
d.	Preparation of spent catalyst for reuse	Preparation of catalyst for reuse (e.g. up to four times for SCR catalysts) restores some or all of the original performance, extending the service life of the catalyst to several decades. Preparation of spent catalyst for reuse is integrated in a catalyst management scheme	The applicability may be limited by the mechanical condition of the catalyst and the required performance with respect to controlling NO_X and NH_3 emissions

17. BAT Conclusion 17

Table 17:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
In order to reduce noise emissions, BAT is to use one or a combination of the techniques given below:	Yes	In place – no noise issues off site from the CCGT demonstrated by measurement. Detailed Inspection and Maintenance regime including any plant or equipment whose deterioration may give rise to increase in noise. Operational measures – start-ups Auxiliary Steam System is to supply steam at the required pressure and temperature for LP Steam Turbine cooling and gland steam sealing during start-up. This reduces start-up process by enabling the plant to establish vacuum earlier. Start-up vents: minimise use, installation of silencers, avoidance of long periods of use at night. Building Doors: doors to generation buildings are kept closed. Noise-control equipment All noisy equipment is housed within enclosures and buildings. Silencers are installed on steam release points. Buildings include soundproofing material on the inside. Noise sources are shielded from receptors using buildings. Location Great Island power station is situated at a location removed from potential receptors; all neighbouring sites and nearest village is approximately 750m away across the estuary Great Island has an annual programme of environmental noise measurements.

Figure 12: BAT Requirements

Technique		Description	Applicability
a.	Operational measures	These include: — improved inspection and maintenance of equipment — closing of doors and windows of enclosed areas, if possible — equipment operated by experienced staff — avoidance of noisy activities at night, if possible — provisions for noise control during maintenance activities	Generally applicable
b.	Low-noise equipment	This potentially includes compressors, pumps and disks	Generally applicable when the equipment is new or replaced
c.	Noise attenuation	Noise propagation can be reduced by inserting obstacles between the emitter and the receiver. Appropriate obstacles include protection walls, embankments and buildings	Generally applicable to new plants. In the case of existing plants, the insertion of obstacles may be restricted by lack of space
d.	Noise-control equipment	This includes: — noise-reducers — equipment insulation — enclosure of noisy equipment — soundproofing of buildings	The applicability may be restricted by lack of space
e.	Appropriate location of equipment and buildings	Noise levels can be reduced by increasing the distance between the emitter and the receiver and by using buildings as noise screens	Generally applicable to new plants. In the case of existing plants, the relocation of equipment and production units may be restricted by lack of space or by excessive costs

Combustion of Gaseous Fuels

18. BAT Conclusion 40

Table 18:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
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:	Yes	In place - The last performance data for this station shows a net efficiency of 57.8% against a BAT associated energy efficiency level quoted below for natural gas of 46 – 54% for an existing CCGT between 50 – 600 MW_{th}.

Figure 13: BAT Requirements

Technique		Description	Applicability
a.	Combined cycle	See description in Section 8.2	Generally applicable to new gas turbines and engines except when operated < 1 500 h/yr. Applicable to existing gas turbines and engines within the constraints associated with the steam cycle design and the space availability. Not applicable to existing gas turbines and engines operated < 1 500 h/yr. Not applicable to mechanical drive gas turbines operated in discontinuous mode with extended load variations and frequent start-ups and shutdowns. Not applicable to boilers

Table 23

BAT-associated energy efficiency levels (BAT-AEELs) for the combustion of natural gas

Type of combustion unit	BAT-AEELs [136] [137]				
	Net electrical efficiency (%)		Net total fuel utilisation (%) [138] [139]	Net mechanical energy efficiency (%) [138] [140]	
	New unit	Existing unit		New unit	Existing unit
Gas engine	39,5–44 [141]	35–44 [141]	56–85 [141]	No BAT-AEEL.	
Gas-fired boiler	39–42,5	38–40	78–95	No BAT-AEEL.	
Open cycle gas turbine, ≥ 50 MWth	36–41,5	33–41,5	No BAT-AEEL.	36,5–41	33,5–41
Combined cycle gas turbine (CCGT)					
CCGT, 50–600 MW_{th}	53–58,5	46–54	No BAT-AEEL.	No BAT-AEEL	
CCGT, ≥ 600 MW_{th}	57–60,5	50–60	No BAT-AEEL	No BAT-AEEL	
CHP CCGT, 50–600 MW_{th}	53–58,5	46–54	65–95	No BAT-AEEL	
CHP CCGT, ≥ 600 MW_{th}	57–60,5	50–60	65–95	No BAT-AEEL	

