H2Teesside Project

Environmental Permit Application Reference: [EPR/AP3328SQ/A001]

Land at and in the vicinity of the former Redcar Steel Works site, Redcar and in Stockton-on-Tees, Teesside

Document Reference: Appendix C2 Assessment of Best Available Techniques for Large Combustion Plant

Environmental Permitting (England and Wales) Regulations 2016

Applicants: H2 Teesside Ltd

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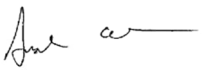
Signed		Date	11/12/2024
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GLOSSARY

Abbreviation	Description
Applicant/Operator	H2 Teesside Ltd
ATR	Auto Thermal Reforming
BAT	Best Available Techniques
BAT-AEL	BAT- Associated Emission Level
BRef	BAT Reference
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Usage and Storage
CO_2	Carbon dioxide
DCO	Development Consent order
FEED	Front-End Engineering Design
FID	Final Investment Decision
H_2	Hydrogen (gaseous)
HRA	Habitats Regulations Assessment
LHV	Lower Heating Value
LNR	Local Nature Reserve
NEP	Northern Endurance Partnership
NNR	National nature Reserve
NWL	Northumbrian Water Limited
NZT	Net Zero Teesside
O_2	Oxygen
SPA	Special Protection Area
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
WwTW	Wastewater Treatment Works

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1.0 OVERVIEW

1.1.1 This report has been prepared by AECOM Limited ('AECOM') on behalf of H2 Teesside Ltd ('H2TS') referred to as "the Operator", in support of the application for environmental permit for the proposed Carbon Capture (CC) enabled Hydrogen (H_2) Production Facility in the Teesside industrial cluster area in Redcar, Stockton-on-Tees.

1.1.2 The purpose of this report is to demonstrate the proposed Installation will be designed and operated in accordance with indicative best available techniques (BAT) for Large Combustion Plant (LCP).

1.1.3 The Hydrogen Production Facility (hereafter referred to as the 'Installation') is subject to ongoing technical studies; however, it is expected to comprise an up to 1.2- Gigawatt Thermal (GWth) (Phase 1, 600-Megawatt thermal (MWth) LHV and Phase 2, 600 MWth LHV) Lower Heating Value (LHV) Carbon Capture (CC) enabled Installation. It will be supported by a natural gas supply connection for the supply of natural gas to the Installation, utility connections (including water and electricity) along with pipelines to export the H_2 gas and carbon dioxide (CO_2). The CO_2 captured from the Installation will be transported (via the export/transport pipeline) for secure storage within the Endurance saline aquifer, located 145 kilometres offshore from Teesside, under the North Sea. The Installation is estimated to have a capacity to export approximately 1.27 megatonnes (Mt) of dehydrated and compressed CO_2 per year per phase, i.e. approximately 2.54 Mt/year once both phases are operational (100% utilisation). No temporary CO_2 storage is required on site.

1.1.4 A high level process flow diagram (Figure 3) and process flow diagrams (PFD) for the Installation are provided in Appendix A (Drawings and Plans) to the main supporting statement (Document Reference: AP3328SQ-APP-SS).

1.1.5 The proposed Installation will be designed to optimise the capture of carbon from the hydrogen production plant, while minimising emissions and waste generation and maximising energy efficiency. While individual BAT assessments have been prepared to demonstrate the application of best available techniques for Blue Hydrogen with Carbon Capture, Large Combustion Plant, Energy Efficiency, and Cooling, the system will be integrated to address multimedia effects across the Installation as a whole.

1.1.6 The electrical, steam, steam condensate and water circuits between the hydrogen production and capture plant will be integrated as far as reasonably practicable in order to reduce energy use, as discussed in the Energy Efficiency BAT Assessment (Appendix C4; Document Reference: AP3328SQ-APP-BAT4-EE).

1.1.7 This BAT assessment has been prepared using concept engineering information provided by the Operator related to initial design parameters of the proposed Installation, available information about the local environment and the existing standards and guidelines presented in published guidance, including the BAT

Reference (BRef) document[1] and BAT Conclusions for Large Combustion Plant (LCP Bref)[2].

1.1.8 The main application document (Document Reference: AP3328SQ-APP-SS "Supporting Statement") provides an overall view of the permit application.

1.1.9 The proposed Installation uses two combustion systems - a fired heater (start-up only) and an auxiliary steam boiler in each phase. The boilers are used to raise steam to support the heating of oxygen, control of the steam-to-carbon (S:C) ratios in the GHR-ATR reforming section and a small amount for regeneration in the CO_2 dryer. Low pressure steam is used for the CO_2 stripper reboiler and deaerator. The net rated thermal capacity of the auxiliary boilers exceeds the thresholds for LCP.

1.1.10 This document should be read with the Supporting Statement (Document Reference: AP3328SQ-APP-SS, Section 4) which provides a detailed description of the operations to be undertaken at the proposed Installation and how it will be operated.

1.1.11 For assessment of BAT for the H_2 production and CC technology, cooling, energy efficiency and emissions management please refer to the separate assessments:

- BAT Assessment for Hydrogen Production and Carbon Capture (Appendix C1; Document Reference: AP3328SQ/APP/BAT1-H2)
- BAT Assessment for Cooling (Appendix C3; Document Reference: AP3328SQ/APP/BAT3-COOL.)
- BAT Assessment for Energy Efficiency (Appendix C4; Document Reference: AP3328SQ/APP/BAT4-EE).
- BAT Assessment for Emissions Management (Appendix C5; Document Reference: AP3328SQ-APP-BAT5-Emissions).

2.0 APPROACH TO BAT APPRAISAL

2.1.1 The development of the hydrogen production plant from concept to full commercial scale must proceed alongside the emerging BAT regulatory positions for hydrogen production as well as existing BAT regulatory positions for Large Combustion Plan, Cooling, and energy efficiency so there is confidence that the project meets indicative BAT before it proceeds with Front-End Engineering Design (FEED) and to drive the vendor procurement processes, whilst maintaining the best protection for the environment as a whole.

2.1.2 At this stage of project development, while the technology provider for the hydrogen production with CCS processes has been selected, the Installation has yet to undergo FEED and we have therefore applied an approach to the derivation of BAT which is driven by:

- The technology licensors requiring commercial confidentiality of aspects of their technology process details to be maintained;
- To allow the FEED process to progress without limiting options for later technology selections;
- To determine indicative BAT and BAT Achievable Emission Levels (BAT-AELs) for the plant which are consentable, taking into consideration the environmental sensitivities and conditions at the site.

2.1.3 The techniques described in this report and the associated BAT assessments are therefore based on the currently anticipated approaches to optimising both combustion processes (i.e. fired start-up heaters and auxiliary steam boilers) associated with hydrogen production.

