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 C5 Assessment of Best Available Techniques For Emissions Management

Environmental Permitting (England and Wales) Regulations 2016

Applicants: H2 Teesside Ltd

Date: October 2024

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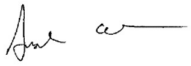
Signed		**Date**	10/10/2024
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GLOSSARY

Abbreviation	**Description**
Applicant/Operator	H2 Teesside Ltd
ATR	Auto Thermal Reforming
BAT	Best Available Techniques
BAT-AEL	BAT- Associated Emission Level
CCP	Carbon Capture Plant
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Usage and Storage
CO_2	Carbon dioxide
DCS	Distributed Control System
ELV	Emission Limit Value
EMS	Environmental Management System
ETP	Effluent Treatment Plant
FEED	Front-End Engineering Design
FID	Final Investment Decision
GHR	Gas Heated Reformer
H_2	Hydrogen (gaseous)
IP	Intermediate Pressure
ITS	Iso Thermal Shift
LCP	Large Combustion Plant
LHV	Lower Heating Value
MP	Medium Pressure
NEP	Northern Endurance Partnership
NWL	Northumbrian Water Limited
NZT	Net Zero Teesside
O_2	Oxygen
PSA	Pressure Swing Adsorption
WwTW	Wastewater Treatment Works

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TABLES

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 and Storage (CCS) 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 the treatment and management of gaseous and wastewater emissions.

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 hydrogen production plant 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) to NEP for offshore underground storage. No temporary CO_2 storage is required on site.

1.1.4 A high level process flow diagram (Figure 3) for the Installation is 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 maximise energy efficiency. While individual BAT assessments have been prepared to demonstrate application of best available techniques for Blue Hydrogen with CC, Large Combustion Plant, Energy Efficiency, Emissions Management and Cooling, the system will be integrated to address multimedia effects across the Installation as a whole.

1.1.6 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:

- Best Available Techniques (BAT) Reference Document and associated BAT Conclusions for Common Waste Gas Management and Treatment Systems in the Chemical Sector[(1)(2)]; and

- Best Available Techniques (BAT) Reference Document and associated BAT Conclusions for Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector[3][4].

1.1.7 The main application document (AP3328SQ/APP/SS "Supporting Statement") provides an overall view of the permit application.

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

1.1.9 For assessment of BAT for hydrogen production, large combustion plant, cooling and energy efficiency 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 Large Combustion Plant (Appendix C2; Document Reference: AP3328SQ-APP-BAT2-LCP).
- 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).

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, 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 their process and solvent blend 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 hydrogen production and carbon capture efficiencies.

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

3.0 BAT CONCLUSIONS FOR GASEOUS EMISSIONS

Table 3-1. BAT Assessment Against BREF for Common Waste Gas Management and Treatment Systems at an Installation Level

Bat Reference		BATC Requirements	H2 Teesside	Operating to BAT?
1		**BAT 1 Environmental Management System** In order to improve the overall environmental performance, BAT is to elaborate and implement an environmental management system (EMS) that incorporates all of the following features:		
	i.	commitment, leadership, and accountability of the management, including senior management, for the implementation of an effective EMS;	As identified in the Section 4, Supporting Statement (AP3328SQ /APP/SS) the Operator will operate the Installation in accordance with an Environmental Management System (EMS) which is attested to BS ISO EN 14001:2015. It is anticipated that the management of emissions from the Installation will form part of this environmental management system. Further details of the management system will be developed prior to commencement of operations but will incorporate: • Relevant policy statements and other management documents. The EMS will recognise emissions as a significant aspect and as a key attribute to monitor and improve. The commitment to review and improve environmental impacts and associated performance will be captured within the EMS and it associated policy statements. • The EMS will include the annual establishment of objectives and targets including those associated with emissions management. 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. • Site-specific procedures which define roles and responsibilities for site personnel. The Operator will implement the relevant procedures within their EMS to ensure any residual risks to the environment are limited. All personnel will undergo training to ensure awareness of environmental policy to work towards continuous improvement. • All members of staff hired at the facility will have relevant training and experience to their role depending on their job level. Training will be given in line with the job descriptions given to members of staff which outline the key accountabilities, skills and competencies required. • The reporting of incidents (which includes all complaints, whether justified or not) will be encouraged at all levels of the organisation. The process of reporting all incidents and near misses will be described in a relevant procedure and will be recorded in the H2TS incident tracking system • As part of the on-site reporting requirements defined in the site major emergency plan, H2TS will notify the Environment Agency within 24 hours of any release occurring that exceeds the agreed limit, or any other release occurring, which might cause harm to the environment.	Yes
	ii.	an analysis that includes the determination of the organisation's context, the identification of the needs and expectations of interested parties, the identification of characteristics of the installation that are associated with possible risks for the environment (or human health) as well as of the applicable legal requirements relating to the environment;		
	iii.	development of an environmental policy that includes the continuous improvement of the environmental performance of the installation;		
	iv.	establishing objectives and performance indicators in relation to significant environmental aspects, including safeguarding compliance with applicable legal requirements;		
	v.	planning and implementing the necessary procedures and actions (including corrective and preventive actions where needed), to achieve the environmental objectives and avoid environmental risks;		
	vi.	determination of structures, roles and responsibilities in relation to environmental aspects and objectives and provision of the financial and human resources needed;		
	vii.	ensuring the necessary competence and awareness of staff whose work may affect the environmental performance of the installation (e.g. by providing information and training);		
	viii.	internal and external communication;		
	ix.	fostering employee involvement in good environmental management practices;		
	x.	establishing and maintaining a management manual and written procedures to control activities with significant environmental impact as well as relevant records;		
	xi.	effective operational planning and process control;	The Installation will be controlled and operated via 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. See Management Techniques (section 4) of Supporting Statement (Document ref: AP3328SQ/APP/SS).	Yes
	xii.	implementation of appropriate maintenance programmes;	The Installation will be subject to regular preventative maintenance cycles to ensure the efficiency of plant and equipment is maintained. 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.	Yes
	xiii.	emergency preparedness and response protocols, including the prevention and/or mitigation of the adverse (environmental) impacts of emergency situations;	H2TS will maintain a site major emergency plan withing the EMS. Appropriate documented procedures will be implemented for environmentally critical plant, equipment and operations, whose failure could lead to adverse impact on the environment. These procedures will cover: • Operation of equipment; • Maintenance of equipment; and, • Spill contingency procedures.	Yes
	xiv.	when (re)designing a (new) installation or a part thereof, consideration of its environmental impacts throughout its life, which includes construction, maintenance, operation and decommissioning;	• The design phases for the Installation will ensure the Installation will be developed to meet relevant regulatory and industry standards taking into consideration locality and equipment requirements in relation to its construction and operation. Design will be completed in accordance with the regulatory requirements defined in the Construction, Design and Management (CDM) Regulations and Control of Major Accident Hazards (COMAH) which require consideration of potential hazards at all stages of the Installation life. • The Environmental Statement submitted as part of the DCO application specifically considered environmental impacts during the construction and full lifecycle of the facility including decommissioning. • Scheduled maintenance and frequent monitoring of the Installation, as stated above, will be implemented to ensure environmental impacts are minimised through the Installation's life.	Yes

