Immingham Green Energy Terminal
Green Hydrogen Production Facility

EPR/VP3425SV/A001
Environmental Permit Application Supporting Statement

Environmental Permitting (England and Wales) Regulations 2016
Applicant: Air Products (BR) Ltd
September 2024

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Supporting Statement

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

Version	**Date**	**Status of Version**
Revision 1	22 March 2024	For Client Review
Revision 2	03 May 2024	Final Revision
Issue 1	24 May 2024	Issue to Regulator
Issue 2	27 September 2024	Re-Issue to Regulator

Glossary

Abbreviation	Definition
AEL	Associated Emissions Level
AEP	Annual Exceedance Probability
AMP	Accident Management Plan
AP	Air Products
AP-E	Air Products Europe
BAT	Best Available Techniques
BCGA	British Compressed Gases Association
BPCS	Basic process Control System
CCPS	Chemical Centre for Process Safety
CEMS	Continuous Emissions Monitoring System
COMAH	Control of Major Accident Hazards
DAA	Directly Associated Activity
DCS	Distributed Control System
DCO	Development Consent Order
EA	Environment Agency
EH&S	Environment, Health & Safety
EHS&Q	Environment, Health, Safety & Quality
EIA	Environmental Impact Assessment
EIGA	European Industrial Gases Association
EMS	Environmental Management System
EP	Environmental Permit
EPR16	Environmental Permitting Regulations (England and Wales) 2016 (as amended)
ERA	Environmental Risk Assessment
FMfP	Flood Map for Planning
FRA	Flood Risk Assessment

Abbreviation	Definition
GHG	Greenhouse Gas
GWP	Global Warming Potential
H1	Horizontal Guidance 1 and Risk Assessment Tool
H2	Hydrogen
HAZOPS	Hazard and Plant Operating Studies
HP	High Pressure
HPU	Hydrogen Production Unit
IED	Industrial Emissions Directive
kV	Kilovolt
LCH	Low Carbon Hydrogen
LDAR	Leak Detection and Repair
LNR	Local Nature Reserve
LOAEL	Lowest-observed-adverse-effect level
LP	Low Pressure
LWS	Local Wildlife Site
MOC	Management of Change
MTPD	Million Tonnes Per Day
MW	Megawatt
NELC	North East Lincolnshire Council
NG	Natural Gas
NH3	Ammonia
NO2	Nitrogen Dioxide
NOX	Oxides of Nitrogen
NPPF	National Planning Policy Framework
NSIP	Nationally Significant Infrastructure Project
NSR	Noise Sensitive Receptors
OEM	Original Equipment Manufacturer

Abbreviation	Definition
OPHR	Operating Plant Hazard Review
OTNOC	Other than normal operating conditions
PLC	Programmable Logic Control
PI&T	Periodic Inspection and Test
P&ID	Piping and instrumentation diagram
PPG	Planning Policy Guidance
ppm	Parts per million
PSA	Pressure Swing Adsorption
SAC	Special Area of Conservation
SCBR	Site Condition and Baseline Report
SCR	Selective Catalytic Reduction
SOAEL	Significant observed adverse effect level
SPA	Special Protection Area
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
TPO	Tree Preservation Order

Table of Contents

Figures

Tables

1. Introduction

1.1 Project Summary

1.1.1 This document has been prepared by AECOM Limited ('AECOM') on behalf of Air Products (BR) Limited ('APBRL' or 'AP'), referred to as 'the Operator', in support of an Environmental Permit application for the proposed Green Hydrogen (H_2) Production Facility ('proposed installation') which forms part of the wider Immingham Green Energy Terminal ('IGET') Nationally Important Infrastructure Project (NISP) being developed by Associated British Ports ('ABP') on the eastern side of the Port of Immingham, situated in northeast Lincolnshire on the south bank of the Humber Estuary.

1.1.2 The Operator and ABP together have made an application to the Secretary of State for Business, Energy and Industrial, under section 37 of the Planning Act 2008, for a development consent order (DCO) for the construction, operation and maintenance of a multi-user liquid bulk terminal and its associated green hydrogen facility for the production of green hydrogen. This application for an Environmental Permit is made under the Environmental Permitting (England and Wales) Regulations ('EPR') 2016, as amended and is submitted in parallel to the DCO application.

1.1.3 The Environment Agency (EA) is a statutory consultee to the DCO application and must provide assurance to the Planning Inspectorate that the proposed installation would be granted a permit to operate, in order that the Examining Authority gain confidence that there is no impediment to the granting of the DCO. It is therefore recognised that the permit application is being made prior to the detailed design of the proposed H_2 installation being completed and wherever possible, conservative or worst-case assumptions have been used in this application. Therefore, a number of pre-operational conditions and/or improvement conditions are likely to be required to be discharged prior to, during or after the installation commissioning to reflect design changes that may have occurred and/or to verify that environmental assessment conclusions remain valid.

1.1.4 The proposed installation will be the UK's first commercial scale project which will utilise green ammonia to generate green H_2 and will initially produce up 105 metric tonnes per day (MTPD) of H_2 rising to 210 MTPD of H_2 in future phases.

1.1.5 This document is structured as follows:

- Section 1 presents general background to the overall project, summarises the purpose of the facility, and describes the legislative context of the development. This section is supported by a number of drawings and plans presented in Appendix A.

- Section 2 summarises the environmental setting of the proposed installation and the current site conditions. It is supported by a Site Condition and Baseline Report (SCBR) in Appendix B.
- Section 3 describes the proposed installation in more detail explaining the technical standards to be met and the proposed H_2 production technology to be employed and associated design philosophies. This section also summarises compliance with the relevant regulatory standards to demonstrate the proposed installation will comply with the relevant Best Available Techniques (BAT). This section is supported detailed assessments of BAT presented in Appendix D.
- Section 4 presents a summary of the management arrangements to be employed at the proposed installation including those for emergency management building on APBRL's existing Environmental Management System (EMS) deployed across its other operations.
- Section 5 summarises emissions to air, land and water associated with the operation of the proposed installation.
- Section 6 presents the proposed arrangements for monitoring and control of the proposed processes.
- Section 7 presents the conclusions of the environmental impact assessment of the proposed installation and is supported by a number of separate assessments in Appendices E-K.
- Section 8 presents an overview of the approach to decommissioning and closure.

1.2 The Operator

1.2.1 APBRL is a world-leading industrial gases company that has been in operation for nearly 80 years, with more than 60 years in the UK and Ireland. APBRL employ more than 1,000 employees across a significant number of operating facilities including 35 production facilities across the UK and Ireland. Additionally, they APBRL operate a number of hydrogen refuelling stations and hydrogen, nitrogen and oxygen plants.

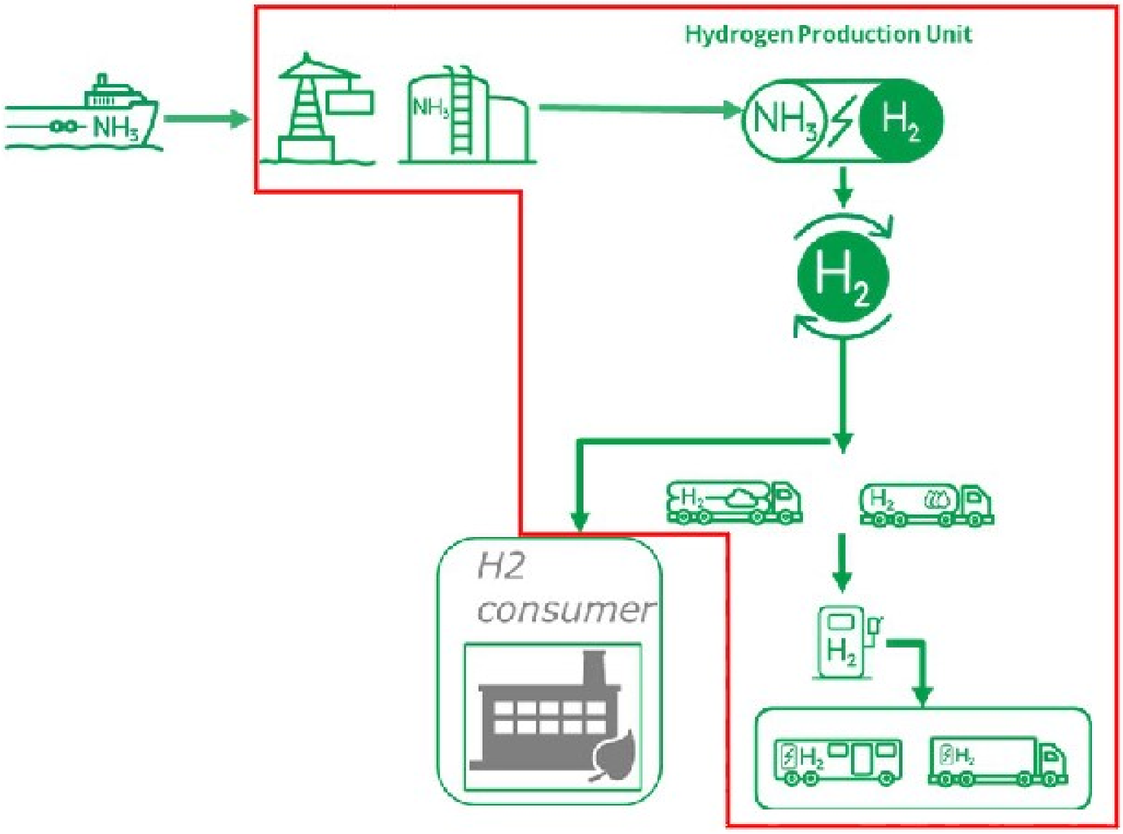
1.2.2 APBRL are focused on serving energy, environment and emerging markets, providing essential industrial gases, related equipment and technical applications expertise to customers in dozens of industries, including refining, chemical, metals, electronics, manufacturing, and food and beverage.

1.2.3 The company develops, engineers, builds, owns and operates some of the world's largest industrial gas and carbon-capture projects, supplying world-scale clean hydrogen for global transportation and industrial markets, as well as the broader energy transition.

1.3 Proposed Installation

1.3.1 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. This is shown visually on the illustration below. Please note this is illustrative only and the red line boundary shows what is included within this application.

Figure 1. Process Illustration



1.3.2 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 proposed installation location will be approximately centred on National Grid Reference (NGR) E520783 N415271.

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

1.3.4 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 ABP. Only the offloading infrastructure is incorporated in the application and the jetty itself remains outside the proposed installation boundary (see Figure 1 in Appendix A).

1.3.5 NH_3 transfer pipeline which links the ship offloading infrastructure with the NH_3 storage tanks located on the east site.

1.3.6 East site which comprises:

- a NH_3 storage tank, boil-off gas compression system 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.
- H_2 production facility comprising up to three H_2 production units including associated flue gas and flare stacks.
- Power distribution buildings for NH_3 and H_2 production plant.
- Instrumentation buildings for NH_3 and H_2 production processes.
- Analyser shelters for the H_2 plant.
- Pipe-racks, pipelines, pipes, utilities and other infrastructure associated with both NH_3 and H_2 equipment.
- Welfare facility.

1.3.7 West site which comprises:

- H_2 production facility comprising up to three H_2 production units including associated flue gas and flare stacks.
- Up to four liquefier units.
- H_2 storage tanks.
- H_2 trailer filling stations.
- H_2 vent stack and associated process equipment.
- H_2 vehicle and trailer filling stations.
- H_2 compressors and associated process equipment.
- Control room and workshop building.
- Security and visitor building.
- Contractor building.
- Warehouse.
- Driver administration building.
- Safe haven building.
- Electrical substation and metering station.
- Power distribution buildings.
- Process instrumentation buildings.
- Analyser buildings.

- 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.

1.3.8 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.

1.3.9 The facility will be constructed to be "export ready" but initially all hydrogen produced will be used for refuelling purposes. In the future, additional H2 consumers could be connected via a pipeline network. At the time an export network becomes viable the Operator will engage with the EA at that time and if necessary an updated permit will be sought. .

1.3.10 The proposed installation boundary (green line) is shown in Appendix A, Figure 1.

Outside the Proposed Installation Boundary

1.3.11 The proposed single berth jetty is being developed and operated by ABP and will extend 1.2km seawards into the Humber Estuary. The jetty infrastructure will include a loading platform, topside infrastructure for the handling of bulk liquids including loading arms and pipelines, berthing and mooring dolphins with link walkways and related landside infrastructure including jetty ramps. The jetty will operate 24 hours a day, seven days a week and 365 days a year and will accommodate up to 292 ship calls per year. Only 12 ship calls will be associated with the receipt of NH_3 and only the specific NH_3 offloading infrastructure will form part of the proposed installation boundary.

1.3.12 The private access road between the new jetty and Laporte Road will include security gates, a security building, a power distribution building and associated utilities and are part of the wider ABP development.

1.4 Regulatory Framework

1.4.1 The proposed installation is listed under Schedule 1 of EPR 2016, as amended.

EPR Schedule 1, Part 2, Chapter 4, Section 4.2, Part A(1)(i) as a process for "Producing inorganic chemicals such as gases (for example ammonia, hydrogen chloride, hydrogen fluoride, hydrogen cyanide, hydrogen sulphide, oxides of carbon, sulphur compounds, oxides of nitrogen, hydrogen, oxides of sulphur, phosgene)".