2.1.4 The approach to BAT has been agreed with the Environment Agency (EA) during the pre-application discussions.

3.0 GENERAL BAT CONCLUSIONS FOR LARGE COMBUSTION PLANT

Table 3.1: BAT Conclusions for the LCP Process

BAT No.		BATc Requirements	Demonstration of BAT – Operator Response	Operating to BAT?
1		Environmental Management Systems 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;	The proposed Installation will be operated under an Environmental Management System (EMS) attested to BS EN ISO14001. The EMS will comprise • an environmental policy and other relevant management documents. • The EMS will include the annual establishment of objectives and targets Performance will be monitored in accordance with defined Key Performance Indicators (KPIs) which will be set once the plant is commissioned and is fully operational. • The site specific procedures will provide the contact details for applicable personnel on the site, and their roles and responsibilities. The EMS will include all elements listed under BATc 1 items as required under ISO14001.	Yes
	(ii)	Definition, by the management, of an environmental policy that includes the continuous improvement of the environmental performance of the installation;		
	(iii)	Planning and establishing the necessary procedures, objectives and targets, in conjunction with financial planning and investment;		
	(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.		
	(v)	Checking performance and taking corrective action, paying particular attention to: a) monitoring and measurement (see also the Reference Report on Monitoring of Emissions to Air and Water – ROM) b) corrective and preventive action c) maintenance of records	a. Monitoring and Measurement - Emissions to Air: The proposed Installation will have an operational procedure document setting out the requirements for monitoring emissions to air as defined by the Environmental Permit. The procedure will also cover monitoring requirements during periods of abnormal operation (such as start-up and shutdown).	Yes

BAT No.		BATc Requirements	Demonstration of BAT – Operator Response	Operating to BAT?
		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.	The document shall include the responsibilities of site personnel with regards to emissions monitoring, applicable daily, monthly and annual emission limits for each pollutant, control measures applied for each pollutant, and reporting methods and requirements. - Emissions to Water: Wastewater treatment will happen in two processes, namely, in the biological treatment plant comprising a membrane bioreactor (MBR) which recirculates the treated streams back to the raw water treatment plant and an effluent treatment plant (ETP) which discharges via the NZT outfall into Tees Bay. An operational procedure document will be prepared setting out the requirements for control and monitoring emissions to water for the selected process as defined by the Environmental Permit. Any emissions to controlled waters will be controlled and monitored appropriately, in line with written procedures developed prior to commencement of operations. - Maintenance Plan: All plant and equipment at the proposed Installation will be regularly maintained by qualified maintenance contractors. The operator will ensure that all equipment on site is appropriately maintained and calibrated as required to ensure monitoring and reporting of emissions for regulatory compliance and other requirements; including equipment used for the continuous and discontinuous monitoring of emissions to air and water. b. Corrective and Preventative Actions	

BAT No.		BATc Requirements	Demonstration of BAT – Operator Response	Operating to BAT?
			The proposed Iinstallation will be controlled and operated via an automated control system (such as a Distributed Control System (DCS)) to continuously monitor the operation of the plant and equipment at the site. Any non-conformance or deviation in normal operating parameters will be identified by the DCS to allow the operator to take action to avoid a breach of permitted emission levels. c. Records The EMS will clearly define the requirements for maintaining and storing records. d. Auditing The EMS will be subject to periodic review and update and is subject to internal corporate audits as well as external certification audits (if certified).	
	(vi)	Review, by senior management, of the EMS and its continuing suitability, adequacy and effectiveness;	Regular Management Review of the EMS will be undertaken at the site.	Yes
	(vii)	Following the development of cleaner technologies;	See (ix) below	-
	(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.	The design of the proposed Installation will consider appropriate measures to minimise the impact of future decommissioning including but not limited to: • maximising the use of existing pipeline corridors; • applying a modular design approach; • minimising the need for new infrastructure by considering the use of third party infrastructure/supply such as replacement of ASU with 3rd party O2 supply, use of the NZT outfall for water discharge, using NWL industrial water supply instead of seeking new abstractions and using Teesworks surface water drainage. With regards to the actual decommissioning of the Installation, this will be regulated under the Environmental Permitting Regulations 2016 (as	Yes

BAT No.		BATc Requirements	Demonstration of BAT – Operator Response	Operating to BAT?
			amended) ("EPR") which requires sites to have a decommissioning plan in place to manage such considerations. This plan will be developed prior to commencement of operations and will be subject to regular reviews to ensure that correct site operations are reflected in the plan.	
	(ix)	Application of sectoral benchmarking on a regular basis.	The proposed Installation will be regulated under the EPR 2016, which requires the application of BAT to the operation of such a facility; this includes the requirement to undertake sectoral benchmarking as and when revised sector guidance is issued (e.g. EA BAT reference document) and to implement compliance with the sector guidance within 4 years of issue. This is implemented through the Regulation 61 notice process.	Yes
	Specifically for this sector, it is also important to consider the following features of the EMS, described where appropriate in the relevant BAT:			
	(x)	Quality assurance/quality control programmes to ensure that the characteristics of all fuels are fully determined and controlled (see BAT 9).	See response under BATc 9 - the Installation will have a contracted supply of natural gas from the National Transmission Service (NTS).	-
	(xi)	A management plan in order to reduce emissions to air and/or to water during other than normal operating conditions (OTNOC), including start-up and shutdown periods (see BAT 10 and BAT 11);	See response to BATc 10 and 11 which detail the Management Plans which will be put in place for monitoring and control of emissions to air and/or water during normal and OTNOC scenarios.	-
	(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.	Opportunities to avoid/reduce waste generation will be assessed during FEED process. The proposed Installation will include dedicated appropriate waste storage areas on site; with the waste handling procedure outlined in a dedicated procedure which will be developed prior to commencement of operations	Yes
	(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.	The potential for fugitive emissions will be regularly reviewed as part of the EMS environmental aspect and impact identification procedure and on a daily basis through on-going site observations. The site operations will include a procedure describing the processes to be followed with respect to the monitoring and reporting of emissions for regulatory compliance (outside of those required under the EP Regs).	Yes

BAT No.		BATc Requirements	Demonstration of BAT – Operator Response	Operating to BAT?
			Additionally, the site will have a site-specific emergency plan and accident management plan to cover management of abnormal emissions and accidents.	
	(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.	Due to the inherent nature of the site operations, the potential for dust generation at the site is minimal. Therefore, no specific dust management plan is proposed to be developed for the site	N/A
	(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.	An assessment of potential noise sources at the proposed development and impact on the sensitive receptors in the vicinity of the site has been undertaken as part of the Environmental Impact Assessment for the proposed Installation. The assessment concluded that no significant noise or vibration effects are expected to occur at any identified sensitive receptor after embedded mitigation measures are considered. This assessment is provided in Appendix H of the Supporting Statement (Document Reference: AP3328SQ/APP/SS).	Yes
	(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.	The auxiliary steam boiler of the proposed Installation uses hydrogen-rich tail gas produced in the process as fuel, therefore is not likely to generate odour. Odour is assessed as part of the qualitative environmental risk assessment provided in Appendix D to the Supporting Statement (Document Reference: AP3328SQ/APP/SS). No odour management plan is proposed at this time.	Yes
2		Monitoring 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, integrated gasification combined cycle (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	Operational performance tests on the auxiliary steam boilers measuring the load, fuel used, and power output will be undertaken during plant commissioning phases. These tests will be undertaken to applicable BS EN standards which will be defined within the Commissioning Plan. The proposed Installation will develop a procedure for monitoring and reporting of fuel consumption, and the energy output from the auxiliary boilers. The data shall be regularly reviewed and reported (as required under relevant regulations).	Yes

