Immingham Green Energy Terminal Green Hydrogen Production Facility

EPR/VP3425SV/A001

Environmental Permit Application

Appendix D1 – Assessment of Best Available Techniques for Emissions

Environmental Permitting (England and Wales) Regulations 2016

Applicant: Air Products BR Ltd

May 2024

Environmental Permitting (England and Wales) Regulations 2016

Immingham Green Energy Terminal Green Hydrogen Production Facility

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Appendix D1 – Assessment of Best Available Techniques for Emissions

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Regulation Reference	EPR Regulations, Part 2, Chapter 1 R12
Environmental Permit Reference	EPR/VP3425SV/A001
Application Document Reference	VP3425SV/APP/BAT01
Author	Air Products (BR) Limited

Version	**Date**	**Status of Version**
Revision 1	22 March 2024	For Client Review
Revision 2	01 May 2024	Final Review
Issue 1	17 May 2024	Issue to Regulator

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1.0 INTRODUCTION

1.1. Purpose of the Report

1.1.1 This report has been prepared by AECOM Limited ('AECOM') on behalf of Air Products (BR) Limited ("the Operator" or AP) and provides an assessment of the emissions management and monitoring measures and techniques for the proposed Green Hydrogen (H_2) Production Facility (the 'installation'). The purpose of this report is to demonstrate that the proposed installation will be designed and operated in accordance with indicative Best Available Techniques (BAT) for related to achieving defined emission standards.

1.1.2 AECOM has prepared this BAT assessment using concept engineering information related to the 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 for Common Waste Gas Management and Treatment Systems in the Chemical Sector; and
- Best Available Techniques (BAT) Reference Document for Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector.

1.1.3 The main Supporting Statement provides an overall view of the Permit application being made for the proposed installation. In addition to this BAT assessment, additional BAT assessments have been prepared for, energy efficiency (Appendix D2), technology (Appendix D3) and Cooling (Appendix D4) recognising that the overall integration of these aspects will determine BAT for the overall proposed installation.

1.2. Proposed Installation Description

1.2.1 The proposed installation comprises the development of a green H_2 production facility which includes infrastructure for the offloading and transfer of green ammonia (NH_3) from ships to ammonia storage facilities, the main H_2 production facility and vehicle and trailer H_2 refuelling facilities.

1.2.2 The proposed installation will be located in North East Lincolnshire on the south bank of the Humber Estuary on the eastern side of the Port of Immingham. The installation location will be approximately centred on National Grid Reference (NGR) E520783 N415271.

1.2.3 The environmental permit application is therefore for an H_2 production facility which comprises the following within the installation boundary:

- NH_3 ship offloading infrastructure to facilitate the receipt of NH_3 for H_2 production. The offloading infrastructure will be located on a new jetty

being constructed by Associated British Ports (ABP). Only the offloading infrastructure is incorporated in the application and the jetty itself remains outside the installation boundary.

- NH_3 transfer pipeline which links the ship offloading infrastructure with the NH_3 storage tanks located on the east site.
- East site which comprises:
  - (a) a NH_3 storage tank and related plant including an NH_3 tank flare stack and boil-off gas compression system to liquefy the generated boil-off gas during offloading from Ship and static boil-off from Ammonia Tank.
  - (b) H_2 production facility comprising up to three H_2 production units including associated flue gas and flare stacks.
  - (c) Power distribution buildings for NH_3 and H_2 production plant.
  - (d) Instrumentation buildings for NH_3 and H_2 processes.
  - (e) Analyser shelters for the H_2 production plant.
  - (f) Pipe-racks, pipelines, pipes, utilities and other infrastructure associated with both NH_3 and H_2 equipment.
  - (g) Welfare facility.
- West site which comprises:
  - (a) H_2 production facility comprising up to three H_2 production units including associated flue gas and flare stacks.
  - (b) Up to four liquefier units.
  - (c) H_2 storage tanks.
  - (d) H_2 trailer filling stations.
  - (e) H_2 vent stack and associated process equipment.
  - (f) H_2 vehicle and trailer filling stations.
  - (g) H_2 compressors and associated process equipment.
  - (h) Control room and workshop building.
  - (i) Security and visitor building.
  - (j) Contractor building.
  - (k) Warehouse.
  - (l) Driver administration building.
  - (m) Safe haven building.
  - (n) Electrical substation and metering station.
  - (o) Power distribution buildings.
  - (p) Process instrumentation buildings.
  - (q) Analyser buildings.
  - (r) Process and utility plant including cooling towers and pumps, fire water tank, instrument air equipment, pipe racks, pipelines, pipes, cable racks, utilities and other infrastructure nitrogen generation package (HPN) with LIN Tank and LIN Vaporizers and steam generation package.
- Pipeline corridor for underground pipelines, pipes, cables and other conducting media for the transfer of NH_3, H_2, nitrogen (N_2) and utilities, with cathodic protection against saline corrosion.

1.2.4 With regards to emissions associated with the process, these are detailed in full in section 5, of the Supporting Statement (document ref: VP3425SV/APP/SS) and include:

- Point source releases to air from Reformer flue gas stacks (x6), H_2 Production Unit (HPU) Flares and pilots (x6), NH_3 storage flare and pilot and H_2 vent stack;
- Point source release of uncontaminated surface water to the ditch network around the site which eventually discharges to the Humber Estuary; and
- Point source release to sewer of process blowdown and condensate waters.

2.0 BEST AVAILABLE TECHNIQUES

2.1. Definition of Best Available Techniques

2.1.1 The Industrial Emissions Directive (2010/75/EU) defines BAT as "the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and where that is not practicable, generally reduce emission and the impact on the environment as a whole".

2.1.2 The Directive continues to provide further definition as follows:

- "available techniques" are those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the cost and advantages, whether or not the techniques are used or produced inside the United Kingdom, as long as they are reasonably accessible to the Operator.