1.4.2 This definition reflects the plant's primary objective of hydrogen production.

1.4.3 It was confirmed during pre-application discussions with the EA, that the application will include the listed activities and directly associated activities as shown in Table 1 below:

Table 1. Listed Activities and Directly Associated Activities

Activity Ref No	Activity under EPR 2016 Schedule 1	Description of specified activity	Limits of specified activity
A1	Schedule 1, Section 4.2, Part A (1)(i) Production of inorganic chemicals.	Production of hydrogen from green ammonia.	From receipt of ammonia
Directly Associated Activities			
A2	Directly Associated Activity	Offloading of ammonia from ship	Jetty top-side ammonia offloading infrastructure from connection point to ship, through transfer pipework to the ammonia storage tank.
A3	Directly Associated Activity	Raw material storage	From receipt of raw materials to handling, on-site storage and handling for use.
A4	Directly Associated Activity	Hydrogen liquefaction	From receipt of gaseous hydrogen to transport of liquid hydrogen to hydrogen storage tanks.
A5	Directly Associated Activity	Hydrogen Storage	Storage of hydrogen after liquefaction and loading.
A6	Directly Associated Activity	Vehicle and tanker loading	Hydrogen vehicle loading area.
A7	Directly Associated Activity	Surface water management	Handling of site drainage until discharge to the site surface water system.
A8	Directly Associated Activity	Effluent Management	From receipt of process effluent its discharge to foul sewer.
A9	Directly Associated Activity	Emergency generator	Diesel powered generator to provide back-up in the event of a power cut.
A10	Directly Associated Activity	Cooling	Site wide cooling system and cooling towers.

2. Environmental Setting and Site Condition

2.1 History of the Site

2.1.1 Historical maps show no notable development on the Site until 1930–1931 when residential housing is shown on Queens Road adjacent to the Site boundary. In addition, the L.N.E.R Grimsby District Electric Light Railway is shown through the centre of the Site. A sewage works was established by 1922 adjacent to south of the Site boundary and is still present.

2.1.2 No notable land use changes occurred at the Site until the period 1951–56. At this time a Gypsum Disposal Bed is shown as being present adjacent to the Site Boundary at the south-western extent. Buildings and railway lines associated with a Chemical Factory were shown as being established approximately 350m southeast of the Site Boundary.

2.1.3 By 1964, the Port had developed more extensively, including the establishment of jetties within the Humber, to the west of the area proposed for the Immingham Green Energy Terminal (“IGET”). By this time a number of small buildings are mapped as present on the western part of the Site, whilst electricity lines run through the East Site. No notable changes have occurred within the Site since this period other than further electricity pylons which were erected across the western part of the Site and also pipelines on the northern boundary of the Site which were established during the period 1969–72.

2.1.4 Multiple changes have occurred between 1964 and the present day in areas within 500m of the Site Boundary. The industrial landscape has continued to develop, including but not limited to the establishment of an Oil Storage Depot and associated infrastructure, further structures associated with the sewage works (now an Anglian Water operational facility), pipelines, and most recently, by 2010 the establishment of a Recycling Centre.

2.1.5 Some of the mapped infrastructure including the mapped Chemical Works and associated railway lines have become disused between 1969 and the present day.

2.2 Current Setting

2.2.1 The proposed installation will be situated to the east of the Port and largely outside of the operational area of the Port. The area surrounding the Port is industrial in nature and dominated by chemical manufacturing, oil processing and power generation facilities. Residential and commercial properties are present to the south of the Port on Queens Road and lie within, and adjacent to, the proposed site boundary. Beyond the industrial facilities, the wider area is largely agricultural. The nearest residential area is on the eastern edge of the town of Immingham approximately 460m from the western edge of the Site.

2.2.2 Figure 1 (Appendix A) shows the proposed installation boundary within the immediate setting.

2.2.3 The proposed Jetty and proposed installation will be located to the east of the existing Immingham Oil Terminal jetty. This area falls within the boundaries of the Humber Estuary Special Area of Conservation (SAC), Special Protection Area (SPA) and Ramsar Site, which collectively form the Humber European Marine Site (EMS).

2.2.4 A proposed Pipeline Corridor will connect the West Site to the East Site and will extend to the Terminal (see Appendix A Figure 2). It crosses an area that has mostly already been impacted by industrial development alongside Queens Road and Laporte Road, and also crosses the Grimsby Docks Branch Line. At the eastern end, the Pipeline Corridor area includes a section of woodland known as 'Long Strip' between Laporte Road and the Humber Estuary that is subject to a Tree Preservation Order (TPO).

2.2.5 The East Site comprises two parcels of land, which are bisected by Laporte Road. The first parcel of land consists of an area of hardstanding to the north of Laporte Road which is in use by the Applicant as a storage area. The second parcel of land is a triangular shaped area of brownfield land that is currently covered by gravel and various stockpiles, which is accessed via Queens Road (A1173) and lies to the south of Laporte Road. The Associated Petroleum Terminals works complex is situated to the north/north-east of the East Site, whilst to the south are various industrial facilities. To the west and north-west is the Port and associated industrial facilities and the ‘Immingham Dock East Gate’ Port entry point from Queens Road. To the east the East Site is bordered by a woodland belt which is subject to a Tree Preservation Order (TPO), and through which a bridleway passes, connecting users to a coastal access path that follows the Humber Estuary east to Grimsby.

2.2.6 The West Site currently comprises three agricultural fields, which are bounded by linear hedgerows and drainage ditches. An electrical sub-station and a gas-fired power generator proposed installation are situated to the north-west (not technically connected to this proposed installation). The north west and western boundaries of the West Site are defined by Kings Road and the A1173. A landfill is located to the south separated by a landscape buffer strip. Queens Road forms the north-eastern boundary of the West Site with a number of residential and commercial properties included within the Site boundary. The east and south-eastern boundary is adjacent to another gas fired power generator proposed installation (again, not technically connected to this proposed development), the community recycling centre and a large waste gypsum landfill. A short tarmac access road has been constructed from Kings Road into the West Site and a series of overhead power cables run across the middle and southern boundary of the site, with a buried mains water and a buried high-pressure gas pipeline also along the southern boundary.

2.2.7 The closest receptors to the installation boundary include ten residential properties located on the west side of Queens Road:

- Houses at Numbers 1-5 and 31 Queens Road (six houses in total).

- Number 6 Queens Road (two flats in total).
- Numbers 7-8 (one flat) and 18 Queens Road (one flat). Numbers 7-8 Queens Road contains vacant commercial premises at ground floor level. The ground floor at 18 Queens Road is understood to be used by the owner for storage.
- Residential properties on the eastern edge of Immingham, including Somerton Road, Worsley Road, Dunster Walk, Ings Lane, Oakham Walk, Kendal Road, Chestnut Avenue, Waterworks Street and Spring Street, which at the closest point are located between approximately 460m and 480m west of the West Site.
- Mauxhall Farm off Stallingborough Road, located approximately 1km south-west of the West Site.
- Other settlements nearby include Grimsby (approximately 5km) to the southeast; Healing (approximately 3.5km) and Great Coates (approximately 5.5km) to the south-east; Stallingborough (approximately 2.5km) to the south; Keelby (approximately 5km) to the south-west; and Habrough (approximately 4.5km) to the west.

2.2.8 The residential use of certain properties on the west side of Queens Road would need to cease as residential use is not considered to be compatible with the operation of the hydrogen production facility on the West Site (based on an assessment undertaken on behalf of Air Products).

2.2.9 There are a number of other business/commercial receptors adjacent to the Installation Boundary in the vicinity of Queens Road. It is considered that the continued use of these business / commercial properties would be compatible with the operation of the hydrogen production facility following assessments undertaken on behalf of Air Products.

2.2.10 The Humber Estuary forms the north-eastern boundary of the Site. There are also a number of surface water features within the vicinity of the Site. The North Beck Drain is located immediately east from the site and the Habrough Marsh Drain is to the west of the site. Middle Drain is also located in the vicinity of the Site.

2.2.11 The Site boundary within the Humber is within the boundary of the Humber Estuary EMA, which is a statutory designated site that encompasses the Humber Estuary SPA, SAC, RAMSAR and Site of Special Scientific Interest ("SSSI") designations.

2.3 Site Condition

2.3.1 A Site Condition and Baseline report for the proposed installation is presented in Appendix B, characterising the condition of the ground and groundwater across the proposed installation site.

2.3.2 The area is predominantly industrial in nature, as described above. The environmental sensitivity of the Site is considered to be as follows:

- Groundwater – Low to Very High sensitivity – The underlying chalk bedrock covering the entire site classified as a Principal Aquifer, with multiple groundwater extractions within a 1km radius of the site. Superficial deposits covering the northeastern boundary of the Site, along the bank of the Humber Estuary (Beach and Tidal Flat Deposits) are classified as a Secondary Aquifer and may support groundwater of a minor value. A secondary superficial deposit includes Tidal Flat Deposits covering the entire Site apart from the bank of the Humber Estuary. The Tidal Flat Deposits comprise of unproductive strata and are therefore designated as an Unproductive Aquifer.
- Surface water – High sensitivity - The Humber Estuary is located within the Site Boundary to the northeast of the Site. The North Beck Drain is located immediately east from the Site and the Habrough Marsh Drain is located to the west of the Site.
- Land use – Medium – Very High sensitivity – The wider area is predominantly commercial/industrial land use, however residential properties are located within 500m of the study area.

2.3.3 As part of the site development prior to the construction of the above infrastructure, the land will be raised to give finished ground levels of approximately 3.8m AOD and 3.6m AOD on the East Site and 2.5m AOD on the West Site. The increase in levels will be achieved through the import of uncontaminated materials.

2.3.4 Information on relevant hazardous substances stored at the facility, their physical containment, the management techniques adopted to prevent and control releases are included within the Site Condition Report.

2.3.5 The activities at the proposed installation site will be carefully controlled both by local containment and operational techniques. The measures put in place will ensure that operations during the life of the facility are unlikely to lead to pollution of groundwater or the ground, and will not lead to deterioration of the state of the land.

2.3.6 An EA Nature and Heritage Screen has been completed as part of the DCO and has been attached to the Site Condition and Baseline Report as Annex C. The screening report ensures all nature conservation sites and protected species and habitats surrounding the proposed installation have been captured. A Shadow Habitat Regulations Assessment was also completed and is provided in Appendix C of this document.

3. Proposed Installation

3.1 Technical Standards

3.1.1 The installation will be operated in accordance with the EPR Permit issued by the Environment Agency. The EPR permit will include the activities and techniques detailed within this application which will be developed in accordance with the standards and guidance which detail 'Best Available Techniques (BAT).The applicable standards and guidance were reviewed and agreed with the EA during pre-application engagement and include:

- BAT conclusions for common waste gas management and treatment systems in the chemical sector
- BAT conclusions for common waste water and waste gas treatment/management systems in the chemical sector
- Reference Document on Best Available Techniques for Energy Efficiency
- Reference Document on Best Available Techniques for the Manufacture of Large Volume Inorganic Chemicals - Ammonia, Acids and Fertilisers
- Reference Document on the application of Best Available Techniques to Industrial Cooling Systems

3.1.2 The EA's guidance for 'Hydrogen production with carbon capture: emerging techniques' has also been used to guide best practice for the operation of the proposed installation. This guidance presents emerging techniques on how to prevent or minimize the environmental impacts of industrial H_2 production from methane or fuel gas with carbon capture for storage. The proposed installation will not produce H_2 from methane or fuel gas and currently carbon capture is not proposed as further studies are required to develop a system which is technically and commercially viable, but this guidance will be used where applicable to address similar important environmental issues and will be used until further guidance is available.

3.1.3 Further details on how the installation with meet the requirements of the above guidance are presented in Appendix D which comprises:

- Appendix D1 - BAT 01: Assessment of Plant Emissions;
- Appendix D2 - BAT 02: Assessment of Energy Efficiency;
- Appendix D3 – BAT 03: Assessment of Process and Technology; and
- Appendix D4 – BAT 04: Assessment of Cooling System.

3.1.4 The proposed site operator will develop a management system prior to commencement of operations in accordance with the EA guidance – 'Develop a management system: Environmental Permits' as a good practice measure.

3.2 Infrastructure Overview

3.2.1 The facility is designed to receive imports of green ammonia from international markets, to be converted to green H2 to supply the UK's hydrogen for mobility (H2fM) market.

3.2.2 Vessels will bring a total of 660,000 tonnes of green NH_3 (comprising 12 ships each transporting 55,000 tonnes) to the Terminal from the Middle East and Netherlands.

Ammonia Offloading and Storage

3.2.3 Vessels will arrive at the jetty head unloading platforms. Pipelines will run from the Terminal to the East Site – Ammonia Storage area to deliver the offloaded refrigerated liquid NH_3 to the 55,000 MT NH_3 storage tank. An indicative design for the NH_3 storage tank is shown in Drawing Figure 7a and will be subject to detailed design.

3.2.4 The NH_3 in the storage tank will be stored at nearly atmospheric pressure and - 33°C. The tank will be a double containment 'tank in wall' design. The inner tank (primary container) is fully closed off to contain liquid and vapor and is surrounded by an external 'wall' which will be constructed using concrete to provide secondary containment (containing any liquid leak) and protection from damage by external impact. The gap between the tank and the wall will allow for easy access for inspection and maintenance without exposure to NH_3. There will be an acoustic emissions monitoring system for warning of stress, corrosion and cracking of the tank. The tank will also be raised to create an air gap underneath to protect against cold propagation to the ground and act as flood protection.