BAT No.	BATc Requirements	Demonstration of BAT – Operator Response	Operating to BAT?
	international standards that ensure the provision of data of an equivalent scientific quality.	Periodic Operational Performance tests on the auxiliary boilers measuring the load, fuel used, and power output shall be undertaken through the life of the facility in accordance with applicable BE EN standards.	
3	Monitoring BAT is to monitor key process parameters relevant for emissions to air and water including those given below.		
	a) Flue gas – Flow – Periodic or continuous determination b) Flue gas – oxygen content, temperature and pressure - Periodic or continuous determination c) Flue gas – Water vapour content - Periodic or continuous measurement d) Waste water from flue-gas treatment – Flow, pH, and temperature – Continuous measurement	The proposed Installation will have separate stacks associated with the fired start-up heater, auxiliary steam boiler and flare for each phase. The flue gases from each auxiliary boiler stack will be monitored using MCERTS certified Continuous Emissions Monitoring system (CEMs) in accordance with BS EN 14181 when the relevant plant is in operation . The continuous monitoring of the auxiliary steam boilers' flue gas flow, oxygen content and water vapour content as well as pollutant emission species to facilitate the conversion of recorded pollutant emission data to standard conditions withing the continuous emissions monitors (CEMs) and data handling systems. Periodic monitoring will be used to monitor the fired heaters, emergency generators and fire pumps as outlined in section 6.2 of the Supporting Statement. This is consistent with monitoring requirements for MCP which operate less than 500 hours per annum. All monitoring equipment on site will be maintained and calibrated regularly to ensure appropriate measurements are recorded.	Yes
4	Monitoring BAT is to monitor emissions to air with at least the frequency given below and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.		

<table>
<tr><th>BAT No.</th><th>BATc Requirements</th><th>Demonstration of BAT – Operator Response</th><th>Operating to BAT?</th></tr>
<tr><td></td><td>
<table>
<tr><th>Parameter</th><th>Standard</th><th>Minimum frequency</th><th>Monitoring associated with</th></tr>
<tr><td>NO_x</td><td>Generic EN standards</td><td>Continuous</td><td>BAT 42, BAT 43</td></tr>
<tr><td>CO</td><td>Generic EN standards</td><td>Continuous</td><td>BAT 49, BAT 56</td></tr>
<tr><td>NH_3</td><td>Generic EN standards</td><td>Continuous</td><td>BAT 7</td></tr>
<tr><td colspan="4">(1) For gas turbines, periodic monitoring is carried out with a combustion plant load of > 70 %.</td></tr>
</table>
</td><td>The flue gas from the site auxiliary boiler stacks will be monitored using MCERTS certified Continuous Emissions Monitoring Systems (CEMs) in accordance with EN 14181.

This system will continuously monitor NO_x, CO and NH_3 (associated with SCR use).</td><td>Yes</td></tr>
<tr><td>5</td><td>Monitoring
BAT is to monitor emissions to water from flue-gas treatment in accordance with EN standards. If EN standards are not available BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality</td><td>Monitoring of emissions to water from flue gas cooling (that may contain ammonia from SCR) is described in the blue hydrogen production BAT Assessment (Appendix C1, AP3328SQ/APP/BAT1-PROCESS)</td><td>Yes</td></tr>
<tr><td>6</td><td>General Environmental and Combustion Performance
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 an optimised combustion and to use an appropriate combination of the techniques given below:
<table>
<tr><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>Fuel blending and mixing</td><td>Ensure stable combustion conditions and/or reduce the emission of pollutants by mixing different qualities of the same fuel type</td><td>Generally applicable</td></tr>
</table>
</td><td>The fired start-up heater and auxiliary steam boiler in each phase will utilise natural gas on start-up and then the auxiliary steam boilers will use a H_2 rich fuel during normal operations.

The tail gas typical composition in mol % is presented below.
<table>
<tr><th>Parameter</th><th>End of Life</th></tr>
<tr><td>Methane:</td><td>5.5</td></tr>
<tr><td>Hydrogen:</td><td>79.7</td></tr>
<tr><td>CO:</td><td>3.1</td></tr>
<tr><td>CO_2:</td><td>0.05</td></tr>
</table>
</td><td>Yes</td></tr>
</table>

BAT No.	BATc Requirements			Demonstration of BAT – Operator Response	Operating to BAT?
				<table><tr><td>N_2:</td><td>10.9</td></tr><tr><td>H_2O:</td><td>0.3</td></tr><tr><td>Methanol:</td><td>0.02</td></tr><tr><td>Ammonia:</td><td>0.02</td></tr><tr><td>Argon</td><td>0.5</td></tr></table> Performance tests measuring the load, fuel used, and power output to calculate overall efficiencies shall be undertaken in accordance with applicable BE EN standards during plant commissioning and at periodic intervals going forward.	
	Maintenance of the combustion system	Regular planned maintenance according to supplier's recommendations	Generally applicable	All plant and equipment at the site will be regularly maintained, including the combustion system, by qualified maintenance contractors.	Yes
	Advanced control system	The use of a computer-based automatic 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 applicability to old combustion plants may be constrained by the need to retrofit the system and/or control command system	The proposed Installation operations will be monitored and operated by suitably trained site personnel and managed via an automated control system such as a Distributed Control System (DCS) to continuously monitor the operation of the plant and equipment at the site. Any non-conformance or deviation in normal operating parameters shall be identified by the DCS to allow operators to take action to avoid a breach of permitted emission levels.	Yes
	Good design of the combustion equipment	Good design of furnace, combustion chambers, burners and associated devices	Generally applicable to new combustion plants	The design of the auxiliary steam boilers will be optimised during the FEED design stage along with the associated automated control system. This will ensure combustion processes are optimised during operation.	Yes
	Fuel choice	Select or switch totally or partially to another fuel(s)	Applicable within the	The auxiliary steam boilers and fired start-up heaters will be fuelled by natural gas on start-up. Natural gas will be supplied by the National	Yes