19. BAT Conclusion 41

Table 19:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
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 below	Yes	N/a

Figure 14: BAT Requirements

Technique		Description	Applicability
a.	Air and/or fuel staging	See descriptions in Section 8.3. Air staging is often associated with low-NO_X burners	Generally applicable
b.	Flue-gas recirculation	See description in Section 8.3	
c.	Low-NO_X burners (LNB)		
d.	Advanced control system	See description in Section 8.3. This technique is often used in combination with other techniques or may be used alone for combustion plants operated < 500 h/yr	The applicability to old combustion plants may be constrained by the need to retrofit the combustion system and/or control command system
e.	Reduction of the combustion air temperature	See description in Section 8.3	Generally applicable within the constraints associated with the process needs
f.	Selective non-catalytic reduction (SNCR)		Not applicable to combustion plants operated < 500 h/yr with highly variable boiler loads. The applicability may be limited in the case of combustion plants operated between 500 h/yr and 1 500 h/yr with highly variable boiler loads
g.	Selective catalytic reduction (SCR)		Not applicable to combustion plants operated < 500 h/yr. Not generally applicable to combustion plants of < 100 MW_{th}. There may be technical and economic restrictions for retrofitting existing combustion plants operated between 500 h/yr and 1 500 h/yr

20. BAT Conclusion 42

Table 20:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
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	Yes	In place - The combustion system is maintained according to original equipment manufacturers recommendations and fitted with an advanced computer based control system to control the combustion efficiency and support the prevention and/or reduction of emissions. This also includes the use of high performance monitoring. The Gas turbines are fitted with dry low NOx burners that include the premixing of the air and fuel before entering the combustion zone. By mixing air and fuel before combustion, a homogeneous temperature distribution and a lower flame temperature are achieved, resulting in lower NOX emissions. The emission limit value defined in BAT for this plant is 50 mg/m^3 for the plant operating over 70% load. The plant is compliant with this ELV. The BAT associated ELV for existing CCGT with a net total fuel utilisation of <75% for a CCCGT ≥ 600MWth is a yearly average of between 10 – 40 mg/Nm^3, or a daily average of between 15 - 50 mg/Nm^3. The installation is compliant with these BAT requirements.

Figure 15: BAT Requirements

Technique		Description	Applicability
a.	Advanced control system	See description in Section 8.3. This technique is often used in combination with other techniques or may be used alone for combustion plants operated < 500 h/yr	The applicability to old combustion plants may be constrained by the need to retrofit the combustion system and/or control command system
b.	Water/steam addition	See description in Section 8.3	The applicability may be limited due to water availability
c.	Dry low-NO_X burners (DLN)		The applicability may be limited in the case of turbines where a retrofit package is not available or when water/steam addition systems are installed
d.	Low-load design concept	Adaptation of the process control and related equipment to maintain good combustion efficiency when the demand in energy varies, e.g. by improving the inlet airflow control capability or by splitting the combustion process into decoupled combustion stages	The applicability may be limited by the gas turbine design
e.	Low-NO_X burners (LNB)	See description in section 8.3	Generally applicable to supplementary firing for heat recovery steam generators (HRSGs) in the case of combined-cycle gas turbine (CCGT) combustion plants
f.	Selective catalytic reduction (SCR)		Not applicable in the case of combustion plants operated < 500 h/yr. 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

21. BAT Conclusion 43

Table 21:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
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 below	Not applicable	Not applicable – no gas fired engines at the installation.

Figure 16: BAT Requirements

Technique		Description	Applicability
a.	Advanced control system	See description in Section 8.3. This technique is often used in combination with other techniques or may be used alone for combustion plants operated < 500 h/yr	The applicability to old combustion plants may be constrained by the need to retrofit the combustion system and/or control command system
b.	Lean-burn concept	See description in Section 8.3. Generally used in combination with SCR	Only applicable to new gas-fired engines
c.	Advanced lean-burn concept	See descriptions in Section 8.3	Only applicable to new spark plug ignited engines
d.	Selective catalytic reduction (SCR)		Retrofitting existing combustion plants may be constrained by the availability of sufficient space. Not applicable to combustion plants operated < 500 h/yr. There may be technical and economic restrictions for retrofitting existing combustion plants operated between 500 h/yr and 1 500 h/yr