- "best techniques" are the most effective in achieving a high general level of protection of the environment as a whole.

- "techniques" are both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned.

2.1.3 BAT may be demonstrated by either:

- Compliance with the sector-level, indicative BAT performance such as Sector Guidance Notes provided by the Environment Agency or in the European Commission 'Reference Documents on BAT' (BREFs) and their associated BAT conclusions; or

- By conducting an installation-specific, options appraisal of candidate techniques.

2.1.4 The indicative BAT provided in the European BREF/BAT Conclusion documents is based on an analysis of the costs and typical benefits for typical, or representative, plants within that sector. When assessing the applicability of the sectoral, indicative BAT standards at the installation level, departures may be justified on the grounds of the technical characteristics of the installation concerned, its geographical location and the local environment.

2.2. BAT for the Installation

2.2.1 The development of the H_2 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.

2.2.2 At this stage of project development, the Jetty and Pipelines, Ammonia storage tank and associated utilities are on east site, FEED is complete for other part of the installation, 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 cycle and catalysis;
- To allow the FEED process to progress without limiting options for later technology optimisations;
- 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.

2.2.3 The techniques described in this report and the associated BAT assessments are therefore based on the currently anticipated approaches to optimising H_2 production and its associated emissions management requirements.

2.2.4 A number of BAT reference documents were confirmed as applicable during pre-application discussions with the Environment Agency covering the process and technology related to H_2 production at Immingham Green Energy Terminal. This section provides an overview of each relevant guidance document associated with emissions and their management, followed by an assessment against the BAT conclusions in tabulated form in the subsequent sections.

BREF and BAT Conclusion for Common Waste Gas Management and Treatment Systems in the Chemical Sector

2.2.5 Common Waste Gas Management and Treatment Systems in the Chemical Sector is the appropriate BAT for detailing gas management and treatment at the proposed installation. BAT conclusions are presented, and approaches justified in section 3 below.

BREF and BAT Conclusion for Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector

2.2.6 Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector is also appropriate for the operation of the installation and the subsequent release of both waste water and gas. BAT conclusions are presented, and approaches justified in section 4 below.

2.3. Conclusions

2.3.1 On the basis of the assessment against the required BAT Conclusions for process and Technology, as shown in Sections 3 and 4, it is considered that

the proposed installation will be designed and operated in accordance with BAT.

3.0 BAT CONCLUSIONS FOR GASEOUS EMISSIONS – COMMON WASTE GAS MANAGEMENT AND TREATMENT

Table 3.1 BAT Assessment Against BREF for Common Waste Gas Management and Treatment Systems in the Chemical Sector

Bat Reference		BATC Requirements	Demonstration of BAT - Operator Response	Operating to BAT?
1		**BAT 1** 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;	The proposed facility will be operated under the BS EN ISO14001:2015 accredited EMS. The AP EMS will comprise: • an environmental policy and other relevant management documents which will set out environmental objectives and KPIs in line with their global standards. • The annual establishment of objectives and targets where performance will be monitored in accordance with defined Key Performance Indicators (KPIs) which will be set once the plant is commissioned and is fully operational. • The site-specific procedures which will define the roles and responsibilities for applicable 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. The installation will undergo regular auditing to ensure it meets standards set internally and by the industry, reviewing and taking corrective action where necessary. The management structure is set out in section 4.2 of the Supporting Statement (Document ref: VP3425SV/APP/SS). Management roles are clearly defined, and responsibilities set out with appropriate training given. All members of staff hired at the facility will have relevant training and experience to their role depending on their job level (see Table 4-1 in the management section of the Supporting Statement). Training will be given in line with the job descriptions given to members of staff which outline the key accountabilities, skills and competencies required. Training given and competencies achieved will be recorded. In addition to general environmental awareness training, specific training will be provided to relevant staff, which will include: • the regulatory requirements associated with the Permit as they affect work activities and responsibilities; • likely potential environmental impacts which may be caused by plant under their control during normal and abnormal circumstances; • reporting procedures to inform supervisors or managers of deviations from permit conditions; • procedures to be used by supervisors or managers for the reporting of deviations from permit conditions to the Agency; and • prevention of accidental emissions and action to be taken when accidental emissions occur. Contractors will be required to undergo formal EH&S training before they are allowed to commence work at the Installation and will be expected to provide the necessary evidence to demonstrate their competence for the scope of work being undertaken.	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;		

Bat Reference		BATC Requirements	Demonstration of BAT - Operator Response	Operating to BAT?
			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 AP incident tracking system As part of the on-site reporting requirements defined in the site major emergency plan, Air Products 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. See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS).	
	xi.	effective operational planning and process control;	Operating procedures will be in line with AP's global standards and Environment, Health, Safety and Quality (EHS&Q) issues are included. The Installation will be controlled and operated via a Basic Process Control System (BPCS) 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 BPCS 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: VP3425SV/APP/SS).	Yes
	xii.	implementation of appropriate maintenance programmes;	There will be yearly planned outages for maintenance including an annual outage of about a week for inspections and minor maintenance. The H_2 production unit maintenance is anticipated every 2 years for catalyst replenishment & every 4 years for a major turnaround. LHY has a 3 year minor turnaround. See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS).	Yes
	xiii.	emergency preparedness and response protocols, including the prevention and/or mitigation of the adverse (environmental) impacts of emergency situations;	AP 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. The following maintenance techniques are used to provide early detection of impending faults or conditions likely to compromise Safety, Environmental Containment or Production: • a portable vibration data collection and analysis package can be used to collect machine-operating data and to evaluate rotating machinery; • electric motor performance is also monitored; • leak detection and repair • ultrasonic testing can be used to monitor valve systems for leakage by detecting stem & flange leakage on gaseous duty, and valve passing on both liquid and gaseous systems; and • emergency response equipment is serviced and maintained in accordance with requirements defined in the site major emergency procedure. Details of the maintenance tasks and compliance are available on-site via the maintenance System. See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS).	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,	Yes