BAT No.	BATc Requirements			Demonstration of BAT – Operator Response	Operating to BAT?
		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	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.	Transmission System (NTS) which will minimise the presence of contaminants otherwise present in refinery fuel gas. During normal operation, the auxiliary steam boilers will be fuelled by a H_2 rich fuel.	
7	General Environmental and Combustion Performance 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).			The plant will include the operation of SCR during normal operation of the auxiliary boilers for NO_x control to ensure compliance with the NO_x ELV, using ammonia as a reagent. The SCR plant will be appropriately designed to maintain optimum ammonia injection rate.	Yes
8	BAT Associated Emission Levels In order to prevent or reduce emissions to air during normal operating conditions, BAT is to ensure, by appropriate design, operation and			The emissions abatement systems will be designed, operated and maintained to ensure use at optimal capacity and availability, as described in response to BAT 6 and BAT 4.	Yes

BAT No.	BATc Requirements	Demonstration of BAT – Operator Response	Operating to BAT?
	maintenance, that the emission abatement systems are used at optimal capacity and availability.		
9	BAT Associated Emission Levels In order to improve the general environmental performance of combustion and/or gasification plants and to reduce emissions to air, BAT is to include the following elements in the quality assurance/quality control programmes for all the fuels used, as part of the environmental management system (see BAT 1): 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 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). Initial characterisation and regular testing of the fuel can be performed by the operator and/or the fuel supplier. If performed by the supplier, the full results are provided to the operator in the form of a product (fuel) supplier specification and/or guarantee.	The auxiliary steam boiler in each phase will utilise natural gas for start-up. No ELVs will be set during start-up conditions The Installation will have a contractual agreement to receive natural gas from the NTS which will include the requirement for the gas to comply with specified quality criteria. This will minimise the presence of contaminants otherwise present in refinery fuel gas. The operator will not have or require an ongoing monitoring procedure to manage the quality of the fuel; however appropriate equipment such as a gas chromatograph (GC) would be put in place to periodically test the quality of the fuel if required and the parameters listed under BATc 9 for natural gas are recorded.	
10	General Environmental and Combustion Performance 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	The plant and associated control systems will be designed to minimise the potential for OTNOC events to occur. The plant will be operated using an automated control system to continuously monitor the operation of the plant and equipment at the site. Any non-conformance or deviation in normal operating parameters is expected to be identified by the	Yes

BAT No.	BATc Requirements	Demonstration of BAT – Operator Response	Operating to BAT?
	BAT 1), commensurate with the relevance of potential pollutant releases, that includes the following elements: • 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 startup and shutdown loads for stable generation in gas turbines); • set-up and implementation of a specific preventive maintenance plan for these relevant systems; • review and recording of emissions caused by OTNOC and associated circumstances and implementation of corrective actions if necessary; • periodic assessment of the overall emissions during OTNOC (e.g. frequency of events, duration, emissions quantification/estimation) and implementation of corrective actions if necessary.	automated control system to allow operators to take action to avoid OTNOC events. Site operators shall be trained to monitor plant operation and take appropriate action(s) in the event of a potential OTNOC event being identified. Start up and Shutdown procedures shall be put in place with the aim to minimise the time during which the plant is operating at non-optimal conditions and operators shall be trained in the appropriate actions required should the potential for an OTNOC event be identified. All plant and equipment at the site will be regularly maintained including those system provided to minimise the potential for OTNOC conditions to occur. A repair and maintenance management plan will be in place. Environmentally critical equipment will be identified and tagged for maintenance and to minimise emissions and discharges. The Installation will also have accident management plan (AMP) and emergency response procedures for the management of spills, firewater, and the blocking of any discharge outlet to the river.	
11	General Environmental and Combustion Performance BAT is to appropriately monitor emissions to air and/or to water during OTNOC	The flue gases from the site auxiliary boilers will be monitored using MCERTS certified CEMs in accordance with BS EN 14181. This system will capture emissions data during OTNOC situations and can be used to inform subsequent incident investigation. Periodic monitoring will be used to monitor the fired heaters, emergency generators and fire pumps as outlined in section 6.2 of the Supporting Statement. This is consistent with monitoring requirements for MCP which operate less than 500 hours per annum. Wastewater will be treated through two processes, namely in biological treatment plant which recirculates treated water back to the raw water	Yes

BAT No.	BATc Requirements		Demonstration of BAT – Operator Response	Operating to BAT?
			treatment plant and the ETP which discharges via the NZT outfall into Tees Bay. Any emissions to controlled waters will be controlled and monitored appropriately, in line with written procedures developed prior to commencement of operations. Monitoring will be done in accordance with relevant BS/ISO standards	
12	Energy Efficiency In order to increase the energy efficiency of combustion, gasification and/or IGCC units operated ≥ 1,500h/yr, BAT is to use an appropriate combination of the techniques given below			Yes
	Technique	Description		
	Combustion optimisation	Optimising the combustion minimises the content of unburnt substances in the flue-gases and in solid combustion residues	The specific control settings for the combustion units shall be preset in the control system to achieve efficient combustion and optimise plant efficiency.	
	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 NOx emissions or the characteristics of energy demanded	Performance tests of the Hydrogen Production Installation shall be undertaken during commissioning and then periodically in accordance with applicable BE EN standards.	
	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	Although the facility will include a steam system which provides heat into the process, it will not include provision of a turbine. The efficiency of the plant will be driven by the design of the hydrogen production plant including the steam system. The plant will be designed to exploit optimum steam pressure and temperature settings to maximise the overall efficiency.	
	Minimisation of energy consumption	Minimising the internal energy consumption (e.g. greater efficiency of the feed-water pump)	All plant and equipment will be designed or specified and maintained to ensure optimal operation.	

BAT No.	BATc Requirements		Demonstration of BAT – Operator Response	Operating to BAT?
	Preheating of combustion air	Reuse of part of the heat recovered from the combustion flue-gas to preheat the air used in combustion	Combustion air will be pre-heated via a combustion air pre-heater coil utilising recovered heat, to optimise combustion.	
	Fuel preheating	Preheating of fuel using recovered heat	A letdown heater has been provided to ensure the NG feed temperature does not fall below the acceptable operating range during pressure letdown from the supply line. The NG feed is then combined with recycled hydrogen product and is heated up in the feed gas preheater (fired heater).	
	Advanced control system	See description in Section 10.8.2. Computerised control of the main combustion parameters enables the combustion efficiency to be improved	Operation of the hydrogen production units including the steam boilers will be controlled by trained site operators using an automated control system, which will be used to control the operation of the plant. The control system will record the data on the plant performance which can be used by the operations team to identify potential issues. The specific control settings for the combustion units shall be pre-set in the control system to achieve efficient combustion and optimise plant efficiency.	
	Feed-water preheating using recovered heat	Preheat water coming out of the steam condenser with recovered heat, before reusing it in the boiler	Once steam energy has been used, the remaining energy will be recovered by condenser and transferred to the feed-water system.	
	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.	The steam demand for the Hydrogen production plant would take precedence over off site users. Steam recovery has been integrated and optimised for use on the wider plant with approximately 80% raised and recovered from the process and the remaining 20% provided from the auxiliary boilers. The plant will have the potential to supply heat to other users, however, currently no viable offtake users are available in the area; and an appraisal of heat export opportunities will be undertaken as the wider area is developed. .	
	CHP readiness	See description in Section 10.8.2.	Not applicable	
	Flue-gas condenser	See description in Section 10.8.2.	Not applicable	