3.2.5 The storage facility will also include a refrigeration (boil-off gas) system, storage flare and supply pumps for the hydrogen production units (HPUs). The flare will operate on pilot and in the event of an emergency or infrequent operational upset will combust any waste gas released during such an event.

Hydrogen Production Units

3.2.6 Peak production the site will utilise three HPUs on the East Site and a further three HPUs on the West Site. HPU installation, commissioning and subsequent use will take place over three phases. Each HPU facilitates the NH_3 dissociation reaction to produce H_2. Each HPU will use natural gas as the primary fuel source which will be supplemented with a H_2 rich gas stream generated in the pressure swing adsorber (PSA) that supports each HPU.

Cooling

3.2.7 A site-wide recirculating cooling system using water to create a cooling loop which will run through the proposed installation via pipelines and will include cooling towers on the West Site. The cooling will be an evaporative cooling system, a method most widely used throughout process industries to remove process waste heat. The system will require non-potable water (service water) sourced via an Anglian Water supply. An evaporative cooling tower system has been chosen over an air-cooled system primarily because of the achievable water cooling temperature. The evaporative cooling system is based on wet-bulb temperature and can use a closer approach temperature in the design due to the nature of the latent heat. The cooling method for an air-cooled system is convective and is a function of the dry bulb temperature of the air (which is warmer than the wet bulb) and needs a larger approach temperature. Simulations have been run and the difference in the specific power consumption of the liquefier between the two different cooling systems is a 7% power penalty with an air cooled system. Given that the liquefier is a large power consumer, an air cooled system would create a much higher demand for energy on the site and would increase site-wide power consumption by more than ~4 MW. The Operator believes for this project, with their current liquefier design, that the most sensible technology to employ for the cooling system is an evaporative cooling tower. A connection to an existing non-potable water main running the length of Laporte Road will be required for cooling water.

3.2.8 The proposed installation will follow Best Available Techniques (BAT) for cooling where applicable (see Appendix D4).

Hydrogen Storage Tanks

3.2.9 There will be eight H_2 storage bullets (tanks) located on the West Site, each with a storage capacity of up to 31 tonnes. The indicative design for the tanks are provided in drawing Figure 7b and will be subject to further detailed design.

Flares

3.2.10 Up to 3 flare stacks (one per HPU) will be located on the East Site along with the NH_3 tank flare stack. A flare stack will also be available for each of the three HPU's located on the West Site, resulting six HPU flare stacks on site in total. The HPU flare stack height will be 37m in height and the NH_3 flare 55m. These are minimum heights as established by dispersion assessment to ensure adequate dispersion of emissions.

3.2.11 Flares will operate for most of the time on pilot mode. They will be required to operate in an emergency or process upsets or operational transitions or during plant start-up or shut down (e.g. during catalyst replacement in HPU) to burn off the release of NH_3 or H_2 emissions, with flaring of the waste gases occurring no more than a few hours per year. The frequency and duration of flaring will be dictated by both scheduled and unscheduled events, such as necessary maintenance and excess pressure conditions. The cumulative maximum flaring events will not exceed 500 hours per year as stated in the application. During commissioning of facilities, the flaring and venting will be kept to the lowest level that is consistent with the safe and efficient commissioning of related plants.

Hydrogen Vent Stacks

3.2.12 Three vent stacks for storage trailer loading facilities installed near H2 bullets. One vent stack in balance of plant area for disposal vaporizer.

3.2.13 There will be 5 Hydrogen Vent stacks across the sites with one vent stack per liquefier which will be installed within the Process area. A further 3 vent stacks for storage trailer loading facilities installed near H_2 bullets. One vent stack in balance of plant area for disposal vaporizer.

3.2.14 Venting for abnormal scenarios will occur infrequently for scenarios such as:

- High pressure excursion in the compressor area of the liquefier;
- Contaminated trailer returned from a customer;
- LHY storage tank relief valves or bursting discs; and
- Storage area overfill.

3.2.15 H_2 is a buoyant flammable gas that will, under normal conditions, disperse safely to the environment in the unburnt state. European Industrial gases association (EIGA) Doc 06/19, 5.1.7, allows venting of H_2 into the vent stack discharging in a safe place in the open air to prevent impingement of escaping gas on to personnel or any structure. Dispersion analysis during detailed design will be conducted to determine the safe location for the vent stack. The vent stack height will be ~40 m from ground.

3.2.16 The H_2 vent pipework will be purged continuously with high purity N_2, to prevent air ingress to the system and any potential solidification of air at valves or PSV outlets. This limits the likelihood of ignition in the vent pipework system itself. Air Products will follow AP standard STD-ENG-MS007 'Venting of Bouyant Flammable Gases' for the design of the venting system.

Drainage

3.2.17 A drainage strategy has been developed as part of the DCO application and will be subject to review during detailed design phases.

3.2.18 For the drainage strategy, the Site has been split into three areas; 'East Site – Hydrogen Production Facility', 'East Site – Ammonia Storage Area' and 'West Site'. These areas represent the permanent operational parts of the Site that would be actively drained by the proposed systems and collectively have a footprint of 27.4ha. A total of 11.8ha of the footprint will be hardstanding and assumed to be impermeable.

3.2.19 Surface water runoff rates have been agreed with the Internal Drainage Board (IDB) to be limited to a Qbar greenfield runoff rate of:

- 49 l/s for the West Site;
- At 70% of the 'real' brownfield runoff rate for the East Site – Hydrogen Production Facility at 12.6 l/s; and
- At 70% of the 'real' brownfield runoff rate for East Site – Ammonia Storage Area, at 7.0 l/s.

3.2.20 This results in storage volumes of 4,565m^3, 2,470m^3 and 18,319m^3 respectively.

3.2.21 These volumes can only be accommodated by the planned raising of ground levels across all three sites. The required levels are 3.8 mAOD, 3.5 mAOD and 2.5 mAOD for the East Site – Hydrogen Production Facility, East Site – Ammonia Storage Area and West Sites, respectively. At these levels, due to the designed gradients, storm water will be stored throughout the system.

3.2.22 The low gradients bring a risk of sedimentation as flows will be slow moving at the peak of the storm. The detailed design of the system and the final drainage plan will include a maintenance strategy to maintain the operation of the system.

3.2.23 Outflow from the drainage system from each site will be controlled to the agreed discharge rate by several Hydrobrake® units. From here, the outflow enters the ditch network surrounding the Site and eventually discharges to the Humber Estuary.

3.2.24 Surface water runoff from non-contaminated areas will be routed through a gravity network of buried piping into retention ponds located under the East and West Sites.

3.2.25 Surface runoff from areas containing accidental contamination (e.g. areas where vehicles are arriving on and off site) will be routed through oil/water separation (OWS) sumps and the resulting oil-free water will be routed through to the retention ponds along with other non-contaminated area runoff. The remaining oil will be collected by contractors and taken off site. Non-contaminated run off water from the HPU area will go into the West Site retention pond and the necessary provisions to contain the contaminants such as glycol will be made within the HPU.

3.2.26 Surface water run-off from the NH_3 storage non-contaminated areas will be routed to retention pond on the east site via. storm sewer networks. Surface water run-off from areas which could have accidental contamination (e.g. boil-off gas compression system installation area) will be routed through oil/water separator sumps resulting in oil free water routed to the retention pond on the east site. Oil/Water sump will have oil in water analyser and also ammonia analyser or detector (to be confirmed during detailed design) and in case ammonia is detected in the sump (due to accidental contamination) the outflow from the sump is isolated using automated isolation valve to contain ammonia contaminated water in the sump. The ammonia contaminated water will trucked out from the facility for offsite treatment.

3.2.27 The retention ponds on both the East and West Site will contain vertical submersible pumps. The pump discharge will be routed to the adjacent area outfall ditches that will carry water to the Humber Estuary. The Operator must sample the water before starting the retention pond pumps to allow flow and document in the Safe Work Instruction Manual. The retention pond should not be contaminated unless a major fire has occurred on site and firewater has trained into the system. The retention pond pumps at both sides will therefore release clean water intermittently, at a rate of 176.4m3/h on the West Site and 25.2m3/h on the East Site (subject to change).

3.2.28 In the event of a fire, fire waters will be retained on site in the drainage network and retention ponds. Water will be tested to confirm the quality and once results are known the route for disposal will be confirmed (i.e. removal from site for third party treatment or disposal or release to external drainage network only if the water quality is confirmed as acceptable)..

3.2.29 The cooling water system and boiler package will use frequent blowdowns to maintain the conductivity of the systems. The wastewater from these systems will contain dosed chemicals (biocide, corrosion inhibitor etc- see Table 2) and will be routed to the blowdown sump, along with the backwash water from the side stream filter. The wastewater from the blowdown sump will be pumped into a wastewater treatment package where treatment returns it non-potable water quality suitable for reuse in the process. The reject stream from the wastewater treatment package will be sent to Anglian Waters via sewer for further treatment. The flow of the reject stream will be subject to change and is predicted to be a continuous flow of <9.6m^3/hr once the whole installation is built.

3.2.30 The components of the wastewater are summarised in Table 17 in section 7.6 below..

Boiler/Steam Generation

3.2.31 The proposed installation will not produce steam as a byproduct of the process. The steam system will comprise an electric steam boiler that has a design capacity to generate 2 ton/hr of steam, and has a multi-heater facility (max thermal duty 1120 kW) which allows the steam generation unit to operate from 0 to 100% of the design capacity. The steam generation unit generates steam at the pressure of 8 barg, which is further letdown and used for maintenance of the equipment in the cryogenic units. There is no continuous consumption of steam in the facility, steam system operation is expected intermittently during maintenance (de-icing of valves in the cryogenic parts of the plant). The maximum potable water consumption for generating steam at rate of 2 ton/h is 2 m3/hr. The unit will be skid mounted and readily available from the Suppliers

3.3 Hydrogen Production Process

Ammonia Dissociation

3.3.1 Hydrogen production will take place in an ammonia Hydrogen Production Unit furnace whereby the liquid ammonia would be split into hydrogen (H_2) and nitrogen (N_2) through an endothermic reaction. The broad reaction can be represented as:

$$NH_3\ (g) \rightarrow \tfrac{1}{2}\ N_2\ (g) + \tfrac{3}{2}\ H_2\ (g)$$

3.3.2 The Hydrogen Production Unit furnace will consist of catalyst filled tubes inside of a gas fired furnace. The catalyst facilitates the NH_3 cracking reaction. The NH_3 will be first fed through a series of heat exchangers which pre-heat and vaporise it prior to it passing into the dissociation section where the catalyst reactor bed facilitates the ‘cracking’ of the NH_3 into H_2 and N_2. The pre-heating of the NH_3 will be provided by heat integration of the cracked gas streams.

3.3.3 The primary fuel source for the furnace is natural gas, supplemented with H_2 rich gas from the PSA (pressure swing adsorption) unit to reduce the carbon intensity of the process. The convection section within the furnace includes an SCR (Selective Catalytic Reduction) unit to reduce emissions of nitrogen oxides (NO_x) to an acceptable level before discharging to the atmosphere.

3.3.4 The Hydrogen Production Unit operating temperature will be limited to minimize nitriding of the piping components and equipment. The Hydrogen Production Unit will be operated at high pressure to reduce or eliminate compression.

3.3.5 The H_2 leaving the Hydrogen Production Unit contains N_2, unreacted NH_3 and a small amount of water and must be purified before being sent to the pipeline and liquefier. The H_2 passes to a PSA unit which is located downstream of the Hydrogen Production Unit and is designed to produce > 99.97% pure H_2.

3.3.6 The PSA consists of multiple beds which operate in cycles, to allow regeneration. The PSA pressure will be controlled by a pressure controller located on the PSA product stream and will open a route to the flare system in the case of a high pressure. The pressure control signal is also fed back to the NH_3 feed control loop to maintain the correct operating pressure in the PSA. The majority of the purified hydrogen gas leaving the PSA unit is sent to the liquefaction trains.