Bat Reference		BATC Requirements	H2 Teesside	Operating to BAT?
	xv.	implementation of a monitoring and measurement programme; if necessary, information can be found in the Reference Report on Monitoring of Emissions to Air and Water from IED Installations;	**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). 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 management includes two separate wastewater treatment processes. The first involves the treatment of process condensate from the syngas plant, DAF waste, filtration waste and flare KO drum liquid in the biological treatment plant followed by recirculation to the raw water treatment plant. The second involves treatment of cooling water blowdown, DMW plant rejects and dewatering filtrate in the ETP followed by discharge via the NZT outfall to 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.	Yes
	xvi.	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
	xvii.	periodic independent (as far as practicable) internal auditing and periodic independent external auditing in order to assess the environmental performance and to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained;	The EMS will be subject to attestation with ISO 14001 and will be subject to periodic review and update and will be subject to internal audits.	Yes
	xviii.	evaluation of causes of nonconformities, implementation of corrective actions in response to nonconformities, review of the effectiveness of corrective actions, and determination of whether similar nonconformities exist or could potentially occur;	The proposed Installation will be controlled and operated via an automated control system (such as a 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.	Yes
	xix.	periodic 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
	xx.	following and taking into account the development of cleaner techniques.	The new Installation is itself a 'cleaner' technology achieving a higher carbon capture rate compared to other technologies that were considered, supporting the decarbonization of industrial activities to assist in the UK's transition towards net zero.	Yes
		Specifically for the chemical sector, BAT is also to incorporate the following features in the EMS:		
	xxi.	an inventory of channelled and diffuse emissions to air (see BAT 2);	H2TS will document emissions and provide an annual report to the Environment Agency in accordance with the Environmental Permit requirements. Channelled and diffuse emissions to air are outlined as part of this permit application. See Emissions to Air, Land and Water (Section 5) and Impact Assessment (Section 7) of Supporting Statement (Document ref: AP3328SQ/APP/SS).	Yes
	xxii.	an OTNOC management plan for emissions to air (see BAT 3);	An OTNOC management plan will be produced for the site and will be in place before commissioning. The plant and associated control systems will be designed to minimise the potential for OTNOC events to occur. The plant will be	Yes

Bat Reference		BATC Requirements	H2 Teesside	Operating to BAT?
			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 automated control system to allow operators to take action to avoid OTNOC events.	
	xxiii.	an integrated waste gas management and treatment strategy for channelled emissions to air (see BAT 4);	A waste gas management strategy will be developed as part of the EMS and will be in place before commissioning	Yes
	xxiv.	a management system for diffuse VOC emissions to air (see BAT 19);	The site will implement a Leak Detection and Repair (LDAR) plan for the monitoring of diffuse emissions. The LDAR will be maintained as part of the EMS.	Yes
	xxv.	a chemicals management system that includes an inventory of the hazardous substances and substances of very high concern used in the process(es); the potential for substitution of the substances that are listed in this inventory, focusing on those substances other than raw materials, is analysed periodically (e.g. annually) in order to identify possible new available and safer alternatives, with no or lower environmental impacts	The storage of hazardous substances during the Installation operational phase will be approved through a Hazardous Substances Consent and regulated by the Health and Safety Executive (as the competent authority) through COMAH. All raw materials stored within tanks will be provided with appropriate containment designed to meet CIRIA C736 standards, including but not limited to storage within bunds having a capacity 110% of the stored materials. Alternatives will be analysed periodically to look for new and safer alternatives. Section 4.8 – Raw Materials of the Supporting Statement (Document ref: AP3328SQ /APP/SS).	Yes
2		**BAT 2 Emissions Inventory** In order to facilitate the reduction of emissions to air, BAT is to establish, maintain and regularly review (including when a substantial change occurs) an inventory of channelled and diffuse emissions to air, as part of the environmental management system (see BAT 1), that incorporates all of the following features:		
	i.	information, as comprehensive as is reasonably possible, about the chemical production process(es), including: a. chemical reaction equations, also showing side products; b. simplified process flow sheets that show the origin of the emissions;	The EMS for the Installation will cover the information in i.-iii where applicable. Details of the proposed process chemical reactions are provided in section 4 of Supporting Statement (Document ref: AP3328SQ/APP/SS).	Yes
	ii.	information, as comprehensive as is reasonably possible, about channelled emissions to air, such as: a) emissions point(s); b) average values and variability of flow and temperature; c) average concentration and mass flow values of relevant substances/parameters and their variability (e.g. TVOC, CO, NOX, SOX, Cl2, HCl); d) presence of other substances that may affect the waste gas treatment system(s) or plant safety (e.g. oxygen, nitrogen, water vapour, dust); e) techniques used to prevent and/or reduce channelled emissions to air; f) flammability, lower and higher explosive limits, reactivity; g) monitoring methods (see BAT 8); h) presence of substances classified as CMR 1A, CMR 1B or CMR 2; the presence of such substances may for example be assessed according to the criteria of Regulation (EC) No 1272/2008 on classification, labelling and packaging (CLP).	• Emissions points are detailed in Section 5 of the Supporting Statement (Document ref: AP3328SQ/APP/SS) and will be updated where changes occur as the Installation develops • 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 NOx, CO and NH_3 (associated with SCR use) for the auxiliary boilers. No provision has been made for SO_2 or particulate monitoring as the fuel will be natural gas and H_2 rich tail gas. O2, water, temperature and pressure will also be recorded. • CEMS will also be used to continuously monitor the emissions from the flares. • 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. • A monitoring plan for the operational phase will be developed prior to the plant becoming operational and will be revised based on the outputs from commissioning.	
	iii.	information, as comprehensive as is reasonably possible, about diffuse emissions to air, such as: a) identification of the emission source(s); b) characteristics of each emission source (e.g. fugitive or non-fugitive; static or moving; accessibility of the emission source; included in an LDAR programme or not); c) the characteristics of the gas or liquid in contact with the emission source(s), including: 1) physical state; 2) vapour pressure of the substance(s) in the liquid, pressure of the gas; 3) temperature; 4) composition (by weight for liquids or by volume for gases); 5) hazardous properties of the substance(s) or mixtures, including substances or mixtures classified as CMR 1A, CMR 1B or CMR 2; d) techniques used to prevent and/or reduce diffuse emissions to air; e) monitoring (see BAT 20, BAT 21 and BAT 22).	• An inventory of diffuse emissions to air will be prepared following completion of FEED and will be maintained as part of the EMS. • The site will implement a LDAR plan for the monitoring of diffuse emissions. The LDAR will be maintained as part of the EMS.	