BAT No.	BATc Requirements		Demonstration of BAT – Operator Response	Operating to BAT?
	Heat accumulation	Heat accumulation storage in CHP mode	Not applicable	
	Wet stack	Generally applicable to new and existing units fitted with wet FGD	Not applicable	
	Cooling tower discharge	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	Not applicable	
	Fuel pre-drying	Only applicable to solid-fuel-fired combustion units and to gasification/IGCC units	Not applicable	
	Minimisation of heat losses	Only applicable to new plants	The plant will be designed to exploit optimum steam pressure and temperature settings to maximise the overall efficiency and to minimise heat losses.	
	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	The site will be a new low carbon hydrogen production plant and will be designed using suitable materials available at the time of construction to optimise operations.	
	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	Not applicable	
	Supercritical and ultra-supercritical steam conditions	Use of a steam circuit, including steam reheating systems, in which steam can reach pressures	Not applicable	

<table>
<tr><th>BAT No.</th><th>BATc Requirements</th><th>Demonstration of BAT – Operator Response</th><th>Operating to BAT?</th></tr>
<tr><td></td><td colspan="2">above 220.6 bar and temperatures above 374 °C in the case of supercritical conditions, and above 250 – 300 bar and temperatures above 580 – 600 °C in the case of ultra-supercritical conditions</td><td></td><td></td></tr>
<tr><td>13</td><td colspan="2">Water Usage and Emissions to Water
In order to reduce water usage and the volume of contaminated waste water discharged, BAT is to use one or both of the techniques given below.
<table><tr><th>Technique</th><th>Description</th><th>Applicability</th></tr><tr><td>Water recycling</td><td>Residual aqueous streams, including run-off water, from the plant are reused for other purposes. The degree of recycling is limited by the quality requirements of the recipient water stream and the water balance of the plant.</td><td>Not applicable to waste water from cooling systems when water treatment chemicals and/or high concentrations of salts from seawater are present</td></tr><tr><td>Dry bottom ash handling</td><td>Dry, hot bottom ash falls from the furnace onto a mechanical conveyor system and is cooled down by ambient air. No water is used in the process.</td><td>Only applicable to Plants combusting solid fuels.</td></tr></table></td><td>The Installation will be serviced by a circulated wet cooling system with cooling towers, where a majority of the cooling water will be recycled, with only a small amount of water (<2% of the cooling demand) required for cooling water make-up. The Installation will not produce any ash from the combustion process; therefore, the techniques for dry bottom ash handling are not applicable to the Installation.</td><td>Yes</td></tr>
<tr><td>14</td><td colspan="2">Water Usage and Emissions to Water</td><td>Wastewater streams generated at the plant are anticipated to comprise process wastewater, cooling tower blowdown, demineralisation plant</td><td>Yes</td></tr>
</table>

BAT No.	BATc Requirements			Demonstration of BAT – Operator Response	Operating to BAT?
	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			rejects, and sanitary effluent; all wastewater streams will be appropriately segregated, treated and disposed of.	
15	Water Usage and Emissions to Water In order to reduce emissions to water from flue-gas treatment, BAT is to use an appropriate combination of the techniques, and to use secondary techniques as close as possible to the source in order to avoid dilution			The need for flue gas treatment is minimised by primary combustion controls identified in BAT 6 and SCR is used during normal operation of the auxiliary boilers.	Yes
16	Waste Management 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 b) which arise as by-products; c) waste preparation for reuse, e.g. according to the specific d) requested quality criteria; e) waste recycling; f) other waste recovery (e.g. energy recovery), g) by using appropriate techniques.			The plant will develop a Waste Management Procedure (WMP) prior to commencement of site operations, detailing the waste storage and handling procedures on site. The WMP shall outline identification of waste streams and how they must be handled, including appropriate segregation and storage within designated waste storage areas on site. The plant will apply the waste hierarchy for the management of any waste produced on site. It is expected that due to the inherent nature of the site operations and fuel used, the site shall only produce minor quantities of waste, primarily from maintenance. The main waste stream generated from the site activities is likely to comprise used lubricating oil, which will be sent off site for appropriately management via licenced contractors.	Yes
17	Noise emissions In order to reduce noise emissions, BAT is to use one or a combination of the techniques given below				
	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	Generally applicable	The site will have a maintenance schedule in place to ensure optimum operation of all plant and equipment. All outdoor equipment will have noise attenuation enclosures, where required.	Yes

BAT No.	BATc Requirements			Demonstration of BAT – Operator Response	Operating to BAT?
		-avoidance of noisy activities at night, if possible -provisions for noise control during maintenance activities.			
	Low-noise equipment	This potentially includes compressors, pumps and disks.		The proposed Installation is a new plant, and all equipment will be selected to avoid noise impacts either via inherent design qualities, or where a noise risk exists, via the Installation of noise attenuation measures.	Yes
	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	All equipment being installed is new and designed to generate low levels of noise, below applicable lowest observed adverse effect level (LOAELs), and all process areas are to be enclosed and not expected to lead to significant noise emissions.	Yes
	Noise-control equipment	This includes: -noise-reducers -vibration or acoustic insulation, or vibration isolation -enclosure of noisy equipment -soundproofing of buildings	The applicability may be restricted by lack of space		
	Appropriate location of equipment and buildings	Noise levels can be reduced by increasing the distance between the emitter and the	Generally applicable to new plants		

<table>
<tr><th>BAT No.</th><th>BATc Requirements</th><th>Demonstration of BAT – Operator Response</th><th>Operating to BAT?</th></tr>
<tr><td></td><td>receiver and by using buildings as noise screens.</td><td></td><td></td></tr>
<tr><td>BAT 18 - 23</td><td>BAT in relation to use of solid fuels</td><td>N/A - Facility does not use solid fuels</td><td>-</td></tr>
<tr><td>BAT 24 - 27</td><td>BAT in relation to use of solid biomass and/or peat</td><td>N/A - The facility does not combust solid biomass and/or peat</td><td>-</td></tr>
<tr><td>BAT 28 - 30</td><td>BAT in relation to use of HFO and/or gas oil in boilers.</td><td>N/A - The facility does not combust HFO and/or gas oil in boilers</td><td>-</td></tr>
<tr><td>BAT 31 - 35</td><td>BAT in relation to use of HFO and/or gas oil in boilers</td><td>N/A - The facility does not combust HFO and/or gas oil in reciprocating engines</td><td>-</td></tr>
<tr><td>BAT 36 -39</td><td>BAT in relation to gas turbines</td><td>N/A – no gas turbines on site</td><td>-</td></tr>
<tr><td>BAT 40</td><td>In order to increase the energy efficiency of natural gas combustion, BAT is to use an appropriate combination of the techniques given in BAT 12 and below.
<table>
<tr><th rowspan="2">Type of Combustion Unit</th><th colspan="5">BAT-AELs (1)(2)</th></tr>
<tr><th>Net electrical efficiency (%)</th><th>Net total fuel utilisation (%) (3) (4)</th><th rowspan="2">Net total fuel utilisation (%) (3) (4)</th><th colspan="2">Net mechanical energy efficiency (%)(4) (5)</th></tr>
<tr><th>New unit</th><th>Existing unit</th><th>New unit</th><th>Existing unit</th></tr>
<tr><td>Gas-Fired Boiler</td><td>39 – 42.5</td><td>38 - 40</td><td>78 - 95</td><td colspan="2">No BAT-AEL</td></tr>
</table>
1) These BAT-AEELs do not apply to units operated < 1 500h/yr.
2) In the case of CHP units, only one of the two BAT-AEELs ‘Net electrical efficiency’ or ‘Net total fuel utilisation’ applies, depending on the CHP unit design (i.e. either more oriented towards electricity generation or heat generation).</td><td>The auxiliary steam boilers only use natural gas during start-up. BAT-AELs do not apply during start-up periods.