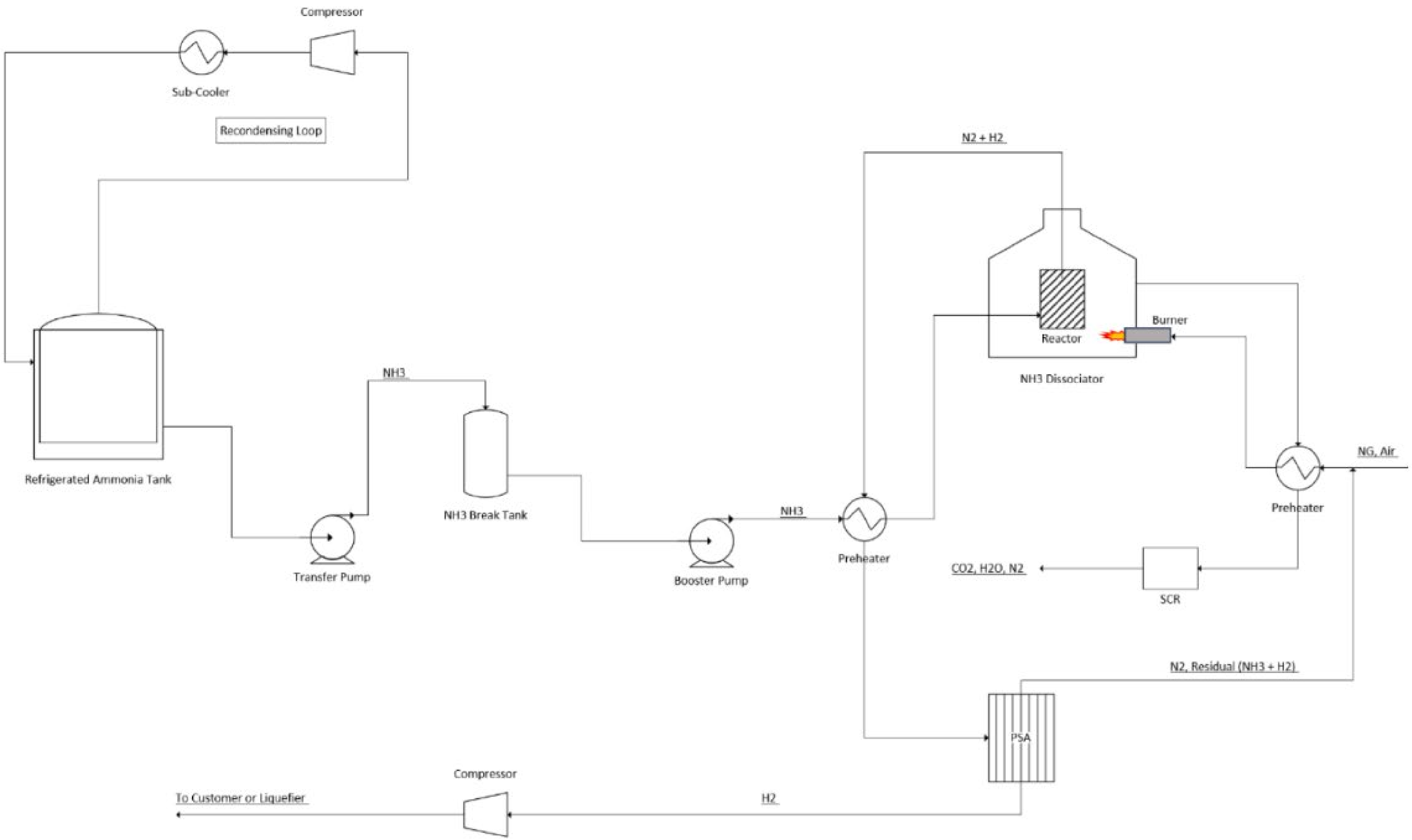
3.3.7 Additional heat exchangers are located in the furnace convection section, before and after the reactor, to recover energy from the flue gas. The convection section also includes heat exchange coils for pre-heating the combustion air and PSA tail gas.

3.3.8 The gas will be recycled to the furnace burners to help reduce the natural gas demand and the carbon intensity of the process. It is anticipated that this process could be further decarbonised in future by using alternative low carbon fuels, potentially including green or low carbon hydrogen (LCH) or biomethane. Any future changes in fuel at the site will be subject to separate determination and a request for variation will be submitted at the time.

3.3.9 Each Hydrogen Production Unit is designed to produce up to 35 MTPD of H_2 and have a thermal capacity estimated at less than 10MW. Therefore, in the initial phase of development up to 30MW would be required for the operation of the initial three hydrogen production units increasing to 60 MW for the operation of up to six hydrogen production units in a future phase.

3.3.10 A simplified process flow diagram of the Hydrogen Production Units is in **Error! Reference source not found.** below.

Figure 2. HPU Simplified Process Flow Diagram



Hydrogen Liquification

3.3.11 The LHY35 hydrogen liquefier will be designed to produce 35 MTPD of sub-cooled liquid hydrogen while loading trailers at a rate of up to 52 MTPD. Cryogenic adsorbers are included at the front end of the process to remove N_2, Ar, CO and CH_4 from the feed gas (if present) before it is liquefied.

3.3.12 There are two forms of H_2 – ortho and para, which differ in the direction of the nucleus spin in the hydrogen atoms. At room temperature, the equilibrium composition of hydrogen is 25% para and 75% ortho. If cooled to liquid temperatures at this normal composition, the equilibrium would move, and liquid hydrogen would slowly convert to 100% para. This conversion is exothermic and the heat of reaction on a mole basis is higher than the heat of vaporisation of the liquid, so the conversion to para would also cause the liquid inventory to boil off. To prevent this from occurring, the hydrogen liquefier includes a series of catalytic reactor beds to progressively convert the ortho hydrogen to para hydrogen as it is cooled down. The final composition is 95% para, which minimises liquid boil-off. There are three primary circuits in the process, described in the following sections.

Hydrogen Feed Circuit

3.3.13 Prior to liquefaction, the feed gas will be cooled to 80 K in the Warm Exchanger and pass across a carbon bed in the Feed Gas 80K Adsorbers, which are designed to remove up to 200 ppm of N_2, Ar, CO and 5 ppm methane from the feed gas for up to 6 days. Dual adsorber vessels will be provided so that one vessel may remain on-line while the other vessel is off-line being regenerated. Regeneration will be performed by depressuring and warming the vessel to ambient temperature to desorb the adsorbed contaminants. The adsorbers can process feed gas with higher levels of contaminants by reducing the on-stream time during the adsorption process.

3.3.14 After removal of trace contaminants, the feed gas will be passed across the first catalyst bed for ortho-para conversion. Due to the heat of reaction, the outlet gas is returned to the Warm Exchanger and cooled back down to 80 K. Because this equipment operates above 80 K, it will be installed in a nitrogen-purged cold box.

3.3.15 The feed gas will subsequently be cooled to 32 K in the Cold Exchanger. As the feed gas cools, it will be passed across additional catalyst beds in series while intercooling at progressively lower temperatures in the Cold Exchanger. The feed gas exiting the final converter will be over 95% para-hydrogen. It will be flashed and then subcooled to 22 K against a slip stream of vaporising hydrogen at lower pressure, and sent to storage or trailer loading. Because this equipment operates below 80 K it will be installed in a vacuum to insulate it from the environment.

3.3.16 The flashed vapour stream will be reheated to ambient temperature in the Warm and Cold Exchangers and recovered into the suction of the IP H_2 Recycle Compressor.

Hydrogen Recycle Circuit

3.3.17 Low and intermediate pressure process flash gas streams and boil-off gas streams from storage and trailer loading will be variously combined, reheated to ambient temperature (if required) and recovered into the LP, IP and MP H_2 Recycle Compressors. After removal of compressor oil, the discharge of the MP Compressor will be cooled in the Warm Exchanger to 80 K.

3.3.18 Trailer loading boil-off gas (and therefore hydrogen recycle gas) can be contaminated with air if trailer loading hoses are not properly purged. If cooled to very low temperatures, any oxygen present in the gas would deposit in the Cold Exchanger as a solid, posing a safety risk. Therefore, in order to remove oxygen the hydrogen recycle gas will be passed across a carbon bed in a H_2 Recycle 80K Adsorber, which will be regenerated approximately once per month.

3.3.19 The purified hydrogen will be split into two streams. The smaller stream will be cooled in the Cold Exchanger and passed across a dedicated recycle ortho-para converter before being mixed with the feed gas. This converter reverts any “back-conversion” to less than 95% para that may have occurred as the hydrogen was processed in the warm temperature compressors and oil removal skid.

3.3.20 The remaining recycle stream will be cooled by progressively expanding it in steps across three expanders in series with additional intercooling through the Cold Exchanger. The expander wheels extract work from the gas as it drops in pressure, producing a larger temperature drop than by simple flashing. The expanders will be oil loaded machines that dissipate the work generated by shearing oil against a rotating drum attached to the same shaft as the expander wheel.

3.3.21 The final expander discharge will then be reheated in the Cold Exchanger providing the refrigeration duty necessary to cool the feed gas and the smaller hydrogen recycle stream. After warming to ambient temperature, the expander discharge is recovered in the MP H_2 Recycle Compressor.

Nitrogen Circuit

3.3.22 Refrigeration will be necessary to cool the hydrogen feed and recycle gas down to 80 K in the Warm Exchanger and this will be provided by expanding high pressure nitrogen across two expanders operating at different temperature and pressure levels.

3.3.23 N_2 comes from the N_2 MP Recycle Compressor and will be split into two streams. One stream will be cooled in the Warm Exchanger and expanded across the expander wheel of the Warm N_2 Compander. This stream will then be returned to the Warm Exchanger where it will be warmed to ambient, cooling the feed and recycle hydrogen streams.

3.3.24 The other stream will be compressed through the compressor wheels of the Warm N_2 Compander and the Cold N_2 Compander, removing heat of compression against cooling water. This high-pressure N_2 will be cooled in the Warm Exchanger and further split into two streams. The larger stream will be expanded across the expander wheel of the Cold N_2 Compander and returned to the Warm Exchanger where it will be warmed to ambient temperature against the cooling H_2 streams. The remainder of the HP N_2 will be flashed in a Surge Tank. The resulting gas stream will be mixed with the expander outlet, while the liquid stream is further flashed and then vaporised in the Warm Exchanger, cooling the feed and hydrogen gas to 80 K.

3.3.25 The two companders are machines consisting of an expander wheel and a compressor wheel attached to the same shaft. As the expander wheel extracts work from the drop in gas pressure, the compressor wheel compresses nitrogen using the generated power.

3.3.26 The warm N_2 streams at two different pressure levels coming out of the Warm Exchanger will be recovered to the suction of the LP and MP N_2 Compressors and recycled back to the cold box.

Tanker Loading

3.3.27 H_2 will be stored in the H_2 storage tanks on the West Site before being loaded into tankers at the trailer filling stations.

3.4 Resource Management

Water Use

3.4.1 The volume of water for the site will not exceed 222.5m^3/h as stated in the DCO application.

3.4.2 The Steam boiler, safety shower, eyewash and welfare drinking water will use potable water.

3.4.3 Non-potable water will be used as make-up for cooling water system due to losses, requirement for make-up to the cooling water system will be continuous. A limited supply will be used for offices (including fire sprinkler systems) and welfare facilities, As agreed with Anglian Water, the maximum non-potable water (service water) supply will be 144m3/hr. However, the peak make-up water demand for cooling water system at the end of phase 3 per estimates is 177 m3/h.

3.4.4 The Operator will install a wastewater treatment package to facilitate r-use in Phase 1 to meet the additional clean water supply requirements by treating blow down waters for reuse. Nalco water has been employed to design blowdown water treatment package. Based on their strong experience they have proposed blowdown recycling through reverse osmosis (RO) combined with multi media filtration (MMF) and ultrafiltration (UF). This this is not a biological treatment method this is for water reuse only.

3.4.5 The Operator also aims to further reduce the make-up water demand for the cooling water system and thus is in discussion with the cooling water system specialists for this purpose.

Raw Materials

3.4.6 The raw materials for the proposed installation are selected at the design stage and reviewed to ensure that the least hazardous materials are used.

3.4.7 NH_3 will be stored in a storage tank situated on the East Site Storage Area and H_2 will be stored in tanks on the West Site. Tanks will be constructed by a specialist tank contractor. The tank will have an inner and outer wall to provide dual containment as explained in the process overview section above.

3.4.8 Additionally, small quantities of chemicals will be stored on the Site, primarily to enable routine maintenance activities, such as oil, diesel and water treatment chemicals. All raw materials will be provided with appropriate containment, including but not limited to storage within bunds having a capacity 110% of the stored materials.

3.4.9 Catalysts will be used at various stages of the H_2 production process and will contain toxic metals.

3.4.10 The storage of hazardous substances will be approved by North East Lincolnshire Council (NELC) through a Hazardous Substances Consent and regulated by the Health and Safety Executive (as the competent authority) through COMAH.