22. BAT Conclusion 44

Table 22:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
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	Will be	The combustion system is maintained according to original equipment manufacturers recommendations and fitted with an advanced computer based control system to control the combustion efficiency and support the prevention and/or reduction of emissions. This also includes the use of high performance monitoring. The indicative yearly average CO emission levels for a combustion plant operated >1500 hours/year, existing CCGT of ≥50 MWth is applied at <5 - 30 mg/Nm^3; the higher end of this range would be 50 mg/Nm^3 for plants that operate at low load. General yearly averages at this plant would comply with the requirements outlined in BAT. Unlike NOx, CO increases exponentially as the gas turbine approaches the emission compliance boundary defined by the combustion system. For this reason, hourly CO emissions are often close to the current 100mg/m^3 ELV when the plant is operating at its stable operating limit (SEL) and gas turbine load is at its minimum. A reduction in the current ELV would therefore necessitate raising SEL which in turn would impact on the commercial viability of the plant remaining operational at night. A potential consequence would be increased "two-shifting" and hence an increase in the total annual emissions of both CO and NOx attributable to the greater number of plant starts. From a holistic perspective, it is believed therefore that reducing the existing ELV for CO to 30mg/m^3 could actually have a negative environmental impact. The applicable top-of-range indicative CO Annual BAT-AEL is 30 mg/m^3. The proposed ELV increases the indicative BAT-AEL to 100 mg/m^3 to allow for the combustion characteristics of this gas turbine and potential combustor degradation relating to combustor air in-leakage.

Figure 17: BAT Requirements

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.

23. BAT Conclusion 45

Table 23:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
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 and/or to use oxidation catalysts	Not applicable	Not applicable - no natural gas spark-ignited lean-burn gas engines.

Figure 18: BAT Requirements

Combustion plant total rated thermal input (MW_{th})	BAT-AELs (mg/Nm^3)		
	Formaldehyde	CH_4	
	Average over the sampling period		
	New or existing plant	New plant	Existing plant
≥ 50	5–15 (162)	215–500 (163)	215–560 (162) , (163)

Combustion of Liquid Fuels

BAT conclusions BAT 18 to 27 are pertinent to coal and lignite – neither are applicable to this plant.

24. BAT Conclusion 28

Table 24:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
In order to prevent or reduce NO_X emissions to air while limiting CO emissions to air from the combustion of HFO and/or gas oil in boilers, BAT is to use one or a combination of the techniques given below	Not applicable	Not applicable - Combustion of liquid fuels (HFO and/or gas-oil-fired boilers) not applicable to site

Figure 19: BAT Requirements

	Technique	Description	Applicability
a.	Air staging	See descriptions in Section 8.3	Generally applicable
b.	Fuel staging		
c.	Flue-gas recirculation		
d.	Low-NO_X burners (LNB)		
e.	Water/steam addition		Applicable within the constraints of water availability
f.	Selective non-catalytic reduction (SNCR)		Not applicable to combustion plants operated < 500 h/yr with highly variable boiler loads. The applicability may be limited in the case of combustion plants operated between 500 h/yr and 1 500 h/yr with highly variable boiler loads
g.	Selective catalytic reduction (SCR)	See descriptions in Section 8.3	Not applicable to combustion plants operated < 500 h/yr. There may be technical and economic restrictions for retrofitting existing combustion plants operated between 500 h/yr and 1 500 h/yr. Not generally applicable to combustion plants of < 100 MW_{th}
h.	Advanced control system		Generally applicable to new combustion plants. The applicability to old combustion plants may be constrained by the need to retrofit the combustion system and/or control command system
i.	Fuel choice		Applicable within the constraints associated with the availability of different types of fuel, which may be impacted by the energy policy of the Member State

Table 1

BAT-associated emission levels (BAT-AELs) for NO_X emissions to air from the combustion of HFO and/or gas oil in boilers

Combustion plant total rated thermal input (MW_{th})	BAT-AELs (mg/Nm^3)			
	Yearly average		Daily average or average over the sampling period	
	New plant	Existing plant (102)	New plant	Existing plant (103)
< 100	75–200	150–200	100–215	210–330 (104)
≥ 100	45–75	45–100 (105)	85–100	85–110 (106) (107)

As an indication, the yearly average CO emission levels will generally be:

— 10-30 mg/Nm^3 for existing combustion plants of < 100 MW_{th} operated ≥ 1 500 h/yr, or new combustion plants of <100 MW_{th},

— 10–20mg/Nm^3 for existing combustion plants of ≥ 100 MW_{th} operated ≥ 1 500 h/yr, or new combustion plants of ≥ 100 MW_{th}.