Bat Reference		BATC Requirements	Demonstration of BAT - Operator Response	Operating to BAT?
			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. See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS), Risk Assessment Report, Noise and Air Quality Assessments of the ES - REF Section 7.4 Impact Assessment of the Supporting Statement (Document ref: VP3425SV/APP/SS).	
	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;	The continuous emissions monitoring system (CEMS) will relay real-time emission data to the operator consoles. This data will also be relayed to the plant SCADA system where monitored emission level alarms are set at agreed levels. See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS).	Yes
	xvi.	application of sectoral benchmarking on a regular basis;	As a first-of-a-kind project, there are no defined sectoral benchmarks for the proposed installation as a whole. It is expected that benchmarks for operational parameters will be developed during commissioning and ongoing operation in consultation and agreement with the Regulator. In the design and development of the installation industry standards will be followed where applicable. The plant design will maintain consistency with relevant national and international standards. Regular auditing ensures the appropriate procedures are implemented and maintained and relevant changes made accordingly. See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS).	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;	Internal operating procedures used to manage the environmental performance will be subject to an auditing programme. This is to ensure the management system is being implemented in accordance with the defined written procedures and is appropriate, effective and meets all relevant legislative and good practice standards. It also gives a general assessment of the environmental performance to identify areas of improvement. Independent EH&S and Quality audits will be carried out by the European EH&S Department (and AP's Corporate Auditors to verify compliance with statutory requirements and established company standards and procedures. The audit frequency will be based on the risk factors for the site. An annual audit plan will be prepared by the European EH&S Department and after approval by management is implemented. See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS).	
	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;	Outputs from the monitoring and review of the management system will be fed back for action as part of the site, business area or worldwide EH&S action plans as appropriate. The outcome of the audits will be formally recorded, together with recommendations for action, in a formal audit report that will be made available to various levels of management, starting with the IGET H_2 Production Facility supervisor and the UK Plant Operations Manager within the group. All corrective actions will be tracked until closure by the European EH&S department. The results of audits will be analysed by the EHS and Q Assurance Manager and published on a quarterly basis to management. It will highlight any trends that may require further action. See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS).	Yes
	xix.	periodic review, by senior management, of the EMS and its continuing suitability, adequacy and effectiveness;	The overall status of the EH&S management will be reviewed at the EH&S Committee and documented with appropriate actions agreed at site level.	

Bat Reference		BATC Requirements	Demonstration of BAT - Operator Response	Operating to BAT?
			The UK Plant Operations Manager will review the performance of the facility with the Plant Supervisor and will provide information on this review at the Operations Organisation's Management Review at European level. Monthly key performance indicators will be reported which include environmental and safety items. The overall organisation EH&S performance will be reviewed by the UK EH&S Incident review committee and at senior Operations management meetings. and . The EHS Director will review performance with the President and report monthly. As a result of these reviews, EH&S Action Plans will be formulated or adjusted as required. Air Products will keep a record of all samples, measurements, tests, surveys, analyses, maintenance, calibration and examinations taken or carried out at the facility. The records will be kept in a manner, place and form approved by the Environment Agency, and will be available for inspection by the Environment Agency at any reasonable time. Records will be maintained for four years unless statutory requirements require a longer retention period. See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS).	
	xx.	following and taking into account the development of cleaner techniques.	The new installation is itself a cleaner technology, supporting the decarbonization of industrial activities to assist in the UK's transition towards net zero. The first set of crackers will be the first industrial implementation of this innovative technology, and learnings and developments in better operation will be used in the subsequent versions.	
		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);	AP 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 Management Section (Section 4) and Impact Assessment (Section 7.4) of Supporting Statement (Document ref: VP3425SV/APP/SS).	Yes
	xxii.	an OTNOC management plan for emissions to air (see BAT 3);	An OTNOC management plan will be produced by AP for the site and will be in place before commissioning	Yes
	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);	See response to BAT 19	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 by NELC 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. See Appendix C of the Supporting Statement (Document ref: VP3425SV/APP/SS). Section 3.5 – Raw Materials of the Supporting Statement (Document ref: VP3425SV/APP/SS).	Yes
2		**BAT 2** 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:		

Bat Reference		BATC Requirements	Demonstration of BAT - Operator Response	Operating to BAT?
	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. See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/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, NO_X, SO_X, Cl_2, 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 and plotted on Figures 4a and 4b in Appendix A of the Supporting Statement (Document ref: VP3425SV/APP/SS) and will be updated where changes occur as the installation develops Air emissions from the flue gas stack will be monitored using a continuous emissions monitoring system (CEMS) certified to MCerts or equivalent standard and will relay real time emissions data. Alarms will be set to agreed levels to trigger before emissions limit value is approached. The flue gas stack is the only continuous source of emissions to air at the facility. Systems which have the possibility to contain ammonia are sent to flare. This includes the storage area and the hydrogen production unit. Air emissions from flare and vent systems will be measured for temperature and pressure . The guarantee of ammonia destruction efficiency from vendors is 98%. Ammonia flare systems are also equipped with 'assist gas', which ensures the complete combustion of ammonia. Hydrogen emissions to air that are not flared, but vented directly to the atmosphere at safe location. It is expected that the hydrogen will ignite due to its' low ignition energy. Safety analysis for the height of the vent stack include the radiation from the hydrogen jet flame. The hydrogen vent systems are continuously purged with nitrogen on a continuous basis to make them oxygen free. Venting of liquid cryogenic hydrogen is prevented by the use of ambient vaporisers, which warm the liquid to a temperature higher than the liquefaction temperature of air. This prevents the formation of an oxygen rich liquid forming at the vent stack tip. This case can only be bypassed for the final layer of protection for the liquid hydrogen tanks, whereby the final relief valve and bursting disc flow is too large to travel through the ambient vaporisers and the liquid is sent directly to the vent stack. Techniques used to prevent and reduce emissions to air at the installation include 'low NOx burner design, stack heights to encourage dispersion and Selective Catalytic Reduction (SCR) technology to reduce NO_x release from the H_2 production units. See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS). See Impact Assessment (section 7) of Supporting Statement (Document ref: VP3425SV/APP/SS). Appendix A Figure 3 Emissions Points	
	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: • physical state; • vapour pressure of the substance(s) in the liquid, pressure of the gas; • temperature; • composition (by weight for liquids or by volume for gases);	Diffuse emissions to air have been identified as potential leaks and/or accidents across the installation from any of the gases used at the site both stored and within the process, including natural gas. These are detailed in Section 5 of the Supporting Statement (Document ref: VP3425SV/APP/SS). Accident and emergency response procedures within the EMS will cover what happens at the site if fugitive emissions are released. Characteristics of raw materials used at the site will be covered in a raw materials list. To control fugitive emissions, a leak detection management system will be in place so leaks can be identified and repaired quickly. A preventative maintenance programme will be implemented to maintain efficiency of the installation and prevent or minimise emissions. Preventative maintenance includes testing, inspection and monitoring of equipment including leak detection and repair.	