Bat Reference		BATC Requirements	H2 Teesside	Operating to BAT?
3		**BAT 3 Other Than Normal Operating Conditions** In order to reduce the frequency of the occurrence of OTNOC and to reduce missions to air during OTNOC, BAT is to set up and implement a risk based OTNOC management plan as part of the environmental management system (see BAT 1) that includes all of the following features:		
	i.	identification of potential OTNOC (e.g. failure of equipment critical to the control of channelled emissions to air, or equipment critical to the prevention of accidents or incidents that could lead to emissions to air ('critical equipment')), of their root causes and of their potential consequences;	• 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 automated control system. The control system will be designed to provide warnings to operators of undesirable deviations from normal operating conditions. The system will be designed to alert operators and provide sufficient time for them to take action to avoid OTNOC events.	Yes
	ii.	appropriate design of critical equipment (e.g. equipment modularity and compartmentalisation, backup systems, techniques to obviate the need to bypass waste gas treatment during start-up and shutdown, high-integrity equipment, etc.);		
	iii.	set-up and implementation of a preventive maintenance plan for critical equipment (see BAT 1 xii.);	• 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.	Yes
	iv.	monitoring (i.e. estimating or, where this is possible, measuring) and recording of emissions and associated circumstances during OTNOC;		Yes
	v.	periodic assessment of the emissions occurring during OTNOC (e.g. frequency of events, duration, amount of pollutants emitted as recorded in point iv.) and implementation of corrective actions if necessary;	• All plant and equipment at the site will be regularly maintained, including those system provided to minimise the potential for OTNOC conditions to occur, and testing of back-up systems will take place.	Yes
	vi.	regular review and update of the list of identified OTNOC under point i. following the periodic assessment of point v.;	• The Installation will also have an accident management plan (AMP) and emergency response procedures for the management of spills, firewater, and the blocking of any discharge outlet to the river.	Yes
	vii.	regular testing of backup systems.		Yes
4		**BAT 4 Channelled Emissions to Air** In order to reduce channelled emissions to air, BAT is to use an integrated waste gas management and treatment strategy that includes, in order of priority, process-integrated recovery and abatement techniques.	A waste gas management strategy will be produced and be in place as part of the EMS in order to reduce emissions to air. This will be produced and in place prior to commissioning.	Yes
5		**BAT 5 Channelled Emissions to Air** In order to facilitate the recovery of materials and the reduction of channelled emissions to air, as well as to increase energy efficiency, BAT is to combine waste gas streams with similar characteristics, thus minimising the number of emission points.	The design has minimised the discharge points to air as far as practicable.	N/A
6		**BAT 6 Channelled Emissions to Air** In order to reduce channelled emissions to air, BAT is to ensure that the waste gas treatment systems are appropriately designed (e.g. considering the maximum flow rate and pollutant concentrations), operated within their design ranges, and maintained (through preventive, corrective, regular and unplanned maintenance) so as to ensure optimal availability, effectiveness and efficiency of the equipment.	• Emissions points are detailed in Section 5 of the Supporting Statement (Document ref: AP3328SQ/APP/SS) and design has been optimised in respect of maximum flow and pollutant concentrations. • The proposed Installation will be controlled and operated via an automated control system (such as a 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. • The Installation will be subject to regular preventative maintenance cycles to ensure the efficiency of plant and equipment is maintained. 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.	Yes
7		**BAT 7 Process Parameter Monitoring** BAT is to continuously monitor key process parameters (e.g. waste gas flow and temperature) of waste gas streams being sent to pretreatment and/or final treatment.	The proposed Installation will be controlled and operated via an automated control system (such as a 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.	Yes
8		**BAT 8 Channelled Emissions to Air Monitoring** BAT is to monitor channelled 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.	• The flue gas from the site stacks will be monitored using MCERTS certified CEMs in accordance with EN 14181. • This system will continuously monitor NOx, CO and NH3 (associated with SCR use) for the auxiliary boilers. No provision has been made for SO2 or particulate monitoring as the fuel will be natural gas and H2 rich tail gas. O2, water, temperature and pressure will also be recorded. • CEMS will also be used to continuously monitor the emissions from the flares. • 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. Periodic monitoring will be used to monitor the fired heaters, emergency	Yes

Bat Reference		BATC Requirements	H2 Teesside	Operating to BAT?
			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.	
9		**BAT 9 Organic Compounds** In order to increase resource efficiency and to reduce the mass flow of organic compounds sent to the final waste gas treatment, BAT is to recover organic compounds from process off-gases by using one or a combination of the techniques given below and to reuse them.	The waste gas at the Installation is not expected to contain organic compounds.	N/A
10		**BAT 10 Organic Compounds** In order to increase energy efficiency and to reduce the mass flow of organic compounds sent to the final waste gas treatment, BAT is to send process off-gases with a sufficient calorific value to a combustion unit that is, if technically possible, combined with heat recovery. BAT 9 has priority over sending process off-gases to a combustion unit.	The waste gas at the Installation is not expected to contain organic compounds. The process will, however, utilise H_2 tail gas from the process as a replacement fuel for natural gas during normal operations.	Yes
11		**BAT 11 Organic Compounds** In order to reduce channelled emissions to air of organic compounds, BAT is to use one or a combination of the techniques given below.	No channelled emissions of organic compounds	N/A
12		**BAT 12 Organic Compounds** In order to reduce channelled emissions to air of PCDD/F from thermal treatment of waste gases containing chlorine and/or chlorinated compounds, BAT is to use techniques a. and b., and one or a combination of techniques c. to e., given below.	No channelled emissions of PCDD/F compounds although the process will use SCR for NOx control.	N/A
13		**BAT 13 Dust** In order to increase resource efficiency and to reduce the mass flow of dust and particulate-bound metals sent to the final waste gas treatment, BAT is to recover materials from process off-gases by using one or a combination of the techniques given below and to reuse them.	Process will use natural gas in startup and H_2 tail gas as a fuel in normal operations which due to fuel composition is not expected to generate dust and particulate bound metals in the waste gas.	N/A
14		**BAT 14 Dust** In order to reduce channelled emissions to air of dust and particulate-bound metals, BAT is to use one or a combination of the techniques given below.	Process will use natural gas in startup and H_2 tail gas as a fuel during normal operation which due to fuel composition is not expected to generate dust and particulate bound metals in the waste gas.	N/A
15		**BAT 15 Inorganic Compounds** In order to increase resource efficiency and to reduce the mass flow of inorganic compounds sent to the final waste gas treatment, BAT is to recover inorganic compounds from process off-gases by using absorption and to reuse them.	Process will use natural gas in startup and H_2 tail gas as a fuel during normal operations which due to fuel composition is not expected to generate inorganic compounds in the waste gas.	N/A
16		**BAT 16 Inorganic Compounds** In order to reduce channelled emissions to air of CO, NOX and SOX from thermal treatment, BAT is to use technique c. and one or a combination of the other techniques given below. a) Choice of fuel b) Low NOx burner c) Optimisation of catalytic or thermal oxidation d) Removal of high levels of NOx precursors e) Absorption f) Selective Catalytic Reduction (SCR) g) Selective Non-Catalytic Reduction (SNCR)	• 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. d. The auxiliary steam boilers are also equipped with SCR which is used to reduce NOx during normal operations. 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 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". Emissions from the auxiliary steam boilers will be less than 80 mg/Nm^3 for NOx as a long term average with potential short term peaks to 110 mg/Nm^3. • In relation to the auxiliary steam boilers, the net rated thermal input means that Large Combustion Plant will apply and as such BAT-AELs were reviewed and it can be confirmed that: a. The auxiliary steam boilers operate on natural gas during start-up and no emission limit values are set during start-up conditions.. b. No BAT-AELs are specified for combustion of a hydrogen rich fuel in the LCP although there are BAT-AELs for using process generated fuels c. Emissions from the auxiliary steam boilers will be less than 80 mg/Nm^3 for NOx as a long term average with potential short term peaks to 110 mg/Nm^3. It is proposed that NOx ELVs set for the boilers are in line with the	Yes