3.4.11 A list of raw materials is provided in Table 2 below

Table 2. Raw Materials

Material	Hazardous Materials Classification	Hazard Statements	Purpose	Estimated Storage Quantity	Storage Type	Annual Consumption (Waste)
Ammonia solution	Hazardous. Toxic	H314 – Causes severe skin burns and eye damage H335 – May cause respiratory irritation H400 – Very toxic to aquatic life	Process	277 tonnes (for 6 HPUs)	Process unit SCR	6,896 tonnes per year (for 6 HPUs)
Ammonia	Hazardous. Toxic, cryogenic.	H332 – Harmful if inhaled H314 – Causes severe skin burns and eye damage H221 – Flammable Gas H280 – Contains gas under pressure: May explode if heated H400 – Very toxic to aquatic life	Process	59,743 tonnes	Tank	None
Hydrogen	Hazardous. Highly flammable.	H220 – Extremely Flammable Gas H280 – Contains gas under pressure, may explode if heated	Product	248 tonnes	Pressurised tank	None
Diesel	Hazardous	H226 – Flammable liquid and vapor. H315 – Causes skin irritation. H304 – May be fatal if swallowed and enters airways. H336 – May cause drowsiness or dizziness.	Common utility	10,000 litres	Tank	<1 tonnes consumed only during power outage scenario

Material	Hazardous Materials Classification	Hazard Statements	Purpose	Estimated Storage Quantity	Storage Type	Annual Consumption (Waste)
		H350 – May cause cancer. H411 – Toxic to aquatic life with long lasting effects. H319 – May cause eye damage/irritation				
MS Corrosion Inhibitor	Hazardous due to phosphoric acid. Dangerous to the environment.	H290 – May be corrosive to metals H314 – Causes severe skin burns and eye damage H318 – Causes serious eye damage	Cooling water treatment	<1,500 litres	Bunded tank	Approx. 2.33 tonnes per year
Cu Inhibitor	Non-hazardous	H314 – Causes severe skin burns and eye damage H318 – Causes serious eye damage H335 – May cause respiratory irritation	Cooling water treatment	<1,500 litres	Bunded tank	Approx. 0.75 kg per year
Scale inhibitor/dispersant	Non-hazardous	No hazard statement(s), no precautionary statement (s) required	Cooling water treatment	<1,500 litres	Bunded tank	Approx. 7.137 tonnes per year
Non-oxidising biocides	Hazardous. Dangerous to the environment.	H319 – Causes eye irritation H312 – May be harmful in contact with skin H302 – Harmful if swallowed H332 – Harmful if inhaled	Cooling water treatment and fire water tank	< 1	Bunded tank	< 1

Material	Hazardous Materials Classification	Hazard Statements	Purpose	Estimated Storage Quantity	Storage Type	Annual Consumption (Waste)
Propylene Glycol	Dangerous to the environment.	No hazard statement(s), no precautionary statement (s) required	Closed loop cooling system	52.8 tonnes (for 6 HPUs)	Pressurised equipment	<1 for making-up the glycol closed loop losses
Sodium hypochloride	Hazardous due to being corrosive and an oxidizer.	H290 – May be corrosive to metals H314 – Causes severe skin burns and eye damage H318 – Causes serious eye damage H400 – Very toxic to aquatic life H411 – Toxic to aquatic life with long lasting effects.	Cooling water treatment	< 5,000 litres	Bunded tank	Approx. 32 tonnes per year
Sulphuric acid 98%	Hazardous. Toxic due to high pH.	H314 – Causes severe skin burns and eye damage H350 – May cause cancer by inhalation H402 – Harmful to aquatic life	Cooling water treatment	< 15,000 litres	Double containment tank (inside kerbed area)	Approx. 120 tonnes per year
Antiscalant	Non-hazardous	No hazard statement(s), no precautionary statement (s) required	Blowdown treatment package	3 daily tanks 100 litres each	Bunded tank	Approx. 0.32 tonnes per year
Ferric chloride 38%	Hazardous	H290 – May be corrosive to metals H302 – Harmful if swallowed H314 – Causes severe skin burns and eye damage	Blowdown treatment package	2 daily tanks 200 litres each	Bunded tank	Approx. 1.1 tonnes per year

Material	Hazardous Materials Classification	Hazard Statements	Purpose	Estimated Storage Quantity	Storage Type	Annual Consumption (Waste)
Sodium metabisulfite (SMBS)	Hazardous	H290 – May be corrosive to metals H302 – Harmful if swallowed	Blowdown treatment package	2 daily tanks 100 litres each	Bunded tank	Approx. 0.49 tonnes per year
Cleaners	Hazardous	H290 – May be corrosive to metals H315 – Causes skin irritation H318 – Causes serious eye damage H373 – May cause damage to organs through prolonged or repeated exposure	Blowdown treatment package	500 litres	Tank	Approx. 0.13 tonnes per year
Sulphuric acid 33%	Hazardous	H314 – Causes severe skin burns and eye damage H402 – Harmful to aquatic life	Blowdown treatment package	2 canisters 25 litres each	Bunded tank	Approx. 0.026 tonnes per year
Sodium hypochlorite	Hazardous due to it being corrosive, oxidizer	H290 – May be corrosive to metals H314 – Causes severe skin burns and eye damage H400 – Very toxic to aquatic life H411 – Toxic to aquatic life with long lasting effects.	Blowdown treatment package	2 daily tanks 100 litres each	Bunded tank	Approx. 0.53 tonnes per year
Oxygen binder	Corrosive	No hazard statement(s), no precautionary statement (s) required	Electric boiler package	30 litre drum	Inside container	Approx. 360 litres per year

Material	Hazardous Materials Classification	Hazard Statements	Purpose	Estimated Storage Quantity	Storage Type	Annual Consumption (Waste)
Nitrogen	Non-hazardous, cryogenic, asphyxiant only. Common utility, back up considered non-hazardous in EU.	H281 – Contains refrigerated gas: may cause cryogenic burns or injury	HPN package	470,000 litres	Pressurised tank	< 1 tonne Will be used only during emergencies or during maintenance of nitrogen generation system
Fired heater catalysts	Hazardous.	H350 – May cause cancer by inhalation H317 – May cause an allergic skin reaction H372 – Causes damage to organs through prolonged or repeated exposure	6 x Precious/semi-precious metal based catalyst	0.25	Intermediate bulk container/drums	0.25 (2-3 years life)
C141/C142 catalysts	Hazardous. Dangerous to the environment, pyrophoric, toxic	H319 – Causes serious eye irritation H315 – Causes skin irritation H251 – Self heating may catch fire H317 – May cause an allergic skin reaction H351 – Suspected of causing cancer H372 – Causes damage to organs through prolonged or repeated exposure H350 – May cause cancer by inhalation	6 x Precious/semi-precious metal based catalyst	0.5	Intermediate bulk container/drums	0.25 (average2-3 years life)

Material	Hazardous Materials Classification	Hazard Statements	Purpose	Estimated Storage Quantity	Storage Type	Annual Consumption (Waste)
		H402 – Harmful to aquatic life H412 – Harmful to aquatic life with long lasting effects.				
SCR catalyst	Non-hazardous.	-	6 x catalyst	1	Intermediate bulk container/drums	0.5 tonnes (average 2-3 years life)
PSA absorber catalyst	Hazardous (carbon is hazardous, sieve and alumina are not). Non-toxic and inert, aluminium toxic to fish in acid conditions.	H316 – Eye irritant (only for carbon)	carbon, molecular sieve, alumina	15	Intermediate bulk container/drums	3 tonnes (average 4-6 year life)
Compressors oil	Not classified	None known	LHY compressor, H_2 Blowers	< 1 tonne	Storage containers	< 1

Waste

3.4.12 Small quantities of operational waste will be generated from the operation and maintenance of the proposed installation, in addition to minor amounts of general waste from plant staff. All waste generated by the proposed installation will be managed in accordance with the waste hierarchy. Any waste will be handled to ensure:

- There is no unauthorized storage, disposal and treatment of waste;
- There is no escape of waste from proper control;
- All waste has separate containers that are labelled correctly;
- Hazardous wastes are stored separately in appropriate containers with warning labels within bunded areas;
- Wastes are only stored for a short period of time where possible;
- Transfer of waste for transport and disposal is only to an authorised person;
- Wastes are segregated where necessary;
- There is a written description of the waste when it is transferred;
- All waste removed from site will be done so under 'Duty of Care' obligations.

3.4.13 When the catalyst change operations need to take place, arrangements will be made so that the waste catalyst is removed as soon as possible for recovery or disposal. If necessary, special storage arrangements would be made on site to temporarily store the catalyst.

3.4.14 Waste ammonia solution will be collected and sent off site for recovery, reuse or treatment as a hazardous waste.

3.4.15 For general/non process waste such as packaging and general office waste, a skip will be placed on site and routinely removed by a licensed waste contractor and packing returned to the supplier where possible.

3.4.16 An Operational Waste Management Plan will be in place once the proposed installation is in place. More details on the waste produced on site is detailed in Section 7.4.

Energy Use and Efficiency

3.4.17 The Project requires a power feed of approximately 90MW for landside works. The East Site will be supplied with electricity via a connection to the Immingham substation from the West Site via the Pipeline Corridor, which will be provided by Northern Power Grid. The voltage level of the supply is approximately 132kV.

3.4.18 The Terminal will be supplied with electricity from a separate connection located in Laporte Road which will connect to an electrical substation on the

East Site for onward transmission to the Terminal. Pressure Swing Adsorber (PSA) waste gas and both have calorific value and are recycled to the reformer for firing thereby reducing natural gas requirements. Plant is designed to recover high grade heat from process to provide feed preheat.

3.4.19 For the East Site, natural gas will be provided by Cadent Gas from a tie-in to a gas main running from an existing gas governor compound on Laporte Road, which is expected to be installed by Cadent Gas. A new intermediate gas connection to the West Site via a tie-in from the existing main intermediate pressure underground gas line beneath Queens Road would be required. Gas will be distributed internally across the West Site and via the Pipeline Corridor to the East Site – Ammonia Storage area.

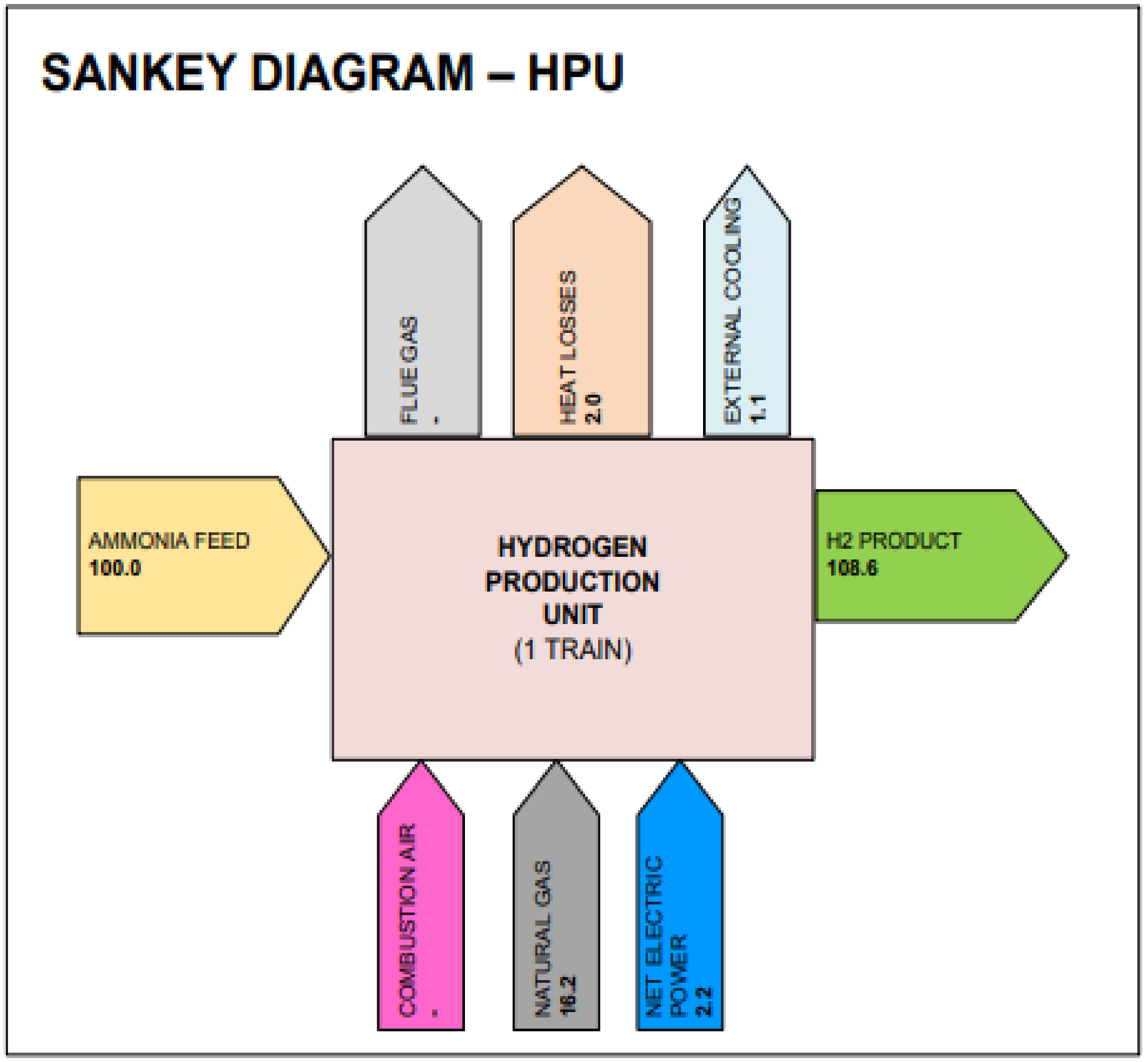
3.4.20 Steam is generated in a separate electric steam boiler using potable water and is used for maintenance purposes only.