Bat Reference		BATC Requirements	Demonstration of BAT - Operator Response	Operating to BAT?
		• 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).	Ultrasonic testing will be used to monitor valve systems for leakage by detecting stem & flange leakage on gaseous duty, and valve passing on both liquid and gaseous systems. The facility contains cryogenic liquids. In the ammonia storage tank and up to the HPU contain liquid ammonia. The liquefier, storage tanks and trailer loading all contain liquid hydrogen. We only ever expect emissions to air to be gaseous. The cryogenic hydrogen is processed before being vented to atmosphere. See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS). See Impact Assessment (section 7) of Supporting Statement (Document ref: VP3425SV/APP/SS). See Qualitative Environmental Risk Assessment (Appendix I)	
3		**BAT 3** 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;	Emergency scenarios, their causes and consequences are within the Environmental Risk Assessment Report. Section 4 of the report also details the control measures that prevent occurrence, including the design of the equipment, and the emergency measure that will be taken. General OTNOC conditions include commissioning, process upsets and trips/unplanned shutdowns.	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.);	Examples of appropriate design include, but are not limited to, the following: • Secondary containment of the ammonia storage tank, designed to industry best standards, to minimise the risk of ammonia release/leak • Although not generally considered flammable (due to narrow range of flammability) ammonia will be routed to a flare system for safe disposal in the event of a process upset. Natural gas systems will also be routed to a flare for safe disposal. • In the event of a process upset, H_2 would be routed to a vent system for disposal. The vent system will be designed to safety vent hydrogen in accordance with EIGA 06/19 Flaring events are envisaged only during emergency, process upset and some operating transitions, start-up, or shutdown, with no flaring continuously during normal operation of the HPU and ammonia tank. The flare ignition system has been 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. However, if the pilot gas becomes unavailable, the HPU safe shutdown will be initiated. It will not be possible to operate the ammonia tank flare if pilot gas is not available so whilst boil of gas can be recovered via the boil off gas recovery system in this situation if this is not operating ammonia boil will be emitted. Flare flame detection will be through retractable thermocouples with redundancy and indications will be provided on the flare ignition panel show pilot status, with loss of pilot alarms provided to alert operators. CEMS will be used to continuously monitor the emissions from the HPU flare, any deviation from the expected emission concentrations would indicate some issue with the flare and Operator will be expected to take required corrective action immediately. Each HPU will have a dedicated flare and normally flare planned maintenance would be coupled with the HPU turnaround, however in the event of an unplanned maintenance of the flare due to malfunction, the respective HPU will be safely shutdown. • Selective Catalytic Reduction is used on the flue gas stack to reduce the emissions of NOx to the atmosphere. The system is designed with two separate layers of catalyst with a static mixer in between. Catalyst deactivation	

Bat Reference		BATC Requirements	Demonstration of BAT - Operator Response	Operating to BAT?
			and degradation will be monitored and periodically replaced in order to ensure that the NO_x emissions limits are met. An Installation pre commissioning, commissioning and start-up safety plan will be agreed prior to commissioning. Risk Assessment Report Section 4 Abnormal Operations, Accident & Fire Risk	
	iii.	set-up and implementation of a preventive maintenance plan for critical equipment (see BAT 1 xii.);	A planned maintenance programme will be implemented that specifies how plant / equipment will be assessed to determine their maintenance criticality and the nature and frequency of maintenance requirements. Regular checks and formal inspections of static items such as tanks, pipework, retaining walls, bunds and ducts will be undertaken. The Planned Inspection and Maintenance procedure will be in place and require that all EHS&Q critical items are covered. The maintenance objectives for the plant are as follows: • to maintain the integrity and efficiency of the facility so as to prevent or, where not possible, minimise emissions, incidents, accidents and process upsets; and, • to undertake all maintenance tasks safely, economically and with no, or minimum, environmental impact. The European wide reliability-based maintenance management system (SAP) will be used for controlling the maintenance of the IGET H_2 Production Facility, and will be controlled centrally by the European Maintenance Manager to ensure an appropriate maintenance programme is developed and applied to each asset. The objective of this approach is to avoid breakdown maintenance and avoid unnecessary preventative maintenance. At a local level, the Plant Supervisor will be responsible for the maintenance of the facility under his control. The maintenance philosophy will be embodied in a computerised preventive maintenance system that requires each plant to perform a programme of tasks at predetermined frequencies and submit feedback reports at regular intervals. The preventive maintenance system incorporates and schedules the following activities: • equipment condition monitoring; • periodic inspection and testing of systems; • functional testing of all safety devices; • inspection and testing of devices according to company standards and the relevant Codes of Practice; and, • relevant Air Products documents for the Periodic Inspection and Test (PI&T) programme relevant to the plant are included in the operational procedures. The following maintenance techniques will be used to provide early detection of impending faults or conditions likely to compromise Safety, Environmental Containment or Production: • a portable vibration data collection and analysis package can be used to collect machine-operating data and to evaluate rotating machinery; • electric motor performance; • leak detection and repair; • ultrasonic testing can be used to monitor valve systems for leakage by detecting stem & flange leakage on gaseous duty, and valve passing on both liquid and gaseous systems; and, • emergency response equipment is serviced and maintained in accordance with requirements defined in the site major emergency procedure. Details of the maintenance tasks and compliance are available on-site via the SAP System. See maintenance in Management Techniques section (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS)	Yes