During normal operation the boilers will operated on a H_2 rich fuel see BATc 55 - 59.</td><td>N/A</td></tr>
</table>

<table>
<tr><th>BAT No.</th><th>BATc Requirements</th><th>Demonstration of BAT – Operator Response</th><th>Operating to BAT?</th></tr>
<tr><td></td><td>3) Net total fuel utilisation BAT-AEELs may not be achievable if the potential heat demand is too low.
4) These BAT-AEELs do not apply to plants generating only electricity.
5) These BAT-AEELs apply to units used for mechanical drive applications.</td><td></td><td></td></tr>
<tr><td>During start</td><td>In order to prevent or reduce NOX emissions to air from the combustion of natural gas in boilers, BAT is to use one or a combination of the techniques given below

Techniques include;
• Air/fuel staging
• Flue-gas recirculation
• Low-NOx burners
• Advanced control system
• Reduction of the combustion air temperature
• Selective non-catalytic reduction
• Selective catalytic reduction</td><td>Natural gas is used in the fired start-up heaters and auxiliary steam boilers during start up.

Site will use use:

• Low NOx burners
• A DCS control system to optimise combustion control</td><td>Yes</td></tr>
<tr><td>BAT 42 - 43</td><td>BAT in relation to reduction of NOx in gas turbines or engines.</td><td>N/A – no gas turbines on site and the only engine on site will be for emergency back-up and is assessed against the BAT standards for such plant (see section 4 below)</td><td>N/A</td></tr>
<tr><td>BAT 44</td><td>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.
<table>
<tr><th rowspan="3">Type of Combustion Plant</th><th colspan="4">BAT-AELs (mg/Nm^3)</th></tr>
<tr><th colspan="2">Yearly Average[1]</th><th colspan="2">Daily average or average over the sampling period</th></tr>
<tr><th>New Plant</th><th>Existing Plant [2]</th><th>New Plant</th><th>Existing Plant [3]</th></tr>
<tr><td>Boiler</td><td>10 - 60</td><td>50 - 100</td><td>30 - 85</td><td>85 - 110</td></tr>
</table></td><td>The auxiliary steam boilers only use natural gas during start-up. BAT-AELs do not apply during start-up periods.

During normal operation the boilers will operated on a H_2 rich fuel see BATc 55 - 59.</td><td>Yes</td></tr>
</table>

<table>
<tr><th>BAT No.</th><th>BATc Requirements</th><th>Demonstration of BAT – Operator Response</th><th>Operating to BAT?</th></tr>
<tr><td></td><td>1) Optimising the functioning of an existing technique to reduce NOX emissions further may lead to levels of CO emissions at the higher end of the indicative range for CO emissions given after this table.
2) These BAT-AELs do not apply to plants operated < 1 500h/yr.
3) For plants operated < 500 h/yr, these levels are indicative.</td><td></td><td></td></tr>
<tr><td>BAT 45</td><td>Combustion of natural gas in engines</td><td>Not applicable</td><td>N/A</td></tr>
<tr><td>BAT 46 - 51</td><td>Combustion of iron and steel process gases</td><td>Not applicable</td><td>N/A</td></tr>
<tr><td>BAT 52 - 54</td><td>Combustion on offshore platforms</td><td>Not applicable</td><td>N/A</td></tr>
<tr><td>BAT 55</td><td>In order to improve the general environmental performance of the combustion of process fuels from the chemical industry in boilers, BAT is to use an appropriate combination of the techniques provided in BAT 6 and below.

• Pre-treatment of process fuel from the chemical industry.

BAT-associated energy efficiency levels (BAT-AEELS) for the combustion of process fuels in boilers.
<table>
<tr><th rowspan="3">Type of Combustion Unit</th><th colspan="4">BAT-AEELs (1)(2)</th></tr>
<tr><th colspan="2">Net electrical efficiency (%)</th><th colspan="2">Net total fuel utilisation (%) (3) (4)</th></tr>
<tr><th>New Unit</th><th>Existing Unit</th><th>New Unit</th><th>Existing Unit</th></tr>
<tr><td>Boiler using liquid process fuels from the chemical industry, including when mixed with HFO, gas oil and/or other liquid fuels</td><td>>36.4</td><td>35.6 -37.4</td><td>80 - 96</td><td>80 - 96</td></tr>
</table></td><td>See the responses to BATc 6 above.

In relation to pre-treatment of the process fuel, the auxiliary boilers will operate on a H_2-rich tail gas during normal operations. The process will employ a PSA which will be designed to produce a high purity hydrogen stream and bring it to export specification for a range of operating cases. The H_2-rich tail gas is an output of this PSA treatment stage.</td><td>Yes</td></tr>
</table>

BAT No.	BATc Requirements					Demonstration of BAT – Operator Response	Operating to BAT?
	Boiler using gaseous process fuels from the chemical industry, including when mixed with natural gas and/or other gaseous fuels	39 – 42.5	38-40	78 - 95	78 - 95		
	1. These BAT-AEELs do not apply to units operated < 1 500 h/yr. 2. In the case of CHP units, only one of the two BAT-AEELs 'Net electrical efficiency' or 'Net total fuel utilisation' applies, depending on the CHP unit design (i.e. either more oriented towards generation electricity or towards heat generation). 3. These BAT-AEELs may not be achievable if the potential heat demand is too low. 4. These BAT-AEELs do not apply to plants generating only electricity.						
BAT 56	In order to prevent or reduce NOX emissions to air while limiting CO emissions to air from the combustion of process fuels from the chemical industry, BAT is to use one or a combination of the techniques given below.						Yes
	Technique	Description	Applicability				
	Low-NOX burners (LNB)	See descriptions in BREF Section 8.3	Generally applicable			• With regards to NOx formation the main sources of this are related to use of the fired start-up heaters, the auxiliary steam boilers and the flares. . In relation to NOx control for the fired heaters and the auxiliary boilers the controls employed include: a. Use of a DCS which will monitor and optimise combustion in both the pre-heaters and the auxiliary boilers. b. Use of low NOx burners in both the pre-heaters and the auxiliary boilers. c. Feed gas is pre-heated before it enters the GHR preheater.	
	Air staging						
	Fuel staging	See description in Section 8.3. Applying fuel staging when using liquid fuel mixtures may require a					