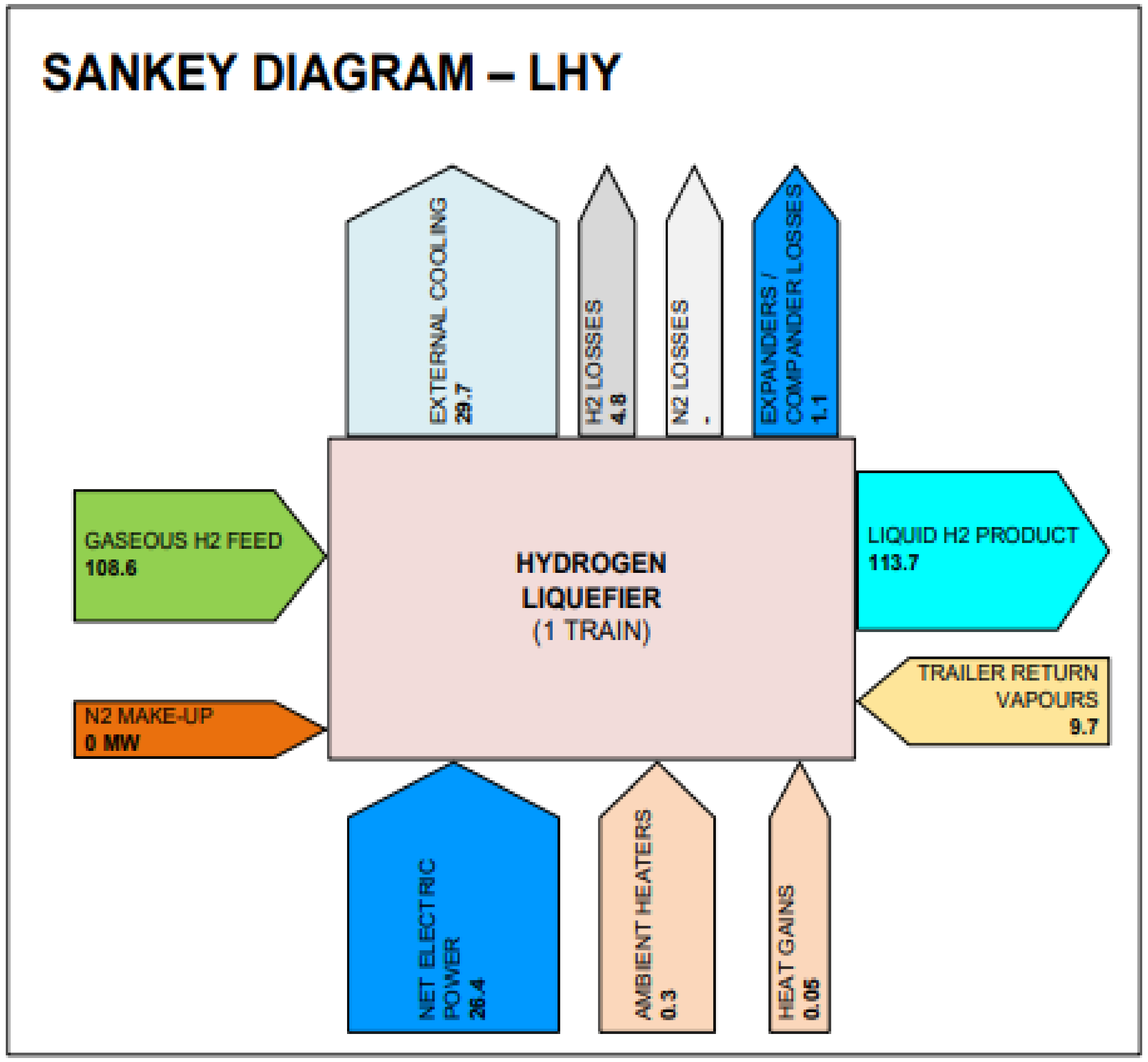
3.4.21 As a large energy user, the Operator has an energy policy and this cascades in practice to energy efficiency targets for each business unit and plant, which are part of the plant key performance indicators. Objectives and targets will be set through the SHE plan to control and minimise the impact of operations, including energy consumption. Periodic energy efficiency assessments will be conducted to identify opportunities for energy savings.

3.4.22 Techniques used to minimise energy consumption will include equipment maintenance and monitoring as part of the preventative maintenance programme. The plant control and maintenance system will be designed to ensure that energy is used as efficiently as possible, with the constraints of the safe operation of the installation.

3.4.23 The energy balance for the HPU and hydrogen liquefier are provided in Figure 2 below. Peak energy consumption with all HPUs and liquefiers in operation is 241.7MW.

Figure 3. Energy Balance Sankey Diagram





3.4.24 Energy efficiency key performance parameters for the HPU and LHY are in Table 3 below.

Table 3. Energy Efficiency Key Performance Parameters

Energy Efficiency Key Performance Parameters (BAT Assessment)	Units	HPU	LHY
Net Feed Gas Energy Conversion Energy content of net hydrogen product / energy content of feed gas (LHV basis)	%	91.1%	96.1%
Electrical Power Consumption Net power import after electrical power generation.	MJ/kg H_2	2.407	26.84
Overall Energy Conversion Energy content of hydrogen product (LHV basis) / overall energy input (LHV basis + power import).	%	89.4%	79.1%
Water Consumption (kg H_2O/ kg gross H_2) (1) Water consumption for process only.	kg **H_2O** /kg **H_2**	0	0
Cooling Duty per unit of H_2 (2) Heat rejected to the cooling medium or air.	MJ/kg H_2	2.81	32.48
Notes: (1) There is no process consumption of water anywhere on the site, only water used for cooling. (2) Includes the heat loss to water cooler, but also losses in the system. (3) Utilities (for example instrument air) consumptions currently not included (consistent with Sankey diagram)			

3.5 IGET Site Layout

3.5.1 Figure 2 Appendix A shows the installation boundary and areas covered by this permit application, containing the East Site, West Site, Pipeline Route and Jetty Topside.

3.5.2 Figure 3 Appendix A shows the indicative site layout within the installation boundary, with Figure 4 (a and b) showing the potential air emissions points within this site layout.

4. Management Arrangements

4.1 Overview

4.1.1 AP operates a formalised Environment, Health and Safety (EH&S) management system covering all their businesses. The management system incorporates the requirements of voluntary systems to which the organisation subscribes and is also consistent with various national and international management systems standards. The most relevant of these for the env installation is BS EN ISO 14001:2015.

4.1.2 AP is also a member of many industry trade associations including the European Industrial Gases Association (EIGA), the British Compressed Gases Association (BCGA) and Chemical Centre for Process Safety (CCPS). These memberships are used to share EH&S best practices and develop environmental guidelines across the sector.

4.1.3 It is AP's policy to maintain consistency with relevant National and International standards and holds certification for all European Operations to BS EN ISO 9001, BS EN ISO 14001, BS EN ISO 46001 and BS EN ISO 18001. The installation will develop EH&S and Quality critical documents specific to the process and these will be controlled within a formal management system which will be certified under the European BS ISO certifications.

4.2 Organisation – Responsibilities and Structure

4.2.1 The H_2 production facility is intended to be a continuous operation, although this will be dependent upon shipping frequency. The intention is therefore that the facility will operate 24 hours a day, seven days a week and 365 day a year. The facility is estimated to have around 120 members of staff, with staff numbers and shift patterns varying across the facility depending upon the duties being undertaken. The Facility Manager role and the 4 Shift Supervisors will have responsibility for the operation of the Hydrogen Production Facility. The operational and maintenance support is flexible and more can be provided at times of peak activity, such as shutdowns. Operational staff numbers and shift patterns will vary across the facility depending upon the duties being undertaken as illustrated in the table below.

Table 4. Staff Roles

Role	Staff Number	Days	Base Location
Facility Manager	1	Mon – Fri	Site
Production Manager	1	Mon – Fri	Site
Integration Manager	1	Mon – Fri	Site
Environment, Health and Safety Coordinator	1	Mon – Fri	AP Central Offices

Role	Staff Number	Days	Base Location
Production Superintendent	1	Mon – Fri	Site
Shift Supervisors	4	7 days a week	Site (shift rotation)
Plant Operators	16	7 days a week	Site (shift rotation)
Jetty Operators (Topside infrastructure)	8	7 days a week	Site (shift rotation)
Clerks	1	Mon – Fri	Site
Plant Maintenance	4	7 days a week	Site
Drivers	50	7 days a week	Transient Work Force
Contractor	8	7 days a week	3rd party contractor
Janitor	2	Mon – Fri	3rd party contractor
Security	9	7 days a week	3rd party contractor
Other workers	14	5 days a week	AP- Transient Work Force Based at the site but will travel outside the site
Total	**120**		

4.2.2 The Facility Manager will be responsible for implementing EH&S policy at local level and will be accountable to the UK Operations Manager. The UK Operations Manager has responsibility for the AP's plants in the UK and reports to the European Operations Director.

4.2.3 The senior AP representative at the proposed installation, with overall responsibility for the safe operation of all of AP's production activities, will be the Facility Manager. Amongst the Facility Managers responsibilities are:

- overall running of operations including; production, maintenance;
- ensuring that all legal requirements, including those of the EPR permit, and Air Products' health, safety and environmental policies are fully implemented;
- ensuring that all safety and environmental targets are achieved;
- achieving good working relationships with the local community and Air Products' customers;
- ensuring that competency assessment procedures are followed for all personnel working at the plant; and,

- ensuring that all personnel receive appropriate leadership and training in order to enhance their overall performance.

4.2.4 Other roles on site are described as follows:

- the Shift Supervisors will be responsible for routine production control and the delegation of tasks during their shift including direction to specialist plant engineers and operators;
- the European Operations group is based at the European Headquarters in Hersham and provides technical and administrative support to all production plants including that at the proposed installation. This includes access to 24-hour support from professional engineering and technical staff;
- the European Environment, and Health and Safety (E and HS) Managers are responsible for setting the EH&S standards for safe operation in Europe and advise all groups on matters of safety, health, environment and training related issues. The UK Field Support Manager, who has a reporting line through to the European HS Manager, will be responsible for providing EH&S support at the site. In addition the European Environmental Advisor, reporting to the European Environment, Manager provides specific environmental support;
- the Facility Manager and their line manager will be responsible for the implementing the EH&S management system on their site. They must ensure they manage safety of their work unit by providing the time, tools, and resources to their team to implement the system. They must coach employees to maintain and improve the process. The performance standard for EH&S leadership and the responsibilities for managers and employees are defined in procedures; and,
- the Facility Manager and their line manager are the links between group procedures and the duty supervisors who operate the plant. They will communicate on a daily basis with the plant operators and feed through information that is of relevance for the safe operation of the plant. For example, they will discuss any near miss occurrence or incident on another Air Products site. The site EH&S Committee will also provide a key focal point in communicating issues and discussing the safety management system.

4.3 Management System

Identification of environmental impacts

4.3.1 Environmental impacts are identified at the design stage in the development of the project environmental strategy (engineering quality procedure) and are additionally reviewed during the hazard and operability study (project hazard review procedure). These impacts are summarised as part of the environmental aspects risk assessment for the site procedure, which fulfils the requirements of the BS EN ISO 14001 compliant aspects assessment.

Compliance with legal requirements

4.3.2 Legal requirements will be built into the EH&S procedures at the appropriate level. Various procedures will provide the requirements for compliance with the EPR permit and general requirements for compliance with legal and other operating permits.

4.3.3 AP operates an SAP based compliance tracking system which is built out with all the relevant permit and legal compliance tasks for the facility. This ensures that these tasks are highlighted, completed on time and action can be taken to correct any non-conformances.

Environmental policy

4.3.4 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.

4.3.5 The policy shall be reviewed regularly and amended where considered necessary. The Chief Executive Officer signs this policy.

Objectives, goals and improvement programme

4.3.6 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.

4.3.7 EH&S plans are developed as part of a cascaded process. The Worldwide EH&S Management develops objectives and goals in conjunction with the business and operational senior leadership. These are based on inputs such as:

- incident and audit trends and findings;
- external legislation;
- waste and emission goals;
- EH&S policy commitments;
- previous EH&S goals;
- feedback from other internal and external interested parties; and,
- environmental aspects assessment.

4.3.8 These can be annual or longer term and are cascaded to the regional EH&S management and down the line via the senior representatives on the committee. Each regional business area develops an annual EH&S action plan, based on the input from the regional EH&S management, on business area specific EH&S issues. In Europe the EH&S Action Plan every fiscal year (Oct - Sept) is formulated by the EH&S, operations and business leadership and is discussed with the Air Products Europe (AP-E) Leadership Council. On agreement by the senior leadership the EH&S Action Plan is issued

4.3.9 The operations organisation develops the group specific action plan, based on the AP-E EH&S Action Plan, which will be cascaded to the plant. The basis of the group plan is the same as AP-E plan but limited to group specific issues.

4.3.10 Site management will develop a site-specific EH&S plan based on the input from the business area EH&S plan, from employees, other relevant interested parties and a site-based assessment of EH&S management system, risk assessments, audit results, permit requirements and incidents as well as any site lead initiatives. This may be during an annual planning meeting attended by all site personnel, with all personnel participating in the decision process based on guidelines provided by site management.

4.3.11 The supervisors responsible for operating all plant and equipment at the proposed installation will have job descriptions, agreed with line management, which include safety and environmental objectives for themselves and communication of those objectives for the whole operation on site, including any that are critical to compliance. These objectives and goals will then be cascaded to responsible individuals and form part of their annual performance appraisal as noted in a leadership procedure. All proposed installation supervisors will have the goal of operating the plant in accordance with the EH&S Management System requirements.

4.3.12 An award and recognition system will be in place to recognise leadership performance in a wide range of EH&S related activities by sites, teams or individuals.

Auditing

4.3.13 The procedures used to manage the environmental performance of the proposed installation will 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;
- 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.

4.3.14 Independent EH&S and Quality audits will be carried out by the European EH&S Department and Air Products 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 will be implemented.

4.3.15 EHS management system self-assessments will be carried out by the site management using the APSAM web based self-assessment tool.

4.3.16 Another means of auditing at the proposed installation will be by carrying out an Operating Plant Hazard Review (OPHR), a procedure requirement. This will be a review carried out at intervals of typically five years for this type of facility, which looks at changes made on the plant since commissioning or since the last review. The methods used during the review can include Hazard and Operability studies (HAZOPs), What If analysis, Consequence analysis, use of checklists, review of near miss incidents, review of management of changes and other appropriate methods. The aim is to ensure that process safety has not been jeopardised by any changes (hardware, procedural, operability, personnel) since the previous review. The OPHR includes a review of site procedures and incorporates a human factors checklist to establish whether the safe operation of the site has been affected.