Bat Reference		BATC Requirements	Demonstration of BAT - Operator Response	Operating to BAT?
	iv.	monitoring (i.e. estimating or, where this is possible, measuring) and recording of emissions and associated circumstances during OTNOC;	Control systems to be installed to continuously monitor process parameters including pressure and temperature including during OTNOC, including the CEMS analyser on the flue gas stack. See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS). Environmental Risk Assessment Report Section 3 Assessment of Accident Risks	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;	The installation will be subject to periodic review and will be reviewed in light of any environmental accidents, incidents, near misses and identified potential scenarios. Where appropriate for certain incidents and near misses a detailed root cause analysis report will be carried out and lessons learn will be communicated to line management and facility personnel. Accidents/incidents and non-conformance of the Management Techniques (section 4) of the Supporting Statement (Document ref: VP3425SV/APP/SS).	Yes
	vi.	regular review and update of the list of identified OTNOC under point i. following the periodic assessment of point v.;	The accidents, incidents, near misses and potential scenarios identified following periodic inspection will be used to update the list of identified OTNOC to ensure future preparedness. Accidents/incidents and non-conformance of the Management Techniques (section 4) of the Supporting Statement (Document ref: VP3425SV/APP/SS).	Yes
	vii.	regular testing of backup systems.	Emergency response equipment is serviced and maintained in accordance with requirements defined in the site major emergency procedure. The backup generator will be tested throughout the year. The backup generator will not be for the purpose of the boil off gas which will result in the use of the flare in as emergency back up on the east site ammonia tank area. See Maintenance within Management Techniques (section 4) of the Supporting Statement (Document ref: VP3425SV/APP/SS)	Yes
4		**BAT 4** 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 made as part of the EMS in order to reduce emissions to air. This includes minimising losses by use of an integrated control logic. Off-gas is used within the process, this process means that ammonia does not reach the flue gas stack. To be produced prior to commissioning.	Yes
5		**BAT 5** 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.	Various gasses are being flared at different parts of the site (reformer box top/flue gas stacks, HPU flare and ammonia storage flare) and due to the phased nature of development at the Immingham terminal, the HPU flares cannot be combined. Inside the HPU unit, the off-gas stream of hydrogen and ammonia that cannot be recovered is combined with the flue gas stream and emitted from a single stack. For the liquefier, it is a channelled emission to air in the form of a vent - due to hydraulic backpressure concerns caused by the distance between the liquefier unit and the storage and trailer loading area, two separate vent systems will be employed.	N/A
6		**BAT 6** 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	The installation has been designed, as far as possible, to avoid and minimise impacts and effects through the embedding mitigation measures into the design.	Yes

Bat Reference		BATC Requirements	Demonstration of BAT - Operator Response	Operating to BAT?
		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.	Channelled emissions to air will be minimised through optimisation of stack heights and placement to encourage optimal dispersion. Detailed modelling has been undertaken to take into consideration pollutant concentrations using worst case scenarios. The Installation will be controlled and operated via a BPCS 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 BPCS to allow the operator to take action to avoid a breach of permitted emission levels. In terms of NOx control the process also utilises SCR. The SCR catalyst will be monitored for degradation and rotated and changed out part of regular, planned maintenance. The hydrogen process overview is in section 3.2 of the Supporting Statement (Document ref: VP3425SV/APP/SS). Impact assessment (section 7) and Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS)	
7		**BAT 7** 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 Installation will be controlled and operated via a BPCS to continuously monitor the operation of the plant and equipment at the site including key process parameters such as flue gas flow, temperatures and pressures. Any non-conformance or deviation in normal operating parameters will be identified by the BPCS to allow the operator to take action to avoid a breach of permitted emission levels	Yes
8		**BAT 8** 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 site will monitor as follows: • NH_3 emissions to air monitored against EN 21877 standards every 6 months in accordance with BAT 17. • NO_x emissions monitoring will be monitored against EN 14792 as the emission rate is < 2.5 kg/h and monitoring will take place once every 6 months. • CO emissions will be monitored in accordance with EN 15058. as the emission is < 2 kg/h and monitoring will be every 6 months. Monitoring plan will be developed in accordance with the permit requirements.	Yes
9		**BAT 9** 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** 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 H2 tail gas from the process as a supplementary/replacement fuel for natural gas.	Yes
11		**BAT 11** 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**	No channelled emissions of PCDD/F compounds although the process will use SCR for NOx control.	N/A