25. BAT Conclusion 29

Table 25:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
In order to prevent or reduce SO_X, HCl and HF emissions to air from the combustion of HFO and/or gas oil in boilers, BAT is to use one or a combination of the techniques given below	Not applicable	Not applicable - Combustion of liquid fuels (HFO and/or gas-oil-fired boilers) not applicable to site

Figure 20: BAT Requirements

Technique		Description	Applicability
a.	Duct sorbent injection (DSI)	See description in Section 8.4	Generally applicable
b.	Spray dry absorber (SDA)		
c.	Flue-gas condenser		
d.	Wet flue-gas desulphurisation (wet FGD)		There may be technical and economic restrictions for applying the technique to combustion plants of < 300 MW_{th}. Not applicable to combustion plants operated < 500 h/yr. There may be technical and economic restrictions for retrofitting existing combustion plants operated between 500 h/yr and 1 500 h/yr
e.	Seawater FGD		There may be technical and economic restrictions for applying the technique to combustion plants of < 300 MW_{th}. Not applicable to combustion plants operated < 500 h/yr. There may be technical and economic restrictions for retrofitting existing combustion plants operated between 500 h/yr and 1 500 h/yr
f.	Fuel choice		Applicable within the constraints associated with the availability of different types of fuel, which may be impacted by the energy policy of the Member State

Table 15

BAT-associated emission levels (BAT-AELs) for SO_2 emissions to air from the combustion of HFO and/or gas oil in boilers

Combustion plant total rated thermal input (MW_{th})	BAT-AELs for SO_2 (mg/Nm^3)			
	Yearly average		Daily average or average over the sampling period	
	New plant	Existing plant (108)	New plant	Existing plant (108)
< 300	50–175	50–175	150–200	150–200 (110)
≥ 300	35–50	50–110	50–120	150–165 (111) (112)

26. BAT Conclusion 30

Table 26:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
In order to reduce dust and particulate-bound metal emissions to air from the combustion of HFO and/or gas oil in boilers, BAT is to use one or a combination of the techniques given below	Not applicable	Not applicable - Combustion of liquid fuels (HFO and/or gas-oil-fired boilers) not applicable to site

Figure 21: BAT Requirements

Technique		Description	Applicability
a.	Electrostatic precipitator (ESP)	See description in Section 8.5	Generally applicable
b.	Bag filter		
c.	Multicyclones	See description in Section 8.5. Multicyclones can be used in combination with other dedusting techniques	
d.	Dry or semi-dry FGD system	See descriptions in Section 8.5. The technique is mainly used for SO_X, HCl and/or HF control	
e.	Wet flue-gas desulphurisation (wet FGD)	See description in Section 8.5. The technique is mainly used for SO_X, HCl and/or HF control	See applicability in BAT 29
f.	Fuel choice	See description in Section 8.5	Applicable within the constraints associated with the availability of different types of fuel, which may be impacted by the energy policy of the Member State

Table 16

BAT-associated emission levels (BAT-AELs) for dust emissions to air from the combustion of HFO and/or gas oil in boilers

Combustion plant total rated thermal input (MW_{th})	BAT-AELs for dust (mg/Nm^3)			
	Yearly average		Daily average or average over the sampling period	
	New plant	Existing plant (113)	New plant	Existing plant (114)
< 300	2–10	2–20	7–18	7–22 (115)
≥ 300	2–5	2–10	7–10	7–11 (116)

27. BAT Conclusion 31

Table 27:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
In order to increase the energy efficiency of HFO and/or gas oil combustion in reciprocating engines, BAT is to use an appropriate combination of the techniques given in BAT 12 and below	Not applicable	Not applicable - Combustion of liquid fuels (HFO and/or gas-oil-fired engines) not applicable to site

Figure 22: BAT Requirements

Technique		Description	Applicability
a.	Combined cycle	See description in Section 8.2	Generally applicable to new units operated ≥ 1 500 h/yr. Applicable to existing units within the constraints associated with the steam cycle design and the space availability. Not applicable to existing units operated < 1 500 h/yr

Table 17

BAT-associated energy efficiency levels (BAT-AEELs) for the combustion of HFO and/or gas oil in reciprocating engines