4.3.17 The Process Safety Department administers the program and the program will be reviewed and updated by line management.

4.3.18 The fire main and hydrants will be periodically audited and tested by AP's insurance company. Inspection reports and records are available at the proposed installation.

Reviewing and reporting performance

4.3.19 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 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, highlighting any trends that may require further action.

4.3.20 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.

4.3.21 The UK Plant Operations Manager will review the performance of the facility with the Facility Manager and provide information on this review at the Operations Organisation's Management Review at European level. Monthly key performance indicators, including environmental and safety items, will be reported.

4.3.22 The overall organisation EH&S performance will be reviewed by the EH&S Incident review committee and at senior Operations management meetings. The Field EHS Manager will review performance with the President and reports on a monthly basis. As a result of these reviews, EH&S Action Plans are formulated or adjusted as required.

4.3.23 AP 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.

Design and capital approval review

4.3.24 AP will operate a formal written procedure for the approval of purchasing and capital expenditure. As part of the authorisation process, environmental considerations including regulatory requirements will be addressed. These issues are covered in the Engineering Quality system procedure and in the operations quality system.

Resource allocation

4.3.25 Resources will be allocated as part of the Capital and Projects approval process and the EH&S action plan process.

Planning and scheduling

4.3.26 The main planning processes will be the Capital and Projects approval process and the EH&S action plan process.

Management reviews

4.3.27 Environmental performance including performance against the environmental management programme will be reviewed on a regular basis. Management reviews are conducted as part of the EN ISO 9001 Quality System/ISO 14001 system, which encompasses the operating procedures and quality and EH&S critical items.

Reporting

4.3.28 Notification and reporting requirements under the EPR permit will be covered in the major emergency procedure and the compliance management system. AP will provide the Environment Agency with an annual report on environmental emissions, waste and resource use, plus any other requirements agreed with the Agency (e.g. PIR reporting).

4.3.29 AP produces an annual Corporate Responsibility Report which is available on the Internet at www.airproducts.com.

4.3.30 AP defines a target audience and appropriate communication with stakeholders for this proposed installation according to the Community Relations procedure.

Environmental cost accounting

4.3.31 It is AP's policy to identify and allocate all costs to the appropriate product or business from which they arise. A procedure will be in place to make it clear that costs associated with waste and emissions must be allocated to the appropriate plant, equipment or product.

Managing documentation and records

4.3.32 The worldwide framework for implementing the broad goals of the EH&S policy can be found in the nineteen applicable EH&S management system elements, each containing specific objectives. For this proposed installation, these will be controlled, and records stored at local level as part of the site BS EN ISO 9001 certification. Documentation management, control and recordkeeping will comply with the above cost accounting procedure, BS EN ISO 9001, or local regulatory requirements, whichever are more stringent.

4.3.33 Environmental issues are reviewed at the design phase during the environmental strategy development and in the HAZOP study. The following HAZOP studies have been performed to date:

- Post HAZOP P&IDs developed for Hydrogen Liquefiers
- Post HAZOP P&IDs in development for Ammonia Crackers
- Pre-HAZOP (operability review) P&IDs developed for sections of remainder of site, outstanding P&ID development ongoing, plan to be issued May 23
- FEED HAZOP and LOPA (Layers of Protection Analysis) were done with Engineering contractors for Liquid Ammonia Storage facility.
- Loading Jetty. HAZID performed with FEED contractors. Ref. No. EN222517-SAIP-PSY-CR4-00001 and EN222517-BEC740-CR4-00001.
- HAZOP undertaken for standard units – Hydrogen Liquefiers & Storage and hydrogen production units(s). Resultant actions implemented or being implemented in design. HAZOP for remainder of plant scheduled to be performed in January 2024, with HAZOP of vendor packages coming in Summer 2024.

4.3.34 In addition, product stewardship reviews cover all aspects of the product life cycle, and these issues are continually reviewed as part of the environmental aspects and risk assessments.

4.3.35 All the issues will also be managed through the relevant operating procedures and the equipment maintained though the preventive maintenance programme.

4.3.36 The following documentation pertinent to effective environmental management of the proposed installation will be stored and controlled appropriately:

- policies;
- roles and responsibilities;
- targets;
- procedures;
- monitoring records;

- results of audits; and,
- results of reviews.

4.4 Competence and training

Air Products staff

4.4.1 The proposed installation will be supervised by staff that are suitably trained and fully conversant with the requirements of the permit. Personnel will have appropriate training to ensure that environmental objectives and targets are met, and that all staff are familiar with those aspects of the permit conditions that are relevant to their duties and that they are competent to perform their duties under the full range of plant operating conditions.

4.4.2 All staff will have a job description which will identify the key accountabilities for the role they perform, and the skills and competencies required for those in key posts (including contractors and purchasing staff). Identification and analysis of training requirements is discussed below. Records will be retained to document the training that has been given and the competencies achieved. 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 and its conditions as they affect work activities and responsibilities;
- potential environmental impacts which could 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 and forms to be used by supervisors or managers for the reporting of deviations from permit conditions to the Environment Agency; and,
- prevention of accidental emissions and action to be taken when accidental emissions occur.

4.4.3 As a general rule, personnel receive refresher training at five-year intervals unless mandated by legislation or corporate requirements. If employee understanding of a topic is not judged to be satisfactory according to the reassessment, then complete retraining will be undertaken.

4.4.4 The minimum requirements for training in EH&S matters to enable employees to perform their work in a safe effective and environmentally responsible manner will be described in a procedure. The proposed installation Supervisor will be responsible for developing training plans (needs assessment) which ensures that all EH&S training, job-related and site-specific training are taken into account. The training plans for employees at the proposed installation will be available; and the site manager will be responsible for organising the training sessions. The proposed installation will utilise an electronic learning solutions (LSO) system which holds all the competence requirements and training for each job role as well a program of future training needs which have been identified.

4.4.5 It is AP's policy to ensure that all personnel are suitably qualified and have sufficient experience to perform their duties competently. AP's requirements for the education and experience of the key personnel described above are summarised below.

Table 5. Typical Education and Experience Requirements for Key Personnel

Position	Education	Experience
Facility Manager	Possibly graduate engineer or appropriate time-served tradesman	Significant (usually >5 years) experience in chemical process industry. Some previous supervisory experience advised.
Duty Supervisors	Time-served tradesman	Significant experience in chemical process industry. Some previous supervisory experience preferred.
Operators	Time-served tradesman	Significant experience in chemical process industry. Some previous supervisory experience preferred.

Purchasing and contractor control

4.4.6 AP will develop and implement procedures to ensure that the environmental risk posed by contractors' work is identified, assessed, and appropriate controls identified. These will ensure that contractors are informed of and adhere to work instructions produced to protect the environment. The standards for contractor selection and review are laid down in an EH&S procedure. The control and monitoring of contractors will also be carried out in accordance with a specific procedure.

4.4.7 Contractors need to become AP approved by completing the relevant documentation supplied by the Purchasing department of Air Products at Hersham. Once approved, they will be added to the SAP supplier database that is maintained centrally by procurement. Evidence of competence & good EH&S culture and performance is required from potential contractors before they are approved for use by AP.

4.4.8 Contractors will be required to undergo formal EH&S training before they are allowed to commence work on the proposed installation.

4.4.9 Contractors will use the "Permit to Work" system at the facility and will be monitored by the supervisors to ensure EH&S standards are being followed.

4.5 Operations and Maintenance

4.5.1 Operating procedures will be written according to the guidelines given in the overarching procedure ‘Operating Procedures’, which requires that Environment, Health, Safety and Quality (EHS&Q) issues are included.

4.5.2 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.

4.5.3 There will also be unplanned outages. A reliability study will be completed to determine the on-stream factor on an annual basis. It will incorporate both planned and unplanned outages in the analysis.

4.5.4 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.

General Maintenance

4.5.5 Routine maintenance will be planned and scheduled, as required by the Original Equipment Manufacturer (OEM) documents.

4.5.6 The H_2 production facility will be designed and operated as a continuous operation, high reliability plant with a run time over 95%. The facility will have a planned preventive maintenance programme. This would include each HPU being shut down for several weeks every two years for catalyst change, whilst other equipment will be taken offline for maintenance regularly without impacting operation of the facility. In order to achieve such a high level of continued operation, certain equipment and controls will be duplicated to allow operations to continue whilst maintenance is underway.

Preventive Maintenance Programmes

4.5.7 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.

4.5.8 The planned maintenance programme will be designed according to the Planned Inspection and Maintenance procedure. This requires that all EHS&Q critical items are covered. The maintenance objectives for the plant will be 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.

4.5.9 A reliability-based maintenance management system (SAP) is used for controlling the maintenance of all AP's production units in Europe, including the proposed installation, and is 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.

4.5.10 At a local level, the Plant Supervisor will be responsible for the maintenance of the facility under his control. The maintenance philosophy is embodied in the 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 will incorporate and schedule 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 AP documents for the Periodic Inspection and Test (PI&T) programme relevant to the plant will be included in the operational procedures.

4.5.11 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;
- monitoring of 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 will be 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.

4.6 Monitoring Systems

4.6.1 The management system for the proposed installation will be monitored by yearly review and independent third party audit. A software package 'APSAM' has been developed to assist in the continual assessment of the implementation of the EHS&Q management system. Monitoring requirements are also incorporated into the relevant procedures, for example checking of waste documentation, storage areas and site physical conditions as well as in some operating procedures such as for monitoring the water treatment chemical dosing.

4.6.2 The operation of the plant will be monitored by the plant monitoring, maintenance and control systems as described in the section below.

Monitoring and Control Systems

4.6.3 The plant will be controlled by a basic process control system (BPCS), often referred to as a distributed control system (DCS). A DCS uses state-of-the-art microprocessors and peripheral equipment designed to comply with the functional requirements of the process in order to maintain steady-state control.

4.6.4 All plant operations will be monitored through PC-based operator consoles. Operator consoles enable the operators to monitor and control process data such as real time variables, set points, controller outputs, motor start/stops and process alarm conditions. Via the console, the operators will be permitted to change all parameters required for process supervising and control. Package units for the facility are provided with their own programmable logic control (PLC) controllers.

4.6.5 The mass balance leak detection system will have it's own dedicated PLC and PC. The process variables like pressure, temperature and flow are continuously monitored using instruments with transmitters transmitting measured variable information to the dedicated PLC which transmits them to the control room. The measured disturbances from the 'ideal' would be flagged to Operator and logged in the system as an separate event.

4.6.6 The BPCS will include a number of critical control loops are summarised in the table below.

Table 6. Critical Control Loops

Area	Control Loop
Jetty	• Mostly automated valves (on/off) that will be opened or closed from the control room coupled with emergency shutdown valves that will close in the event of a process upset. • Ship cargo pump capacity will be controlled via VSD which is an integral part of the Ship and not part of the AP facility Design. • The marine loading operation will be a highly manned operation. Operators will be relied upon to hit emergency shutdown buttons near the jetty head or ESD button in the control room that initiate a shutdown for most scenarios. The first scenario is leak detection. Leaks experienced in the pipeline between the jetty head and the storage tank will be detected by mass balance. A high difference in the mass

	balance will result in an alarm to the operator, the operator will be responsible for the decision to shut down the import. • The movement of the loading arms will be done using hydraulic pack which will be integral part of the loading arm package supplied by Vendor. The marine loading arms will signal when they are outside of their designed range of movement. This will trigger an automatic shutdown of the offloading operation.
NH_3 Storage Area	• The most critical loop in the storage area will be the boil-off compressor control. The pressure controllers (PIC) from a reliable 2oo3 PIC control loop on the ammonia storage tank will modulate the slide valve at the inlet of the compressor system, to maintain the operating pressure of the tank in the range of (35 mbarg to 70 mbarg). • The storage tank will have a control valve (PV) to flare, which is set to open at 85 mbarg, the opening and closing of the valve will be controlled via. reliable 2oo3 PIC control loop. • All ammonia pumps will have dedicated flow control loop (FIC) which will open the minimum continuous flow valve (FV) to avoid pump running below its allowable turndown capacity. Pumps will be provided with temperature safety interlocks, to ensure cold start-up of all the ammonia pumps. • The refrigerated ammonia tank will contain level indicators which have both high- and low-level trips. A low-level trip will prevent export to the HPU. This will be necessary because some liquid is required in the bottom of the tank in order to complete the filling operation from the ships. A high-level trip has more obvious safety functions to prevent overfilling during an import operation. This will close the shutdown valves close to the jetty head and those close to the tank. • As a preventing provision, tanks will be provided with acoustic monitoring system which helps in monitoring the corrosion attack in the inner containment and it gives before failure indication for Air Product to take necessary actions to mitigate the tank failure. There will be gas detectors in the annular space and also temperature sensors with alarms inside the annular space between the two tank walls will alert Air Products to a loss of containment from the inner tank to the outer containment wall. If multiple indicators are confirming this leakage into the annular space, alarms will be initiated, and the operator will take the decision to close the valves to the tank. • The Boil-off-gas (BOG) compressor system will have a compressor machine monitoring system that will allow the early detection of performance deterioration. This allows manual intervention to switch to an alternate compressor in a controlled manner or to reduce the flow of the import operation. • Inside the BOG package there will be some level control loops (LIC) to maintain liquid ammonia level in the Ammonia Receiver and Ammonia Sub-Cooler shell side level. • Leak detection between the storage tank and the HPU will be initiated by the operator on detection of a leak based on two different measurement systems.
HPU	• The natural gas feed to the reformer will have a flow control based on the reformer outlet temperature. This will be designed to ensure that the tubes are not exposed to overtemperatures that could cause material damage. • The flow of combustion air will be controlled via variable frequency drive (VFD) of the air fan. This is based on the feedback signal of oxygen in the flue gas stream, programmed to ensure that the desired percent excess oxygen is maintained. There will be an additional signal which ensures that sufficient pressure of air is supplied to the burners which is fed into the controller. • The reformer unit will contain pressure alarms and shutdowns that will initiate at the appropriate intervals. • Emissions to air from the flue gas stack will be measured by a continuous CEMS analyser. This includes measurement of NO_x and NH_3 concentrations, which will