Bat Reference		BATC Requirements	Demonstration of BAT - Operator Response	Operating to BAT?
		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.		
13		**BAT 13** 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 and/or H2 tail gas as a fuel which due to fuel composition is not expected to generate dust and particulate bound metals in the waste gas.	N/A
14		**BAT 14** 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 and/or H2 tail gas as a fuel which due to fuel composition is not expected to generate dust and particulate bound metals in the waste gas.	N/A
15		**BAT 15** 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 and/or H2 tail gas as a fuel which due to fuel composition is not expected to generate inorganic compounds in the waste gas.	N/A
16		**BAT 16** In order to reduce channelled emissions to air of CO, NO_X and SO_X from thermal treatment, BAT is to use technique c. and one or a combination of the other techniques given below.	There is a potential for NOx and CO from the process and the site will employ: • Use of natural gas and/or H_2 tail gas as a fuel • Low NOx burners for systems heating • Selective catalytic reduction (SCR) • Optimised process control. The process emissions of NOx will meet the BAT-AELs	Yes
17		**BAT 17** 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 NO_X emissions (ammonia slip), BAT is to optimise the design and/or operation of SCR or SNCR (e.g. optimised reagent to NO_X ratio, homogeneous reagent distribution and optimum size of the reagent drops).	The onshore hydrogen production units will be fuelled initially by natural gas. The main pollutant of concern from this is the NO_X emissions from the combustion of the gases used for heating the furnace. The H_2 production units will have continuous Selective Catalytic Reduction (“SCR”) technology installed to reduce the amount of NO_X released. The SCR is a two-stage system with a static mixer in between. This ensures good mixing and therefore better NOx reduction. NH_3 emissions are as a result of NH3 slip through the SCR system and therefore very high NO_x may occasionally see a slightly higher NH_3 slip The process emissions of NH_3 will not exceed the BAT-AEL of 8 mg/nm^3. The Installation will be controlled and operated via a BPCS to continuously monitor the operation of the plant and equipment at the site including monitoring and optimisation of key process parameters such as reagent to NOx ratio, reagent distribution and reagent drop size. Section 3.2 (Process Overview) and 6.3 (Emissions to Air) of the Supporting Statement (Document ref: VP3425SV/APP/SS). Air Quality chapter of the ES (Appendix E of Supporting Statement) (Document ref: VP3425SV/APP/SS). The installation will meet BAT AELs set in BAT 17 as these are most appropriate for the site (Document ref: VP3425SV/APP/SS).	Yes
18		**BAT 18** 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	See responses to BAT 16 and BAT 17 above.	Yes

Bat Reference		BATC Requirements	Demonstration of BAT - Operator Response	Operating to BAT?
		non-catalytic reduction (SNCR) for the abatement of NO_X emissions), channelled emissions to air of CO, NO_X and SO_X from the use of thermal treatment, and channelled emissions to air of NO_X from process furnaces/heaters, BAT is to use one or a combination of the techniques given.		
19		**BAT 19 – 22** Monitoring and management of diffuse/Fugitive VOC Emissions from solvents	Solvents and natural gas are not stored at the installation.	N/A
23		**BAT 23** 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.	While natural gas is not stored at site but is imported from the grid the following has been included within the design of the transfer system: • Gas pipeline length has been optimised and length minimised as far as practicable; • Number of flanges and valves will be minimised; • Welded fittings and connections will be used; • High integrity equipment will be installed and maintained.	Yes
24		**BAT 24 - 25** BAT associated with the production of polyolefin products	No polyolefin products produced by the installation.	N/A
26		**BAT 26 - 30** 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** 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** BAT associated with the production of viscose	Not applicable- the production of viscose using CS_2 does not take place at the installation.	N/A
36		**BAT 36** In order to prevent or, where that is not practicable, to reduce channelled emissions to air of CO, dust, NO_X and SO_X, BAT is to use technique c. and one or a combination of the other techniques given below.	The H_2 production units will be fuelled initially by natural gas supplemented with H_2 tail gas. The main pollutants of concern from this is the NO_X and CO emissions from the combustion of the gases. The following techniques will be employed: • The fuel choice will be gaseous – natural gas, tail gas containing H_2 and ammonia and in the future potentially H_2 gas from production. • H_2 production units will have Selective Catalytic Reduction (“SCR”) technology installed to reduce the amount of NO_X released (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 BPCS 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.	Yes

Bat Reference		BATC Requirements	Demonstration of BAT - Operator Response	Operating to BAT?
			• The operation of the installation is not likely to produce emissions of dust and SO_x due to the fuels employed. See Proposed Emissions- Emissions to Air (section 5.2) in Supporting Statement (Document ref: VP3425SV/APP/SS).	

4.0 BAT CONCLUSIONS FOR GASEOUS AND WASTEWATER EMISSIONS - COMMON WASTEWATER AND WASTE GAS TREATMENT/MANAGEMENT

Table 4.1 BAT Assessment Against BREF for Common Waste Gas Management and Treatment Systems in the Chemical Sector

Bat No.		BATC Requirements	Demonstration of BAT – Operator Response	Operating to BAT
1		**BAT 1** In order to improve the overall environmental performance, BAT is to implement and adhere to an environmental management system (EMS) that incorporates all of the following features:		
	i.	commitment of the management, including senior management;	The management structure is set out in section 4.2 of the Supporting Statement (Document ref: VP3425SV/APP/SS). Management roles are clearly defined, and responsibilities set out with appropriate training given with regards to the environmental management of the site.	Yes
	ii.	an environmental policy that includes the continuous improvement of the installation by the management;	AP's environmental, health and safety policy defines broad principles for environmental, health and safety performance. This EH&S policy is built upon underlying core EH&S values, or beliefs that are an integral part of the corporate culture, and it: • contains a commitment to continual improvement and prevention of pollution; and, • includes a commitment to comply with relevant legislation and other requirements to which the organisation subscribes. The policy shall be reviewed regularly and amended where considered necessary. The Chief Executive Officer signs this policy.	Yes
	iii.	planning and establishing the necessary procedures, objectives and targets, in conjunction with financial planning and investment;	Air Products has a formal management programme which identifies, sets, monitors and reviews environmental objectives and targets and key performance indicators independently of the permit. These will be in line with financial planning and investment and will be defined as the installation develops further. See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS).	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;	Procedures will be developed prior to commissioning in line with the categories provided in iv.	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;	The requirements associated with monitoring of performance and taking corrective will be defined within the EMS and includes: • Use of a BPCS system to monitor and control key parameters for all processes including but not limited to those associated with emissions monitoring and control. • Defined procedure for identifying, reporting, investigating and recording non-conformances and corrective/preventative action required to be taken. • Document control procedures which define the requirements and retention timeframes associated with the management and maintenance of records. The procedures used to manage the environmental performance of the installation will also be subject to an auditing programme. This programme will ensure that the following objectives are attained: • identification that the management system is being implemented in accordance with the defined written procedures;	Yes