Bat Reference		BATC Requirements	H2 Teesside	Operating to BAT?
			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. 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. d. • In relation to the fired start-up heaters, back-up generators and firewater pumps, the net rated thermal input means they are classed as medium combustion plant (MCP). However, as the fire heaters only operate during start-up, and the generators and firewater pumps in emergency conditions, the overall annual runtime of each will be <500 hours and as such no emission limit values will be applied.	
17		**BAT 17 Inorganic Compounds** In order to reduce channelled emissions to air of ammonia from the use of selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR) for the abatement of NOX emissions (ammonia slip), BAT is to optimise the design and/or operation of SCR or SNCR (e.g. optimised reagent to NOX ratio, homogeneous reagent distribution and optimum size of the reagent drops).	The plant will include the operation of SCR on auxiliary boilers during normal operations 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
18		**BAT 18 Inorganic Compounds** In order to reduce channelled emissions to air of inorganic compounds other than channelled emissions to air of ammonia from the use of selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR) for the abatement of NOX emissions), channelled emissions to air of CO, NOX and SOX from the use of thermal treatment, and channelled emissions to air of NOX from process furnaces/heaters, BAT is to use one or a combination of the techniques given.	See responses to BAT 16 and BAT 17 above.	Yes
19		**BAT 19 Diffuse VOC Emissions** In order to prevent or, where that is not practicable, to reduce diffuse VOC emissions to air, BAT is to elaborate and implement a management system for diffuse VOC emissions, as part of the environmental management system (see BAT 1), that includes all of the following features: I. Estimating the annual quantity of diffuse VOC emissions (see BAT 20). II. Monitoring diffuse VOC emissions from the use of solvents by compiling a solvent mass balance, if applicable (see BAT 21). III. Establishing and implementing a leak detection and repair (LDAR) programme for fugitive VOC emissions. The LDAR programme typically lasts from 1 to 5 years depending on the nature, scale and complexity of the plant (5 years may correspond to large plants with a high number of emission sources). IV. Establishing and implementing a detection and reduction programme for non-fugitive VOC emissions that includes all of the following features: a. Listing of equipment identified as relevant non-fugitive VOC emission sources in the inventory of diffuse VOC emissions (see BAT 2). b. Monitoring non-fugitive VOC emissions from equipment listed under point iv. a. (see BAT 22). c. Planning and implementing techniques to reduce non-fugitive VOC emissions (see BAT 23, techniques a., c. and g. to j.). The planning and implementation of the techniques are prioritised according to the hazardous properties of the emitted substance(s), the significance of the emissions and/or operational constraints. d. Filling in the database mentioned in point v. V. Establishing and maintaining a database, for diffuse VOC emissions sources that are identified in the inventory mentioned in BAT 2, for keeping record of: a. equipment design specifications (including the date and description of any design changes); b. the equipment maintenance, repair, upgrade, or replacement actions, performed or planned, and their date of implementation;	• The site will implement a LDAR plan for the monitoring of diffuse emissions. The LDAR will be reviewed and maintained as part of the EMS. • No non-fugitive VOC emissions are expected.	Yes

Bat Reference		BATC Requirements	H2 Teesside	Operating to BAT?
		c. the equipment that could not be maintained, repaired, upgraded or replaced due to operational constraints; d. the results of the measurements or monitoring, including the concentration(s) of the emitted substance(s), the calculated leak rate (as kg/year), the recording from OGI cameras (e.g. from the last LDAR programme) and the date of the measurements or monitoring; e. the annual quantity of diffuse VOC emissions (as fugitive and non-fugitive emissions), including information on non-accessible sources and accessible sources not monitored during the year. VI. Reviewing and updating the LDAR programme periodically. This may include the following: a. lowering the leak and/or maintenance/repair thresholds (see point iii. b.); b. reviewing the prioritisation of equipment to be monitored, giving higher priority to (the type of) equipment identified as leaky during the previous LDAR programme; c. planning the maintenance, repair, upgrade or replacement of equipment that could not be performed during the previous LDAR programme due to operational constraints. VII. Reviewing and updating the detection and reduction programme for non-fugitive VOC emissions. This may include the following: VIII. a. monitoring non-fugitive VOC emissions from equipment where maintenance, repair, upgrade or replacement actions were implemented, in order to determine if those actions were successful; IX. b. planning the maintenance, repair, upgrade or replacement actions that could not be performed due to operational constraints.		
20		**BAT 20 Diffuse VOC Emissions** BAT is to estimate fugitive and non-fugitive VOC emissions to air separately at least once every year by using one or a combination of the techniques given below, as well as to determine the uncertainty of this estimation. The estimation distinguishes between VOCs classified as CMR 1A or 1B and VOCs that are not classified as CMR 1A or 1B. a. Use of emission factors b. Use of a mass balance c. Use of thermodynamic models	Diffuse VOC emissions will be determined at least annually in accordance with Pollution Inventory reporting requirements.	Yes
21		**BAT 21 Diffuse VOC Emissions** BAT is to monitor diffuse VOC emissions from the use of solvents by compiling, at least once every year, a solvent mass balance of the solvent inputs and outputs of the plant, as defined in Part 7 of Annex VII to Directive 2010/75/EU and to minimise the uncertainty of the solvent mass balance data by using all of the techniques given below. a. Full identification and quantification of solvent inputs and outputs, including associated uncertainty. b. Implementation of a solvent tracking system. c. Monitoring if changes that may influence the uncertainty of the solvent mass balance data.	Diffuse VOC emissions from solvents will be determined at least annually in accordance with Pollution Inventory reporting requirements.	Yes
22		**BAT 22 Diffuse VOC Emissions** BAT is to monitor diffuse VOC 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. **Type of sources of diffuse VOC emissions(1)(2)** / **Type of VOCs** / **Standards** / **Minimum Monitoring Frequency** Sources of fugitive emissions / VOCs classified as CMR 1A or 1B / EN 15446 (8) / Once every year (3)(4)(5)	• The site will implement a LDAR plan for the monitoring of diffuse emissions. The LDAR will be reviewed and maintained as part of the EMS.	Yes