Type of combustion unit	BAT-AEELs ([118])	
	Net electrical efficiency (%) ([120])	
	New unit	Existing unit
HFO- and/or gas-oil-fired reciprocating engine — single cycle	41,5–44,5 ([121])	38,3–44,5 ([121])
HFO- and/or gas-oil-fired reciprocating engine — combined cycle	> 48 ([122])	No BAT-AEEL

28. BAT Conclusion 32

Table 28:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
In order to prevent or reduce NO_X emissions to air from the combustion of HFO and/or gas oil in reciprocating engines, BAT is to use one or a combination of the techniques given below	Not applicable	Not applicable - Combustion of liquid fuels (HFO and/or gas-oil-fired engines) not applicable to site

Figure 23: BAT Requirements

Technique		Description	Applicability
a.	Low-NO_X combustion concept in diesel engines	See descriptions in Section 8.3	Generally applicable
b.	Exhaust-gas recirculation (EGR)		Not applicable to four-stroke engines
c.	Water/steam addition		Applicable within the constraints of water availability. The applicability may be limited where no retrofit package is available
d.	Selective catalytic reduction (SCR)		Not applicable to combustion plants operated < 500 h/yr. There may be technical and economic restrictions for retrofitting existing combustion plants operated between 500 h/yr and 1 500 h/yr. Retrofitting existing combustion plants may be constrained by the availability of sufficient space

29. BAT Conclusion 33

Table 29:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
In order to prevent or reduce emissions of CO and volatile organic compounds to air from the combustion of HFO and/or gas oil in reciprocating engines, BAT is to use one or both of the techniques given below	Not applicable	Not applicable - Combustion of liquid fuels (HFO and/or gas-oil-fired engines) not applicable to site

Figure 24: BAT Requirements

	Technique	Description	Applicability
a.	Combustion optimisation		Generally applicable
b.	Oxidation catalysts	See descriptions in Section 8.3	Not applicable to combustion plants operated < 500 h/yr. The applicability may be limited by the sulphur content of the fuel

30. BAT Conclusion 34

Table 30:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
In order to prevent or reduce SO_X, HCl and HF emissions to air from the combustion of HFO and/or gas oil in reciprocating engines, BAT is to use one or a combination of the techniques given below	Not applicable	Not applicable - Combustion of liquid fuels (HFO and/or gas-oil-fired engines) not applicable to site

Figure 25: BAT Requirements

Technique		Description	Applicability
a.	Fuel choice	See descriptions in Section 8.4	Applicable within the constraints associated with the availability of different types of fuel, which may be impacted by the energy policy of the Member State
b.	Duct sorbent injection (DSI)		There may be technical restrictions in the case of existing combustion plants Not applicable to combustion plants operated < 500 h/yr
c.	Wet flue-gas desulphurisation (wet FGD)		There may be technical and economic restrictions for applying the technique to combustion plants of < 300 MW_{th}. Not applicable to combustion plants operated < 500 h/yr. There may be technical and economic restrictions for retrofitting existing combustion plants operated between 500 h/yr and 1 500 h/yr

31. BAT Conclusion 35

Table 31:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
In order to prevent or reduce dust and particulate-bound metal emissions from the combustion of HFO and/or gas oil in reciprocating engines, BAT is to use one or a combination of the techniques given below	Not applicable	Not applicable - Combustion of liquid fuels (HFO and/or gas-oil-fired engines) not applicable to site

Figure 26: BAT Requirements

Technique		Description	Applicability
a.	Fuel choice	See descriptions in Section 8.5	Applicable within the constraints associated with the availability of different types of fuel, which may be impacted by the energy policy of the Member State
b.	Electrostatic precipitator (ESP)		Not applicable to combustion plants operated < 500 h/yr
c.	Bag filter		

Table 20

BAT-associated emission levels (BAT-AELs) for dust emissions to air from the combustion of HFO and/or gas oil in reciprocating engines

Combustion plant total rated thermal input (MW_{th})	BAT-AELs for dust (mg/Nm^3)			
	Yearly average		Daily average or average over the sampling period	
	New plant	Existing plant (120)	New plant	Existing plant (121)
≥ 50	5–10	5–35	10–20	10–45

32. BAT Conclusion 36

Table 32:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
In order to increase the energy efficiency of gas oil combustion in gas turbines, BAT is to use an appropriate combination of the techniques given in BAT 12 and below	Yes	Net Efficiency 53.4% The site is a CCGT and utilises the combination of two or more thermodynamic cycles, e.g. a Brayton cycle (gas turbine/combustion engine) with a Rankine cycle (steam turbine/boiler), to convert heat loss from the flue-gas of the first cycle to useful energy by subsequent cycle(s).