Bat No.		BATC Requirements	Demonstration of BAT – Operator Response	Operating to BAT
			• the management system including written procedures is appropriate, effective and meets all relevant legislative and good practice standards; and, • a general assessment of environmental performance is made and identification of areas for improvement is carried out. See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS).	
	vi.	review of the EMS and its continuing suitability, adequacy and effectiveness by senior management;	Feedback from the auditing of the EMS discussed in v. will be reviewed by management to ensure its suitability, adequacy and effectiveness for the installation and changes/improvements to the EMS made where necessary action needs to be taken. See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS).	Yes
	vii.	following the development of cleaner technologies;	The new installation is itself a cleaner technology, 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 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. See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS), Risk Assessment Report, Noise and Air Quality Assessments of the ES Section 7.4 Impact Assessment of the Supporting Statement (Document ref: VP3425SV/APP/SS).	Yes
	ix.	application of sectoral benchmarking on a regular basis;	As a first-of-a-kind project, there are no defined sectoral benchmarks for the proposed installation as a whole. It is expected that benchmarks for operational parameters will be developed during commissioning and ongoing operation in consultation and agreement with the Regulator. In the design and development of the installation industry standards will be followed where applicable. It is AP's current policy to maintain consistency with relevant national and international standards. Regular auditing ensures the appropriate procedures are implemented and maintained and relevant changes made accordingly. See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS).	Yes
	x.	waste management plan (see BAT 13)	An internal waste management plan for the operation of the installation will be produced as part of AP's procedures. To be produced prior to commissioning. See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS).	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).	See BAT 2.	Yes
		In some cases, the following features are part of the EMS:		

Bat No.		BATC Requirements	Demonstration of BAT – Operator Response	Operating to BAT
	xiii.	odour management plan (see BAT 20);	An Odour Management Plan has been developed for the operation of the installation. See Odour Management Plan (Appendix H of Supporting Statement)	Yes
	xiv.	noise management plan (see BAT 22).	A Noise Management Plan has been developed for the operation of the installation. See Noise Management Plan (Appendix G of the Supporting Statement)	Yes
2		**BAT 2** 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. Emissions points are detailed in Section 5 of the Supporting Statement (Document ref: VP3425SV/APP/SS) and will be updated where changes occur as the installation develops See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS). See Impact Assessment (section 7) of Supporting Statement (Document ref: VP3425SV/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))		
	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).		
3		**BAT 3** 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).	Nominally clean waste water emissions from storm water runoff will be monitored at point source releases to detect possible contaminants such as oil and ammonia to be tested and removed prior to discharge to the waste water collection system (sump) before discharge to the North Beck Drain. Equipment/process discharge will undergo treatment at the sewage works. See drainage section within section 3 Process Description of the Supporting Statement (Document ref: VP3425SV/APP/SS).	Yes
4		**BAT 4**	Wastewater from the blowdown sump will be subject to a wastewater treatment package to be converted to non-potable water.	Yes

Bat No.		BATC Requirements	Demonstration of BAT – Operator Response	Operating to BAT
		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.	The recycling of blowdown reduces both the amount of water being imported to the site and the amount of water that is discharged for treatment. Furthermore, this water will only contain normal water treatment chemicals (e.g. chlorine, algaecides, corrosion inhibitors), and will not have any process contaminants. The reject stream from this process will be monitored in accordance with relevant standards and will be sent to Anglian Water for further treatment to meet standards. Other runoff will be subject to testing in line with standards before being pumped into local water sources. See drainage section within section 3 Process Description of the Supporting Statement.	
5		**BAT 5** 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;	No VOC emissions released from the installation.	N/A
	ii.	optical gas imaging methods;	No VOC emissions released from the installation.	N/A
	iii.	calculation of emissions based on emissions factors, periodically validated (e.g. once every two years) by measurements.	No VOC emissions released from the installation.	N/A
6		**BAT 6** BAT is to periodically monitor odour emissions from relevant sources in accordance with EN standards.	Odour emissions will be monitored in line with the Odour Management Plan. Leak detection and management systems will be in place. An odour monitoring regime will set out the frequency of sniff tests, monitoring of meteorological conditions, maintaining an odour diary and logging and investigating complaints. There are only three places where there are expected ammonia emissions to air. 1) The marine loading arms have a small section between the loading arm itself and the ship that cannot be cleared. 2) In an emergency, the ammonia storage flare can only achieve 98% destruction efficiency of ammonia 4) flue gas stack will have a small amount of ammonia slip from the SCR. Other than these known entities there are no planned emissions of ammonia to air. All emissions of ammonia to air that would cause an odour issue will be as a result of fugitive emission See Odour Management Plan (Appendix H of Supporting Statement) (Document ref: VP3425SV/APP/SS)	Yes
7		**BAT 7** 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.	Within the Project design various water reduction and reuse measures have been incorporated based on BAT and also to enhance water re-use potential. Embedded measures include use of recirculating cooling water system rather than once pass though cooling water, reuse and segregation of water streams and process control of chemical dosing and cooling water and boiler blow down systems. Cooling section of Supporting Statement (within section 3 - Operating Techniques) (Document ref: VP3425SV/APP/SS).	Yes
8		**BAT 8** 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.	A new surface water drainage network and management system would be provided for the terrestrial areas of the Site that would provide adequate interception, conveyance and treatment of surface water runoff from buildings and hard standing, with foul systems for welfare facilities and process wastewater generated by the site operations. The drainage system would be designed to be inherently safe and protect the local environment from urban diffuse pollutants that may be present. The drainage system would segregate clean surface water, oily water and water that may have contamination from liquid chemicals (water treatment chemicals, or ammonia solution). Cooling water blowdown and Boiler package blowdown would be directed to the on-site package treatment plant Reject stream from the on-site treatment package will go to third party (Anglian Waters) treatment system and clean water if non-potable quality will be reused in the facility. Clean water will be the surface water run-off from 'clean areas', which is gravity drained into the retention pond and pumped out to an external location along with surface run-off from oil contaminated areas where oil has been skimmed off in an Oily Water Separator (OWS)and sent to a third party. Run-off from possible ammonia contaminated areas in the East Site will go to an ammonia containment sump where ammonia is detected and contained so that ammonia contaminated water is not slipped to	Yes
9		**BAT 9** 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).		Yes