Bat Reference		BATC Requirements	H2 Teesside	Operating to BAT?
		<table><tr><td></td><td>VOCs not classified as CMR 1A or 1B</td><td></td><td>Once during the period covered by each LDAR programme (see BAT 19 point iii.) (6)</td></tr><tr><td>Sources of non-fugitive emissions</td><td>VOCs classified as CMR 1A or 1B</td><td rowspan="2">EN 17628</td><td>Once every year</td></tr><tr><td></td><td>VOCs not classified as CMR 1A or 1B</td><td>Once every year(7)</td></tr></table> 1) The monitoring only applies to emission sources that are identified as relevant in the inventory given in BAT 2. 2) The monitoring does not apply to equipment operated under sub atmospheric pressure. 3) In the case of inaccessible sources of fugitive VOC emissions (e.g. if the monitoring requires the removal of insulation or the use of scaffolding), the monitoring frequency may be reduced to once during the period covered by each LDAR programme (see BAT 19 point iii.). 4) For the production of PVC, the minimum monitoring frequency may be reduced to once every 5 years if the plant uses VCM gas detectors to continuously monitor VCM emissions in a way that allows an equivalent level of detection of VCM leaks. 5) In the case of high-integrity equipment (see BAT 23 b.) in contact with VOCs classified as CMR 1A or 1B, a lower minimum monitoring frequency may be adopted, but in any case at least once every 5 years. 6) In the case of high-integrity equipment (see BAT 23 b.) in contact with VOCs other than VOCs classified as CMR 1A or 1B, a lower minimum monitoring frequency may be adopted, but in any case at least once every 8 years. 7) The minimum monitoring frequency may be reduced to once every 5 years if non-fugitive emissions are quantified by using measurements. 8) This standard may be complemented by EN 17628.		
23		**BAT 23 Diffuse VOC Emissions** In order to prevent or, where that is not practicable, to reduce diffuse VOC emissions to air, BAT is to use a combination of the techniques given below with the following order of priority. a. Limiting number of emission sources b. Use of high integrity equipment c. Collecting diffuse emissions and treating off-gases d. Facilitating access and/or monitoring activities e. Tightening f. Replacement of leaky equipment and/or parts g. Reviewing and updating process design h. Reviewing and updating operating conditions i. Using closed systems j. Using techniques to minimise emissions from surfaces.	• While natural gas is not stored at site but is pumped from the grid the following has been included within the design of the transfer system: a) Gas pipeline length has been optimised and length minimised as far as practicable; b) Number of flanges and valves will be minimised; c) Welded fittings and connections will be used; d) High integrity equipment will be installed and maintained. • The site will implement a LDAR plan for the monitoring of diffuse emissions. The LDAR will be reviewed and maintained as part of the EMS. • The Installation will be subject to regular preventative maintenance cycles to ensure the efficiency of plant and equipment is maintained. 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.	Yes
24		**BAT 24 – 25 Polyolefin Products** BAT associated with the production of polyolefin products	No polyolefin products produced by the Installation.	N/A
26		**BAT 26 – 30 Polyvinyl Chloride** BAT associated with the production of polyvinyl chloride (PVC)	Not applicable- no production of polyvinyl chloride (PVC) or vinyl chloride materials (VCM) takes place at the Installation.	N/A
31		**BAT 31 – 32 Synthetic Rubbers** BAT associated with the production of synthetic rubbers.	Not applicable- the production of synthetic rubbers does not take place at the Installation.	N/A
33		**BAT 33 – 35 Viscose** BAT associated with the production of viscose	Not applicable- the production of viscose using CS2 does not take place at the Installation.	N/A
36		**BAT 36 Process Furnaces / Heaters** In order to prevent or, where that is not practicable, to reduce channelled emissions to air of CO, dust, NOX and SOX, BAT is to use technique c. and one or a combination of the other techniques given below.	• With regards to NOx formation from the fired start-up heaters, the controls employed include: a. Use of a DCS which will monitor and optimise combustion in the startup heaters.	Yes

Bat Reference		BATC Requirements	H2 Teesside	Operating to BAT?
		a) Choice of fuel b) Low NOx burner c) Optimisation of catalytic or thermal oxidation d) Removal of high levels of NOx precursors e) Absorption f) Selective Catalytic Reduction (SCR) g) Selective Non-Catalytic Reduction (SNCR)	b. Use of low NOx burners in the startup heaters. • In relation to the fired start-up heaters, the net rated thermal input means they are classed as medium combustion plant (MCP). However, as the fire heaters only operate during start-up, the overall annual runtime of each will be <500 hours and as such no emission limit values will be applied	

4.0 BAT CONCLUSIONS FOR WASTE GAS AND WASTEWATER TREATMENT AND MANAGEMENT

Table 4-2. BAT Assessment against BREF for Common Waste Gas and Wastewater Treatment and Management at the Installation

Bat No.		BATC Requirements	H2 Teesside	Operating to BAT
1		**BAT 1 Environmental Management System** 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;	As identified in the Section 4, Supporting Statement (AP3328SQ /APP/SS) the Operator will operate the Installation in accordance with an Environmental Management System (EMS) which is attested to BS ISO EN 14001:2015. It is anticipated that the management of emissions from the Installation will form part of this environmental management system. Further details of the management system will be developed prior to commencement of operations but will incorporate: • Relevant policy statements and other management documents. The EMS will recognise emissions as a significant aspect and as a key attribute to monitor and improve. The commitment to review and improve environmental impacts and associated performance will be captured within the EMS and it associated policy statements. • The EMS will include the annual establishment of objectives and targets including those associated with emissions management. 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. • Site-specific procedures which define roles and responsibilities for site personnel. The Operator will implement the relevant procedures within their EMS to ensure any residual risks to the environment are limited. All personnel will undergo training to ensure awareness of environmental policy to work towards continuous improvement. • All members of staff hired at the facility will have relevant training and experience to their role depending on their job level. Training will be given in line with the job descriptions given to members of staff which outline the key accountabilities, skills and competencies required.	Yes
	ii.	an environmental policy that includes the continuous improvement of the installation by the management;		Yes
	iii.	planning and establishing the necessary procedures, objectives and targets, in conjunction with financial planning and investment;		Yes
	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) maintenance programmes; (h) emergency preparedness and response; (i) safeguarding compliance with environmental legislation;		Yes
	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 from IED installations — ROM); (b) corrective and preventive action; (c) maintenance of records; (d) independent (where practicable) internal or external auditing in order to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained;	**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). 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 management includes two separate wastewater treatment processes. The first involves the treatment of process condensate from the syngas plant, DAF waste, filtration waste and flare KO drum liquid in the biological treatment plant followed by recirculation to the raw water treatment plant. The second involves treatment of cooling water blowdown, DMW plant rejects and dewatering filtrate in the ETP followed by discharge via the NZT outfall to 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** The proposed Installation will be controlled and operated via an automated control system (such as a 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.	Yes

Bat No.		BATC Requirements	H2 Teesside	Operating to BAT
			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 of the EMS and its continuing suitability, adequacy and effectiveness by senior management;	Regular Management Review of the EMS will be undertaken at the site.	Yes
	vii.	following the development of cleaner technologies;	The new Installation is itself a 'cleaner' technology achieving a higher carbon capture rate compared to other technologies that were considered, supporting the decarbonization of industrial activities to assist in the UK's transition towards net zero.	Yes
	viii.	consideration for the environmental impacts from the eventual decommissioning of the plant at the design stage of a new plant, and throughout its operating life;	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 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.	Yes
	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
	x.	waste management plan (see BAT 13)	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
		Specifically for chemical sector activities, BAT is to incorporate the following features in the EMS:		
	xi.	on multi-operator installations/sites, establishment of a convention that sets out the roles, responsibilities and coordination of operating procedures of each plant operator in order to enhance the cooperation between the various operators;	The Installation will not involve multi operator activities.	N/A
	xii.	establishment of inventories of waste water and waste gas streams (see BAT 2).	Channeled and diffuse emissions to air are outlined as part of this permit application. See Emissions to Air. Land and Water (Section 5) and Impact Assessment (Section 7) of Supporting Statement (Document ref: AP3328SQ/APP/SS).	Yes
		In some cases, the following features are part of the EMS:		
	xiii.	odour management plan (see BAT 20);	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
	xiv.	noise management plan (see BAT 22).	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	Yes