Figure 27: BAT Requirements

Technique		Description	Applicability
a.	Combined cycle	See description in Section 8.2	Generally applicable to new units operated ≥ 1 500 h/yr. Applicable to existing units within the constraints associated with the steam cycle design and the space availability. Not applicable to existing units operated < 1 500 h/yr

Table 21

BAT-associated energy efficiency levels (BAT-AEELs) for gas-oil-fired gas turbines

Type of combustion unit	BAT-AEELs (132) Net electrical efficiency (%) (133)	
	New unit	Existing unit
Gas-oil-fired open-cycle gas turbine	> 33	25–35,7
Gas-oil-fired combined cycle gas turbine	> 40	33–44

33. BAT Conclusion 37

Table 33:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
In order to prevent or reduce NO_X emissions to air from the combustion of gas oil in gas turbines, BAT is to use one or a combination of the techniques given below	Yes	Water injection is the process used at site to reduce NOx emissions when utilising Gas Oil. Low-NOx burners installed. Retrofitting of a selective catalytic reduction system is constrained by the availability of sufficient space. There is little gas oil running data to verify the emissions. BREF is silent on limits therefore Great Island will request to maintain the licence limits of 90 mg/m^3

Figure 28: BAT Requirements

	Technique	Description	Applicability
a.	Water/steam addition	See description in Section 8.3	The applicability may be limited due to water availability
b.	Low-NO_x burners (LNB)		Only applicable to turbine models for which low-NO_x burners are available on the market
c.	Selective catalytic reduction (SCR)		Not applicable to combustion plants operated < 500 h/yr. There may be technical and economic restrictions for retrofitting existing combustion plants operated between 500 h/yr and 1 500 h/yr. Retrofitting existing combustion plants may be constrained by the availability of sufficient space

Note 1: As an indication, the emission level for NO_X emissions to air from the combustion of gas oil in dual fuel gas turbines for emergency use operated < 500 h/yr will generally be 145–250 mg/Nm^3 as a daily average or average over the sampling period.

34. BAT Conclusion 38

Table 34:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
In order to prevent or reduce CO emissions to air from the combustion of gas oil in gas turbines, BAT is to use one or a combination of the techniques given below	Yes	The combustion system is maintained according to original equipment manufacturers recommendations and fitted with an advanced computer based control system to control the combustion efficiency and support the prevention and/or reduction of emissions. This also includes the use of high performance monitoring. Retrofitting of an oxidation catalyst system is constrained by the availability of sufficient space. There is little gas oil running data to verify the emissions. Great Island will therefore requesting to maintain the licence limits of 100 mg/m^3 or remove it from the licence altogether.

Figure 29: BAT Requirements

Technique		Description	Applicability
a.	Combustion optimisation	See description in Section 8.3	Generally applicable
b.	Oxidation catalysts		Not applicable to combustion plants operated < 500 h/yr. Retrofitting existing combustion plants may be constrained by the availability of sufficient space

35. BAT Conclusion 39

Table 35:

Aspect defined in BAT	Compliant with BAT Yes / No / Will be	In place, Not applicable or Date for Implementation if required
In order to prevent or reduce SO_X and dust emissions to air from the combustion of gas oil in gas turbines, BAT is to use the technique given below	Yes	IED Annex V Part 3 (2) (1) Continues monitoring of SO_2 is not required for plants firing Natural gas and for unabated plants firing oil with a known sulphur content. It is recommended a limit of on gas oil sulphur content be used instead i.e. Gas oil not to exceed 0.1% w/w sulphur content. Great Island will be requesting to maintain the gas oil licence limits of: SOx 50 mg/m^3 Dust 20 mg/m^3. Any limits for natural gas not listed in BREF should be removed from the licence.

Figure 30: BAT Requirements

Technique		Description	Applicability
a.	Fuel choice	See description in Section 8.4	Applicable within the constraints associated with the availability of different types of fuel, which may be impacted by the energy policy of the Member State

Table 22

BAT-associated emission levels for SO_2 and dust emissions to air from the combustion of gas oil in gas turbines, including dual fuel gas turbines

Type of combustion plant	BAT-AELs (mg/Nm^3)			
	SO_2		Dust	
	Yearly average [124]	Daily average or average over the sampling period [125]	Yearly average [124]	Daily average or average over the sampling period [125]
New and existing plants	35–60	50–66	2–5	2–10