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10		**BAT 10** 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.	Retention Pond on East Site. Equipment/process wastewater will go through an OWS before being discharged to foul sewer along with sanitary waste. See drainage section within section 3 Process Description of the Supporting Statement (Document ref: VP3425SV/APP/SS). See Management Techniques (section 4) of Supporting Statement (Document ref: VP3425SV/APP/SS).	Yes
11		**BAT 11** 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.	No pre-treatment necessary at the site.	N/A
12		**BAT 12** In order to reduce emissions to water, BAT is to use an appropriate combination of final waste water treatment techniques.	Final wastewater treatment includes physical separation of oil through OWS. Any ammonia contaminated water (if at all) will be trucked out for safe disposal to third party. See impact assessment section 7 of Supporting Statement	Yes
13		**BAT 13** 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.	AP will have a waste management plan that sets out the expectation of waste during operation, stating the order in which waste should be managed on site, starting with prevention. It will outline waste storage arrangements in order to prevent contamination and encourage the best possible waste management scenario. This is in line with their global standards set out for all AP installations.	Yes
14		**BAT 14** 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.	No sludge generated at the site.	N/A
15		**BAT 15** 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.	The site treats releases to air through a selective catalytic reduction (SCR system).	Yes
16		**BAT 16** 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.	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, H_2 tail gas and in the future potentially H_2 gas from production. • H_2 production units will have Selective Catalytic Reduction (“SCR”) technology installed to reduce the amount of NO_X released (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 BPCS 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
17		**BAT 17**		Yes

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		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 have flares operating for safety reasons and these will operate on pilot mode for most of the time unless in the event of an emergency or during plant start-up. This is not expected to occur for more than a few hours per year. The flares are used to combust any ammonia or H2 that would otherwise be released to atmosphere. Flares will also be used to control pressure and purity during process upsets. This is not expected to occur for more than 200 hours per year and the quantity flared will be less than during a safety incident. See section 5 Process Emissions of Supporting Statement (Document ref: VP3425SV/APP/SS).	
		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	The flare systems will be subject to detailed design to meet the requirements of COMAH and will have sufficient capacity for the management of the gas streams produced and an appropriate arrangement of high integrity relief valves where appropriate.	
		Plant management	This includes balancing the fuel gas system and using advanced process control.	The Installation will be controlled and operated via a BPCS 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.	
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 has been optimised to ensure the operation will be smokeless and reliable including assessment of the most effective stack height by dispersion assessment. Flare systems will be continuously monitored and controlled via the BPCS system including measurements of gas flow, temperature and pressures to ensure that combustion is optimised, and emissions minimised. Records will be maintained via the BPCS 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. See section 5 Process Emissions of Supporting Statement (Document ref: VP3425SV/APP/SS).	
		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** 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.		No VOC emissions to air from the installation.	NA

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20		**BAT 20** 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 Odour Management Plan covers elements i to ii to prevent and reduce odour emissions from the installation. See Odour Management Plan (Appendix H of Supporting Statement) (Document ref: VP3425SV/APP/SS)	Yes
	ii.	a protocol for conducting odour monitoring;		
	iii.	a protocol for response to identified odour incidents;		
	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** 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.	Sanitary waste water from welfare facilities on the jetty and the jetty control room will be collected in cess tanks located at the jetty head. The land side development will be drained via conventional foul sewer and treated through the local sewage treatment work. Retention basins will provide attenuation storage and suitable water quality management for treatment of runoff from impermeable areas where there is a low risk of contamination by any chemicals used by the energy generation processes, to ensure potential adverse effects on water quality and habitat of receiving water bodies are avoided. No sludge is generated at the installation. ES Chapter 18: Water Use, Water Quality, Coastal Protection, Flood Risk and Drainage Drainage section within section 3 Operating Techniques of the Supporting Statement (Document ref: VP3425SV/APP/SS)	Yes
22		**BAT 22** 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;	The Noise Management Plan covers elements i to ii to prevent and reduce noise emissions from the installation. See Noise Management Plan (Appendix G) of Supporting Statement. (Document ref: VP3425SV/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.	Examples of techniques for noise reduction at the installation include, but are not limited to, the following measures: • Reducing the breakout noise from plant through the use of enhanced enclosures, or potentially containing them within a building. • Reducing air inlet noise emissions by the addition of further in-line attenuation. • The flare is designed to be less than 80dBA. Since the selection and design of the flare should inherently limit the noise dBA and only in a case if not possible to meet noise limits, then other methods to control would be deployed.	Yes

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			• . • Reducing fan noise emissions by screening, re-sizing, fitting low noise fans or attenuation. • Screening or enclosing the compressors or other equipment. • Orientation of plant within the site to provide screening of low-level noise sources by other buildings and structures, or orientating fans and the air inlets away from sensitive receptors. See Noise Impact Assessment and Noise Management Plan (Appendix F and G of Supporting Statement). Impact Assessment (section 7) of Supporting Statement (Document ref: VP3425SV/APP/SS)	