Bat No.		BATC Requirements	H2 Teesside	Operating to BAT
			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).	
2		**BAT 2 Emissions Inventory** In order to facilitate the reduction of emissions to water and air and the reduction of water usage, BAT is to establish and to maintain an inventory of waste water and waste gas streams, as part of the environmental management system (see BAT 1), that incorporates all of the following features:		
	i.	information about the chemical production processes, including: (a) chemical reaction equations, also showing side products; (b) simplified process flow sheets that show the origin of the emissions; (c) descriptions of process-integrated techniques and waste water/waste gas treatment at source including their performances;	The EMS for the Installation will cover the information in i.-iii where applicable. Details of the proposed process including chemical reactions and process-integrated techniques for wastewater and waste gas management is provided in section 4 of Supporting Statement (Document ref: AP3328SQ/APP/SS).	Yes
	ii.	information, as comprehensive as is reasonably possible, about the characteristics of the waste water streams, such as: (a) average values and variability of flow, pH, temperature, and conductivity; (b) average concentration and load values of relevant pollutants/parameters and their variability (e.g. COD/TOC, nitrogen species, phosphorus, metals, salts, specific organic compounds); (c) data on bioeliminability (e.g. BOD, BOD/COD ratio, Zahn-Wellens test, biological inhibition potential (e.g. nitrification))	• Wastewater management includes two separate wastewater treatment processes. The first involves the treatment of process condensate from the syngas plant, DAF waste, filtration waste and flare KO drum liquid in the biological treatment plant followed by recirculation to the raw water treatment plant. The second involves treatment of cooling water blowdown, DMW plant rejects and dewatering filtrate in the ETP followed by discharge via the NZT outfall to Tees Bay. • Discharges of treated effluent to the Tees Bay will be monitored in accordance with relevant BS EN monitoring standards if this option is pursued. • A Monitoring Plan will be in place to monitor discharges to water as per the relevant schedule in the Environmental Permit. This will be developed prior to the plant becoming operational and will be revised based on the outputs from commissioning.	Yes
	iii.	information, as comprehensive as is reasonably possible, about the characteristics of the waste gas streams, such as: (a) average values and variability of flow and temperature; (b) average concentration and load values of relevant pollutants/parameters and their variability (e.g. VOC, CO, NO_X, SO_X, chlorine, hydrogen chloride); (c) flammability, lower and higher explosive limits, reactivity; (d) presence of other substances that may affect the waste gas treatment system or plant safety (e.g. oxygen, nitrogen, water vapour, dust).	• Emissions points are detailed in Section 5 of the Supporting Statement (Document ref: AP3328SQ/APP/SS) and will be updated where changes occur as the Installation develops. • The flue gas from the site auxiliary boilers stacks will be monitored using MCERTS certified CEMs in accordance with EN 14181. • This system will continuously monitor NOx, CO and NH3 (associated with SCR use) for the auxiliary boilers. No provision has been made for SO2 or particulate monitoring as the fuel will be natural gas and H2 rich tail gas. O2, water, temperature and pressure will also be recorded. • CEMS will also be used to continuously monitor the emissions from the flares. • 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. 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.	Yes
3		**BAT 3 Monitoring** For relevant emissions to water as identified by the inventory of waste water streams (see BAT 2), BAT is to monitor key process parameters (including continuous monitoring of waste water flow, pH and temperature) at key locations (e.g. influent to pretreatment and influent to final treatment).	• Discharges of treated effluent to the Tees Bay will be monitored in accordance with relevant BS EN monitoring standards if this option is pursued. • A Monitoring Plan will be in place to monitor discharges to water as per the relevant schedule in the Environmental Permit. This will be developed prior to the plant becoming operational and will be revised based on the outputs from commissioning.	Yes
4		**BAT 4 Monitoring** BAT is to monitor emissions to water in accordance with EN standards with at least the minimum frequency given below. 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.	• Discharges of treated effluent to the Tees Bay will be monitored in accordance with relevant BS EN monitoring standards if this option is pursued. • A Monitoring Plan will be in place to monitor discharges to water as per the relevant schedule in the Environmental Permit. This will be developed prior to the plant becoming operational and will be revised based on the outputs from commissioning.	Yes
5		**BAT 5 Monitoring** BAT is to periodically monitor diffuse VOC emissions to air from relevant sources by using an appropriate combination of the techniques I-III or, where large amounts of VOC are handled, all of the techniques i-iii.		
	i.	sniffing methods (e.g. with portable instruments according to EN 15446) associated with correlation curves for key equipment;	• The site will implement an LDAR plan for the monitoring of diffuse emissions. The LDAR will be developed following completion of FEED and will be reviewed and maintained as part of the EMS.	Yes
	ii.	optical gas imaging methods;		
	iii.	calculation of emissions based on emissions factors, periodically validated (e.g. once every two years) by measurements.		

Bat No.		BATC Requirements	H2 Teesside	Operating to BAT
6		**BAT 6 Odour** BAT is to periodically monitor odour emissions from relevant sources in accordance with EN standards.	• The site will implement a LDAR plan for the monitoring of diffuse emissions. The LDAR will be developed following completion of FEED and will be reviewed and maintained as part of the EMS.	Yes
7		**BAT 7 Emissions to Water** In order to reduce the usage of water and the generation of waste water, BAT is to reduce the volume and/or pollutant load of waste water streams, to enhance the reuse of waste water within the production process and to recover and reuse raw materials.	• The anticipated raw water source will be from Northumbrian Water Ltd (NWL) raw water supply. • Raw water will be pre-treated prior to demineralisation in a raw water treatment plant which will include coagulation, flocculation, clarification, sludge dewatering, dissolved air flotation (DAF), ultrafiltration (UF) for removal of fine solids, and granulated activated carbon filtration. Further details are provided in Section 4.4 of the Supporting Statement (Document Reference: AP3328SQ-APP-SS). • Treated raw water will pass to the demineralisation plant which comprises two-stage reverse osmosis (RO) for the removal of ions and Electrodeionisation EDI. The exact treatment package will be confirmed during FEED. • The selected Hydrogen process has reduced freshwater consumption. • The opportunities for re-use and recovery of water within the process will be determined at FEED stage, but are anticipated to include: a. Steam system condensate through the demineralisation plant; b. Recovery of water from the effluent treatment plant; and c. Recovery of process condensate and flare knockout liquid through a bio-treatment plant. d. Segregation of different effluent streams – oily water, stormwater, and process effluents e. Consideration of Hybrid Cooling Towers – if those can meet other project criteria such as energy, economics & noise. f. Use of stormwater to reduce freshwater abstraction	Yes
8		**BAT 8 Wastewater Collection and Segregation** In order to prevent the contamination of uncontaminated water and to reduce emissions to water, BAT is to segregate uncontaminated waste water streams from waste water streams that require treatment.	**Surface Water** • A suitable surface water drainage network and management system will be provided to segregate uncontaminated surface waters from those that could be potentially contaminated. • The drainage network will provide appropriate interception, conveyance, treatment and attenuation of surface water run-off, including: a. Clean stormwater off will discharge to either the Tees Bay or Tees Estuary. b. Clean surface run-off will be collected in a SuDs drainage system and discharge to controlled waters. c. Surface run-off within main process equipment areas will be segregated from main 'clean' surface drainage areas using kerbs, bunds and sumps. Contaminated surface water will be directed to the onsite effluent treatment plant. d. Effluents collected in the carbon capture area of the plant will be collected in a separate carbon capture closed drainage system and fully segregated from other effluents. The closed drainage system facilitates sampling of this effluent stream so that undegraded solvent can be reused on the process and degrade solvent can be disposed via vacuum tanker for offsite disposal. **Process Wastewater** • Wastewater streams generated at the plant are anticipated to comprise process wastewater, cooling tower blowdown, demineralisation plant rejects, and sanitary effluent. • Wastewater management includes two separate wastewater treatment processes. The first involves the treatment of process condensate from the syngas plant, DAF waste, filtration waste and flare KO drum liquid in the biological treatment plant followed by recirculation to the raw water treatment plant. The second involves treatment of cooling water blowdown, DMW plant rejects and dewatering filtrate in the ETP followed by discharge via the NZT outfall to Tees Bay. • . • Direct discharges to the NZT outfall will meet the BAT-AELs specified in the BREF for Common Wastewater and Waste Gas Treatment and Management Systems in the Chemical Sector.	Yes
9		**BAT 9 Wastewater Collection and Segregation** In order to prevent uncontrolled emissions to water, BAT is to provide an appropriate buffer storage capacity for waste water incurred during other than normal operating conditions based on a risk assessment (taking into account e.g. the nature of the pollutant, the effects on further treatment, and the receiving environment), and to take appropriate further measures (e.g. control, treat, reuse).		