BAT No.	BATc Requirements			Demonstration of BAT – Operator Response	Operating to BAT?
		specific burner design		d. The auxiliary steam boilers are also equipped with SCR which is used to reduce NOx during normal operations.	
	Flue-gas recirculation	See descriptions in BREF Section 8.3	Generally applicable to new combustion plants.		
	Water/steam addition		The applicability may be limited due to water availability		
	Fuel choice		Applicable within the constraints associated with the availability of different types of fuel and/or an alternative use of the process fuel		
	Selective non-catalytic reduction (SNCR)		Not applicable to combustion plants operated < 500 h/yr. The applicability may be limited in the case of combustion plants operated between 500 h/yr and 1 500h/yr with frequent fuel changes and frequent load variations		
	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 500h/yr. Not generally applicable to combustion plants of < 100 MWth		
	Fuel Phase Used In Combustion	BAT-AELs (mg/Nm^3)		The site will also recirculate hydrogen rich tail gas from the PSA during normal operations where it will be the fuel for the auxiliary steam boilers. The NOx emissions from the combustion of hydrogen are generally higher	Yes
		Yearly Average	Daily Average or Average Over the Sampling Period		

<table>
<tr><th>BAT No.</th><th>BATc Requirements</th><th>Demonstration of BAT – Operator Response</th><th>Operating to BAT?</th></tr>
<tr><td></td><td>
<table>
<tr><td></td><td>New Plant</td><td>Existing Plant(1)</td><td>New Plant</td><td>Existing Plant(2)</td></tr>
<tr><td>Mixture of gases and liquids</td><td>30 - 85</td><td>80 – 290(3)</td><td>50 - 110</td><td>100 – 330(3)</td></tr>
<tr><td>Gases only</td><td>20 - 80</td><td>70 – 100(4)</td><td>30 - 100</td><td>85 – 110 (5)</td></tr>
</table>
1) For plants operated < 1 500h/yr, these BAT AELs do not apply.
2) For plants operated < 500 h/yr, these levels are indicative.
3) For existing plants of ≤ 500 MWth put into operation no later than 27 November 2003using liquid fuels with a nitrogen content higher than 0,6 wt-%, the higher end of the BAT-AEL range is 380 mg/Nm3.
4) For existing plants put into operation no later than 7 January 2014, the higher end of the BAT-AEL range is 180 mg/Nm3.
5) For existing plants put into operation no later than 7 January 2014, the higher end of the BAT-AEL range is 210 mg/Nm3.</td><td>than those for combusting natural gas due to differences in the flue gas volume and it is proposed that NOx ELVs set for the boilers when using tail gas are in line with the emerging guidance “Emission Limit Values (ELVs) for Hydrogen Combustion Plant Greater than 1 megawatt thermal input”. This guidance indicates that correction factors should be applied to natural gas ELVs to account for changes in flue gas volume when using H_2-rich fuels. The correction factor for gas streams at >95% H_2 content would be 1.37 or 137% of the natural gas ELV.

Emissions from the auxiliary steam boilers will be less than 80 mg/Nm3 for NOx as a long term average with potential short term peaks to 110 mg/Nm3. The proposed NOx ELVs for the plant would therefore be 82.2 mg/Nm^3 yearly average and 116.45 mg/Nm^3 daily average.</td><td></td></tr>
<tr><td>BAT 57</td><td colspan="3">In order to reduce SOX, HCl and HF emissions to air from the combustion of process fuels from the chemical industry in boilers, BAT is to use one or a combination of the techniques given below.</td><td>Yes</td></tr>
<tr><td></td><td>
• Fuel choice
• Boiler sorbent injection
• Duct sorbent injection
• Spray dry absorber
• Wet scrubbing
• Wet flue-gas desulphurisation (wet FGD)
• Seawater FGD

BAT-associated emission levels (BAT-AELs) for SO_2 emissions to air from the combustion of 100 % process fuels from the chemical industry in boilers</td><td>The site will use fuels with sulphur content:

• natural gas during start-up of the auxiliary boilers
• hydrogen rich tail gas from the PSA will be used during normal operation of auxiliary steam boilers.</td><td></td></tr>
<tr><td></td><td>
<table>
<tr><td rowspan="2">Type of Combustion Plant</td><td colspan="2">BAT-AELs (mg/Nm^3) for SO_2</td></tr>
<tr><td>Yearly Average(1)</td><td>Daily Average or Average Over the Sampling Period(2)</td></tr>
</table>
</td><td>• No emission limit values for SO_2, HCl and HF are proposed based on the nature of the fuels being combusted.</td><td></td></tr>
</table>

<table>
<tr><th>BAT No.</th><th>BATc Requirements</th><th>Demonstration of BAT – Operator Response</th><th>Operating to BAT?</th></tr>
<tr><td></td><td>
<table>
<tr><td>New and existing boilers</td><td>30 - 85</td><td>50 - 110</td></tr>
<tr><td colspan="3">1) For existing plants operated < 1 500h/yr, these BAT-AELs do not apply.
2) For existing plants operated < 500 h/yr, these levels are indicative.</td></tr>
<tr><td colspan="3">BAT-associated emission levels (BAT-AELs) for HCl and HF emissions to air from the combustion of process fuels from the chemical industry in boilers</td></tr>
</table>
<table>
<tr><td rowspan="5">Combustion Plant total rated thermal input (MW_{th})</td><td colspan="4">BAT-AELs (mg/Nm^3) for SO_2</td></tr>
<tr><td colspan="2">HCL</td><td colspan="2">HF</td></tr>
<tr><td colspan="4">Average of samples obtained during one year</td></tr>
<tr><td>New Plant</td><td>Existing Plant(1)</td><td>New Plant</td><td>Existing Plant(1)</td></tr>
<tr><td><100</td><td>1 - 7</td><td>2 - 15(2)</td><td>< 1 - 3</td><td><1 - 6(3)</td></tr>
<tr><td>>100</td><td>1 - 5</td><td>1 – 9(2)</td><td>< 1 - 3</td><td><1 - 6(3)</td></tr>
</table>
1) For plants operated < 500 h/yr, these levels are indicative.
2) In the case of plants operated < 1 500h/yr, the higher end of the BAT-AEL range is 20 mg/Nm3.
3) In the case of plants operated < 1 500h/yr, the higher end of the BAT-AEL range is 7 mg/Nm3.
</td><td></td><td></td></tr>
<tr><td>BAT 58</td><td>In order to reduce emissions to air of dust, particulate-bound metals, and trace species from the combustion of process fuels from the chemical industry in boilers, BAT is to use one or a combination of the techniques given below.</td><td></td><td></td></tr>
<tr><td></td><td>

Electrostatic precipitator
Bag filter
Fuel choice
Dry of semi-dry FGD
Wet FGD

BAT-associated emission levels (BAT-AELs) for dust emissions to air from the combustion of mixtures of gases and liquids composed of 100 % process fuels from the chemical industry in boilers
</td><td>The site will use fuels with no dust content:

natural gas during start-up of the auxiliary boilers
hydrogen rich tail gas from the PSA will be used during normal operation of auxiliary steam boilers.