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10		**BAT 10 Wastewater Collection and Segregation** In order to reduce emissions to water, BAT is to use an integrated waste water management and treatment strategy that includes an appropriate combination of the techniques in the priority order given below. a. Process-integrated techniques b. Recovery of pollutants at source c. Wastewater pre-treatment d. Final wastewater treatment	• The opportunities for re-use and recovery of water within the process will be determined at FEED stage, but are anticipated to include: a. Steam system condensate through the demineralisation plant; b. Recovery of water from the effluent treatment plant; and c. Recovery of process condensate and flare knockout liquid through a bio-treatment plant. d. Segregation of different effluent streams – oily water, stormwater, and process effluents e. Consideration of Hybrid Cooling Towers – if those can meet other project criteria such as energy, economics & noise. f. Use of stormwater to reduce freshwater abstraction. • Wastewater management includes two separate wastewater treatment processes. The first involves the treatment of process condensate from the syngas plant, DAF waste, filtration waste and flare KO drum liquid in the biological treatment plant followed by recirculation to the raw water treatment plant. The second involves treatment of cooling water blowdown, DMW plant rejects and dewatering filtrate in the ETP followed by discharge via the NZT outfall to Tees Bay.	Yes
11		**BAT 11 BAT-AELS** In order to reduce emissions to water, BAT is to pretreat waste water that contains pollutants that cannot be dealt with adequately during final waste water treatment by using appropriate techniques.	• • Raw water feed is treated by coagulation, flocculation, clarification, dewatering, DAF, UF and GAC which removes solids from the process water streams.	Yes
12		**BAT 12 Wastewater Final Treatment** In order to reduce emissions to water, BAT is to use an appropriate combination of final waste water treatment techniques. ***Preliminary and Primary Treatment*** • Equalisation • Neutralisation • Physical separation ***Biological Treatment*** • Activated Sludge • Membrane Bioreactor ***Nitrogen Removal*** • Ntirification/denitrification ***Phosphorous Removal*** • Chemical precipitation ***Final Solids Removal*** • Coagulation and flocculation • Sedimentation • Filtration • Flotation	• Wastewater final treatment involves treatment of process effluent in the membrane bioreactor and ETP and discharge via the NZT outfall into Tees Bay. • The membrane bioreactor will receive feed water from the following: process condensate, DAF (Dissolved Air Flotation) waste, Filtration waste, and Flare Liquid KO Drum. The process is a biological treatment stage which initially involves an anoxic denitrification stage followed by an aerobic nitrification stage with the MBR product being recirculated back to the raw water feed tank. The overflow from the nitrification step is recycled back to anoxic denitrification for further treatment while the sludge from each stage is passed through a dewatering unit. The solid waste from dewatering is removed for third party waste disposal while the dewatered liquid is either passed back through the nitrification stage or to the ETP. • The cooling water blowdown, DMW plant rejects and dewatering filtrate is collected at the ETP feed tank. The water passes a media filtration stage which transfers backwash into the dewatering stage and final effluent to the NZT outfall for discharge to the Tees Bay. The solid waste from dewatering is removed for third party waste disposal while the dewatered liquid is either passed back through the nitrification stage or to the ETP. • If direct discharges to the NZT outfall is selected, then these will meet the BAT-AELs specified in the BREF for Common Wastewater and Waste Gas Treatment and Management Systems in the Chemical Sector.	
13		**BAT 13 Waste** In order to prevent or, where this is not practicable, to reduce the quantity of waste being sent for disposal, BAT is to set up and implement a waste management plan as part of the environmental management system (see BAT 1) that, in order of priority, ensures that waste is prevented, prepared for reuse, recycled or otherwise recovered.	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
14		**BAT 14 Waste**	• The anticipated waste streams from the pre-treatment of water include: a. Water treatment sludge from pre-treatment plant and	Yes

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		In order to reduce the volume of waste water sludge requiring further treatment or disposal, and to reduce its potential environmental impact, BAT is to use one or a combination of the techniques given below.		b. Bio-sludge from the membrane bioreactor and ETP. The above waste streams will be removed to a suitably licenced facility for treatment. • Liquid Effluent - rejects from the effluent treatment plant will be trucked to a suitable disposal facility or disposed of via pipeline.	
15		**BAT 15 Emissions to Air** In order to facilitate the recovery of compounds and the reduction of emissions to air, BAT is to enclose the emission sources and to treat the emissions, where possible.		A waste gas management strategy will be made as part of the EMS in order to reduce emissions to air. The main pollutants of concern from the process are NO_X and CO emissions The following techniques will be employed: • The fuel choice will be gaseous – natural gas and H_2 tail gas.. • H_2 production units will have Selective Catalytic Reduction ("SCR") technology installed to reduce the amount of NO_X released during normal operation of the auxiliary boilers (a "Secondary" technique according to BAT). The NO_x emissions predicted for the site are within the average BAT-AEL range. • Low NOx burners will be employed. • The Installation will be controlled and operated via a DCS to continuously monitor the operation of the plant and equipment at the site including monitoring and optimisation of key process parameters such as combustion control. • The operation of the Installation is not likely to produce emissions of dust and SO_x due to the fuels employed.	Yes
16		**BAT 16 Emissions to Air** In order to reduce emissions to air, BAT is to use an integrated waste gas management and treatment strategy that includes process-integrated and waste gas treatment techniques.			
17		**BAT 17 Flaring** In order to prevent emissions to air from flares, BAT is to use flaring only for safety reasons or non-routine operational conditions (e.g. start-ups, shutdowns) by using one or both of the techniques given below.		• The Installation will be equipped with a DCS with appropriate control loops, set points, alarms and shutdown initiators. The role of the DCS will be to dynamically control the system within its' operating envelope or regime. This will minimise the occurrence of any unsafe deviations and will function as second layer of protection. A well designed DCS will make the incidence of plant trips rare. The alarm and trip summary shall include a record of the setpoint for every alarm, trip and permissive shown on the P&ID • A flare system will be provided for each phase and will be designed with sufficient capacity for all normal, abnormal, and emergency operating conditions arising from Phase 1 and 2 combined. • The flares will be designed subject to planned preventative maintenance as described in the response to 3.2 in Table 4 above. • In operation the PSA hydrogen recovery will be optimised over the plant life to ensure that tail gas is not over-produced and be otherwise sent to flare • During normal operation, flaring of hydrogen will only be used for off-spec operational and emergency conditions. Otherwise, the flares will operate in pilot mode Outside of normal operation, flaring will be used during start-up and for plant performance testing. • Flare design will be finalised during FEED but will be designed, fabricated, and tested in accordance with appropriate standards (e.g., API standards or similar). • Procedures will be developed as part of the EMS for flare start-up, operations, shutdown, maintenance and cleaning and flare operation will be monitored and controlled via the DCS control system to ensure: a. combustion is optimised. b. key parameters such as gas flow, temperature and pressures are monitored; and c. operation is smokeless. • The flare ignition system will be specified with built in redundancy and will meet or exceed API 537 requirements for wind speed and rainfall so that the pilot remains lit in adverse environmental conditions. Pilot gas will be supplied from a third-party reliable gas supplier through piped connection and failure of pilot gas from the source is unlikely. • Flare flame detection will be through retractable thermocouples with redundancy and indications will be provided on the flare ignition panel showing pilot status, with loss of pilot alarms provided to alert operators. CEMs will be used to continuously monitor the emissions from the flare, any deviation from the expected emission concentrations would indicate some issue with the flare and the Operator will be expected to take required corrective action immediately. • Records will be maintained via the Business Planning and Control System including recording of flaring events (i.e., combustion of process gases), the estimated gas composition, the volume of gas combusted and the duration of the flaring event.	Yes
		Technique	**Description**		
		Correct plant design	This includes the provision of a gas recovery system with sufficient capacity and the use of high-integrity relief valves		
		Plant management	This includes balancing the fuel gas system and using advanced process control.		

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				• The plant commissioning procedures will be developed in accordance with the bp system handover management process (SHMP). The SHMP is a stage gated process from factory dispatch through to handover to Operations. The purpose of the process is to validate completion and the technical integrity, which has been designed into the plant by Engineering, is demonstratively delivered through Commissioning activities.	
18		**BAT 18** In order to reduce emissions to air from flares when flaring is unavoidable, BAT is to use one or both of the techniques given below.			Yes
		Technique	**Description**		
		Correct design of flaring devices	Optimisation of height, pressure, assistance by steam, air or gas, type of flare tips (either enclosed or shielded), etc., aimed to enable smokeless and reliable operation and to ensure the efficient combustion of excess gases.	• Flare design will be finalised during FEED but will be designed, fabricated, and tested in accordance with appropriate standards (e.g., API standards or similar). • Flare flame detection will be through retractable thermocouples with redundancy and indications will be provided on the flare ignition panel showing pilot status, with loss of pilot alarms provided to alert operators. CEMs will be used to continuously monitor the emissions from the flare, any deviation from the expected emission concentrations would indicate some issue with the flare and the Operator will be expected to take required corrective action immediately.	
		Monitoring and recording as part of flare management	Continuous monitoring of the gas sent to flaring, measurements of gas flow and estimations of other parameters (e.g. composition, heat content, ratio of assistance, velocity, purge gas flow rate, pollutant emissions (e.g. NOX, CO, hydrocarbons, noise)). The recording of flaring events usually includes the estimated/ measured flare gas composition, the estimated/ measured flare gas quantity and the duration of operation. The recording allows for the quantification of emissions and the potential prevention of future flaring events.		
19		**BAT 19 Diffuse VOC Emission** In order to prevent or, where that is not practicable, to reduce diffuse VOC emissions to air, BAT is to use a combination of the techniques given below. a. Limit the number of potential emission sources b. Maximise process-inherent containment features c. Select high-integrity equipment d. Facilitate maintenance activities by ensuring access to potentially leaky equipment e. Ensure well-defined and comprehensive procedures for plant/ equipment construction and assembly. This includes using the designed gasket stress for flanged joint assembly (see the de scription in Section 6.2) f. Ensure robust plant/equipment commissioning and handover procedures in line with the design requirements g. Ensure good maintenance and timely replacement of equipment h. Use a risk-based leak detection and repair (LDAR) programme (see the description in Section 6.2) i. As far as it is reasonable, prevent diffuse VOC emissions, collect them at source, and treat them		• While natural gas is not stored at site but is pumped from the grid the following has been included within the design of the transfer system: e) Gas pipeline length has been optimised and length minimised as far as practicable; f) Number of flanges and valves will be minimised; g) Welded fittings and connections will be used; h) High integrity equipment will be installed and maintained. • The site will implement a LDAR plan for the monitoring of diffuse emissions. The LDAR will be reviewed and maintained as part of the EMS. • The Installation will be subject to regular preventative maintenance cycles to ensure the efficiency of plant and equipment is maintained. 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 plant commissioning procedures will be developed in accordance with the bp system handover management process (SHMP). The SHMP is a stage gated process from factory dispatch through to handover to Operations. The purpose of the process is to validate completion and the technical integrity, which has been designed into the plant by Engineering, is demonstratively delivered through Commissioning activities.	Yes
20		**BAT 20 Odour** In order to prevent or, where that is not practicable, to reduce odour emissions, BAT is to set up, implement and regularly review an odour management plan, as part of the environmental management system (see BAT 1), that includes all of the following elements:			
	i.	a protocol containing appropriate actions and timelines;		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
	ii.	a protocol for conducting odour monitoring;			
	iii.	a protocol for response to identified odour incidents;			

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	iv.	an odour prevention and reduction programme designed to identify the source(s); to measure/estimate odour exposure; to characterise the contributions of the sources; and to implement prevention and/or reduction measures.		
21		**BAT 21 Odour from Wastewater** In order to prevent or, where that is not practicable, to reduce odour emissions from waste water collection and treatment and from sludge treatment, BAT is to use one or a combination of the techniques given below. a. Minimise residence times b. Chemical treatment c. Optimise aerobic treatment d. Enclosure e. End of pipe treatment	• Wastewater streams generated at the plant are anticipated to comprise process wastewater, cooling tower blowdown, demineralisation plant rejects, and sanitary effluent. • Wastewater management includes two separate wastewater treatment processes. The first involves the treatment of process condensate from the syngas plant, DAF waste, filtration waste and flare KO drum liquid in the biological treatment plant followed by recirculation to the raw water treatment plant. The second involves treatment of cooling water blowdown, DMW plant rejects and dewatering filtrate in the ETP followed by discharge via the NZT outfall to Tees Bay. • .	Yes
22		**BAT 22 Noise** In order to prevent or, where that is not practicable, to reduce noise emissions, BAT is to set up and implement a noise management plan, as part of the environmental management system (see BAT 1), that includes all of the following elements:		
	i.	a protocol containing appropriate actions and timelines;	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
	ii.	a protocol for conducting noise monitoring;		
	iii.	a protocol for response to identified noise incidents;		
	iv.	a noise prevention and reduction programme designed to identify the source(s), to measure/estimate noise exposure, to characterise the contributions of the sources and to implement prevention and/or reduction measures.		
23		**BAT 23** In order to prevent or, where that is not practicable, to reduce noise emissions, BAT is to use one or a combination of the techniques given below.		

5.0 CONCLUSION

5.1.1 On the basis of the assessment against the required BAT Conclusions, as shown in Sections 3 and 4, and in the principles to be applied in the design and integration of the Hydrogen Production and Carbon Capture plant, it is considered that the proposed Installation will be designed and operated in compliance with the BRef and BAT for common waste gas and common wastewater management and treatment.

6.0 REFERENCES

1. European Parliament and Council of European Union, 2023, Best Available Techniques (BAT) Reference Document for Common Waste Gas Management and Treatment Systems in the Chemical Sector.
2. European Parliament and Council of European Union, December 2022, Commission Implementing Decision EU 2022/2427 Establishing Best Available Techniques (BAT) Conclusions Under Directive 2010/75/EU for Common Waste Gas Management and Treatment Systems in the Chemical Sector.
3. European Parliament and Council of European Union, 2017. Best Available Techniques (BAT) Reference Document for Common Wastewater and Waste Gas Treatment/Management Systems in the Chemical Sector.
4. European Parliament and Council of European Union, May 2016, Commission Implementing Decision EU 2016/902 Establishing Best Available Techniques (BAT) Conclusions Under Directive 2010/75/EU for Common Wastewater and Waste Gas Treatment/Management Systems.