</td><td></td></tr>
<tr><td></td><td>BAT-AELs (mg/Nm^3)</td><td></td><td>Yes</td></tr>
</table>

<table>
<tr><th>BAT No.</th><th>BATc Requirements</th><th>Demonstration of BAT – Operator Response</th><th>Operating to BAT?</th></tr>
<tr><td></td><td>
<table>
<tr><td rowspan="2">Combustion Plant total rated thermal input (MW_{th})</td><td colspan="2">Yearly Average</td><td colspan="2">Daily Average or Average Over the Sampling Period</td></tr>
<tr><td>New Plant</td><td>Existing Plant(1)</td><td>New Plant</td><td>Existing Plant(2)</td></tr>
<tr><td><300</td><td>2 - 5</td><td>2 - 15</td><td>2 - 10</td><td>2 - 22(3)</td></tr>
<tr><td>>300</td><td>2 - 5</td><td>2 – 10(4)</td><td>2 - 10</td><td>2 - 11(3)</td></tr>
<tr><td colspan="5">1) For plants operated < 1 500h/yr, these BAT-AELs do not apply.
2) For plants operated < 500 h/yr, these levels are indicative.
3) For plants put into operation no later than 7 January 2014, the higher end of the BAT-AEL range is 25 mg/Nm3.
4) For plants put into operation no later than 7 January 2014, the higher end of the BAT-AEL range is 15 mg/Nm3.</td></tr>
</table>
</td><td>No emission limit values for dust are proposed based on the nature of the fuels being combusted.</td><td></td></tr>
<tr><td>BAT 59</td><td>
In order to reduce emissions to air of volatile organic compounds and polychlorinated dibenzo-dioxins and -furans from the combustion of process fuels from the chemical industry in boilers, BAT is to use one or a combination of the techniques given in BAT 6 and below.

Activated carbon injection
Rapid quenching using wet scrubbing/flue gas condenser
Selective catalytic reduction

BAT-associated emission levels (BAT-AELs) for PCDD/F and TVOC emissions to air from the combustion of 100 % process fuels from the chemical industry in boilers
<table>
<tr><td rowspan="2">Pollutant</td><td rowspan="2">Unit</td><td>BAT-AELs</td></tr>
<tr><td>Average over the Sampling period</td></tr>
<tr><td>PCDD/F(1)</td><td>ng I-TEQ/Nm³</td><td>< 0,012–0,036</td></tr>
<tr><td>TVOC</td><td>mg/Nm³</td><td>0,6–12</td></tr>
<tr><td colspan="3">(1) These BAT-AELs only apply to plants using fuels derived from chemical processes involving chlorinated substances.</td></tr>
</table>
</td><td>

See response to BAT 6
The site will use natural gas during start-up and H2-rich tail gas during normal operation of the auxiliary boilers. The chosen fuels do not comprise of chlorinated substances.

No emission limit values for volatile organic compounds are proposed based on the nature of the fuels being combusted.</td><td>Yes</td></tr>
</table>

BAT No.	BATc Requirements	Demonstration of BAT – Operator Response	Operating to BAT?
BAT 60 - 71	Combustion with co-incineration of waste	Not applicable	
BAT 72 – 75	IGCC and gasification units	Not applicable	

4.0 BEST AVAILABLE TECHNIQUES – EMERGENCY BACKUP DIESEL ENGINES ON INSTALLATIONS

4.1.1 Emergency generators at the site are required to meet the requirements in the Environment Agency "BAT Guidance for Emergency Backup Diesel engines in installations(3) and will be used for:

- Start up
- for emergency backup power supply

4.1.2 The generators will have capacity more than or equal to 1 megawatt thermal (MWth) and less than 50MWth burning any fuel.

4.1.3 The assessment of BAT for the generators is presented in the table below.

Table 4.1: BAT Assessment for Emergency Backup Diesel Engines

Item No.	BAT Standard	Demonstration of BAT – Operator's Response	Operating to BAT
1	Emission Requirements: ▪ Engines must be optimised to reduce emissions. ▪ Combustion plant specification sheets that keep to one or more of the former 2g TA Luft and United States Environment Protection Agency (EPA) Tier 2 (or equivalent) standards are acceptable proof of BAT plant. ▪ Approximately 750mg per m^3 NO_x (as NO_2) at 15% O_2 standard temperature and pressure, dry, 273K and 101.3kPa (equivalent to 2,000mg per m^3 at 5% O_2 – commonly termed '2g') at a typical emergency load (usually greater than 67% of standby power rating). A copy of engine specification sheet should be supplied with application.	• Engines will be optimised and meet the relevant standards – we have modelled the emissions based on a Tier 2 equivalent engine; • The stack will ensure good flue gas dispersion: and • vertical stacks will be employed unobstructed by caps or cowls.	Yes

Item No.	BAT Standard	Demonstration of BAT – Operator's Response	Operating to BAT
	Your stack design should ensure good flue gas dispersion. Stacks should be vertical and emissions should not be obstructed by caps or cowls.		
2	Operational Testing and Maintenance plan in place for all site equipment within the installation boundary, including the backup generator diesel engines. To meet standards for operational controls these will include; – diesel engines to be tested one at a time, – they will not be tested for more than 50 hours per annum, – or during periods of poor air quality.	Diesel engines will be included in the Operational Maintenance Plan that will be in place before commissioning We can confirm that operated engines will be tested individually, and testing won't exceed 50 hrs/annum.	Yes

5.0 CONCLUSION

5.1.1 On the basis of the assessment against the required BAT Conclusions, as shown in Section 3 and 4, it is considered that the proposed Installation will be designed and operated in compliance with the LCP BRef and the BAT for backup engines and therefore in accordance with BAT.

6.0 REFERENCES

1. European Parliament and Council of European Union, 2017, Best Available Techniques (BAT) Reference Document for Large Combustion Plants.

2. European Parliament and Council of European Union, November 2021, Commission Implementing Decision EU 2021/2326 Establishing Best Available Techniques (BAT) Conclusions Under Directive 2010/75/EU for Large Combustion Plants.

3. Environment Agency, August 2023, Emergency Backup Diesel Engines on Installations: Best Available Technique (BAT).