	be tied into a control loop to adjust the quantity of aqueous ammonia injected into the SCR unit. This will allow Air Products to minimise the quantity of NO_x and NH_3 released to the air on a continuous basis.
Liquefier	• The plant liquefier plant will be flow controlled using a master controller, if it is detected that the pressure is running too high in critical areas of the plant, the flow rate will be decreased. • The liquid hydrogen tank operating pressure will be maintained using pressure control loop (PIC) on the tank, which will route the excess vapor from the tank to the vapor recovery system. • The liquefier storage tanks will have level control with high alarms which will allow the operator to make a decision to turn the plant down to prevent overfill. An overfill scenario will not happen instantly and can therefore respond to warnings at various setpoints. A high-high alarm will initiate a final shutdown. • The compressor systems will be protected via. recycle valve pressure control loop (PIC) and the compression system will have independent pressure control loops (PIC) which will open and vent excess hydrogen inventory in case of process upsets to avoid system overpressure as one of the safety level of protections.
Balance of Plant	• Wastewater sumps will have continuous measurement for contaminants according to the risk of contamination in that area. The sumps act as a holdup volume and if unacceptable contaminants (like oil or ammonia) are detected then the volumes will be trucked out for treatment to third party. • The cooling water system will be kept running on a continuous basis, if there is a drop in cooling water header pressure then a spare pump will be auto started to ensure operation continues.

4.6.7 PLC control systems will be provided by the vendor of the respective package. Interface to the facility DCS for process alarms, real time process variables and control signals will be accomplished via serial communications and hardwired signals. The facility will have three PC-based operator stations, which station configured with dual monitors. Each operator station will have full access to all process variables and is able to control all aspects of the process and subsequent unit operations. The operator stations will be located in the plant control building. A dedicated PC-based data acquisition system will be provided for archiving all process data. Data is typically used for process trending, efficiency calculations and troubleshooting process and equipment anomalies.

4.6.8 The BPCS will provide the basis for monitoring and control. In addition, physical and procedural checks will be in place via the planned maintenance system and monitoring.

4.6.9 Continuous emissions monitoring systems (CEMS) will relay real-time emission data to the operator consoles for operational control only. This data will also be relayed to the plant SCADA system where monitored emission level alarms are set at agreed levels. An alarm highlights any issues to the operator in a timely manner before emission limit values are approached. It will then be an operator action to review the associated process parameters and the current time averaged data and decide if the cause of the alarm is a short-term spike, the result of some other process issue or indeed a problem requiring the process to be halted and waste feed stopped.

4.6.10 Flare monitoring and recording plan is a compliance plan that will be prepared by the facility. Continuous monitoring of the flare system will be done using flowmeter on the main flare header, the flowmeter will transmit information using transmitter to the control system in the control room. Increase in measured flow value by the flare header flowmeter will be a direct indication of the flaring occurrence. All data as generated by the flowmeters will be continuously recorded by computers. The flaring incidences will be recorded and reported to the permitting authorities.

4.6.11 Online monitoring of the heating value of gases to flare system will be done using heating value analyser. The monitoring system will include an output compatible with a data acquisition system (DAS) or similar system that can process data generated by the analyser and record the results. A data recorded compatible with analyser output and capable of recording analyser output will be supplied by the instrument. The flaring incidences will be recorded and reported to the permitting authorities.

4.6.12 All production operations will be controlled by operating procedures which will be developed according to guidelines set out in a specific procedure tested by procedural audit and are continually reviewed in operation. These procedures will implement the operating philosophy and the EH&S policy. These procedures will be part of the plant operations manual and are controlled by a BS EN ISO 9001 quality system.

4.6.13 The AP ‘permit to work’ system will be applied at the facility. This ensures that precautions appropriate to the activity in question are understood, implemented and verified before and after the completion of the activity. The permit to work system controls the number of work permits of any one type in operation in a given area and ensure only compatible activities are taking place at one time. Local procedures covering the permit to work system specific to the facility will be in place.

Process Change

4.6.14 There will be a formal change control process to ensure that the change considers environmental implications. The formal change control process will include changes associated with design, construction and other capital projects. Since the facility will be subject to continual change to increase efficiency and improve safety and operability, there exists the potential for significant changes to introduce new hazards or compromise the safeguards built into the system. The management of change (MOC) procedure will require that an evaluation be conducted to ensure that a significant change does not introduce new hazards or compromise safeguards. The evaluation will be completed before a change can be made. The evaluation may require reviews and/or changes in such areas as relief systems, corrosion protection, training, etc. These MOCs will be recorded, approved and monitored via an electronic management system.

4.7 Emergency Management

Emergency response

4.7.1 The site will have procedures covering a major accident prevention policy and a site emergency plan.

4.7.2 The site accident plan will be subject to periodic review and will be reviewed in light of any environmental accidents, incidents, near misses and identified potential scenarios to ensure that it remains appropriate to the nature and scale of the activities of the proposed installation.

Incidents and Non-Conformances

4.7.3 Incidents and complaints will be reported and investigated in accordance with a specific procedure which defines details to be reported to whom, timings, investigations and legal requirements.

4.7.4 Where appropriate for certain incidents and near misses a detailed root cause analysis report will be carried out. Lessons learnt will be communicated to line management and all facility personnel.

4.7.5 The reporting of incidents and near misses in AP is done electronically using the Air Products Event Management System and records are processed and stored electronically. This will be how reporting will be done at the proposed installation.

4.7.6 Formal written procedures will be implemented at site level to cover:

- the reporting of non-conformances, assigning actions and tracking to completion of the actions;
- the handling, investigating, communicating, and reporting environmental complaints, and tracking the completion of appropriate corrective actions; and,
- the reporting, recording and investigating incidents and near-misses per an AP global procedure. The procedure shall ensure that appropriate corrective actions are identified and tracked to completion via AP's incident tracking system.

4.7.7 All incidents are analysed on a monthly basis by the EH&S department and a report issued to the operating group line management for review at the EH&S committees and the incident review committee. Trends are highlighted, and bulletins are issued so that lessons learned, or common themes are shared throughout the organisation such that procedures, training and Engineering Standards are updated.

Communication

4.7.8 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 is described within a procedure and will be recorded in the AP incident tracking system. EH&S professionals and other specialists take part in the investigation. The reporting of incidents and near misses in AP is done electronically using an incident tracking and management system.

4.7.9 As part of the on-site reporting requirements defined in the site major emergency plan, AP will notify the Environment Agency within 24 hours of any release occurring that exceeds the permitted limit, or any other release occurring, which might cause harm to the environment.

Corrective action to prevent faults re-occurring

4.7.10 Incidents and complaints will be reported and investigated in accordance with its own procedure by a team on site. The site team will be responsible for preparing a report that will record the cause of the incident and recommend corrective actions to avoid repetition. The site will be responsible for closing out all corrective actions. For certain incidents and near misses a detailed root cause analysis report will be carried out. Lessons learnt will be communicated to line management and all facility personnel.

4.7.11 All incidents will be analysed on a quarterly basis by the European EH&S department and a report issued to the operating group line management for review at the EH&S committees. Trends will be highlighted, and bulletins will be issued so that lessons learned or common themes are shared throughout the organisation such that Procedures, training and Engineering Standards are updated.

4.8 Climate Change

4.8.1 As per the EA “Develop a Management System Guidance: Environmental Permits”, climate change adaption will be included within the planning arrangements for the EMS. A climate change adaptation risk assessment has been included in the Environmental Impact Assessment (Section 7) and its associated Appendix K – this assessment will be reviewed in response to new information, plant changes that could require a re-evaluation or in response to lessons learned to ensure it remains current.

5. Emissions

5.1 Overview

5.1.1 This section sets out a summary of the emissions from the proposed installation.

5.2 Emissions to Air

5.2.1 The point source air emissions during the operational phase are as follows:

- Flue Gas Stacks Reformer x6;
- HPU Flares Unit and Pilots x6;
- Ammonia storage flare and Pilots.

5.2.2 The details of the point source emissions are provided in Table 7 and their locations are given in Appendix A Figure 4 (a and b) as part of this document. The final locations of the flare stacks on the West Site are not currently set and the flare stack locations have been modelled at their most likely locations. The construction of the flare stacks in a different location within the same West Site area would not affect the conclusions of the impact assessment given the distance between those potential locations and the nearest receptors.

5.2.3 Other assumptions are that the combustion and process emissions associated with the landside H_2 production units will be operational up to 8760 hours per year and the H_2 plant will be fitted with Selective Catalytic Reduction (SCR) technology to reduce emissions of NO_X. It is anticipated that this will cause NH_3 slip and a reasonable worst case of 5ppm has been considered.

Table 7. Point Source Emissions to Air

Emission Point ID	Description	x	y	Height (minimum)
A1	Reformer Box Top/Flue Gas Stacks	520910	415277	30.5
A2	Reformer Box Top/Flue Gas Stacks	520906	415305	30.5
A3	Reformer Box Top/Flue Gas Stacks	520841	415333	30.5
A4	Reformer Box Top/Flue Gas Stacks	519771	414475	30.5
A5	Reformer Box Top/Flue Gas Stacks	519757	414401	30.5
A6	Reformer Box Top/Flue Gas Stacks	520009,	414578	30.5

Emission Point ID	Description	x	y	Height (minimum)
A7	Hydrogen Production Unit (HPU) Flare Pilot	520952	415363	37
A8	Hydrogen Production Unit (HPU) Flare Pilot	520887	415391	37
A9	Hydrogen Production Unit (HPU) Flare Pilot	520823	415419	37
A10	Hydrogen Production Unit (HPU) Flare Pilot	519687	414505	37
A11	Hydrogen Production Unit (HPU) Flare Pilot	519839	414372	37
A12	Hydrogen Production Unit (HPU) Flare Pilot	520092	414549	37
A13	Ammonia Storage Flare Pilot	520801	415200	55

5.2.4 The main pollutants from the onshore H_2 production units are the NO_x emissions from the combustion of the natural gas and NH_3 from the SCR system.

5.2.5 Flares will also be a source of combustion emissions. The flares will operate for most of the time on pilot mode. They will only operate on flare mode in the event of an emergency, during plant start-up, or when transitioning between operating modes to burn off the release of any uncontrolled NH_3. This kind of flaring should not exceed 200 hours per year.

5.2.6 H_2 venting is an additional point source emission to air which occurs infrequently and takes place through the H_2 vent stacks. This is most likely to take place during plant shut-down or during trailer loading and unloading.

5.2.7 A summary of the emissions to air is presented in Table 8 below:

Table 8. Emissions Data

Parameter	Reformer Box Top/Flue Gas Stacks	Hydrogen Production Unit (HPU) Flare Pilot	Ammonia Storage Flare Pilot	Unit/ Notes
Coordinates	520910, 415277 520906, 415305 520841, 415333 519771, 414475	502952, 415363 520887, 415391 520823, 415419 519687, 414505	520801, 415200	x,y

Parameter	Reformer Box Top/Flue Gas Stacks	Hydrogen Production Unit (HPU) Flare Pilot	Ammonia Storage Flare Pilot	Unit/ Notes
	519757, 520009, 414401 414578	519839, 520092, 414372 414549		
Profile	8760	8760	8760	Hrs/Yr
Height[1]	30.5	37	55	m
Diameter	0.45	0.15	0.6	m
Temperature	144	1700	1700	°C
Mass flow Dry Basis, 3% O2 assumed	6.296	-[3]	-[3]	kg/s
A.Vol Flow	-[3]	0.005	0.009	Am^3/s
N.Vol Flow	4.65	0.001	0.001	Nm^3/s
Emissions Concentration for NOx	94.1	-[3]	-[3]	mg/Nm_3
Emissions Concentration for NH_3[2]	3.5	-[3]	-[3]	mg/Nm_3
Mass Emission Rate for NO_X	0.437	0.002	0.002	g/s
Mass Emission Rate for NH_3[2]	0.016	-[3]	-[3]	g/s
Mass Emission Rate for CO [4]	-[3]	0.014	0.014	g/s
Mass Emission Rate for SO_2 [4]	-[3]	0.00003	0.00003	g/s
Mass Emission Rate for VOCs [4]	-[3]	0.001	0.001	g/s

Notes:
[1] Design not fixed, but 30.5m considered the minimum height envelope and therefore worst-case.
[2] Emissions due to NH_3 slip, provided as 5 ppmv.
[3] Data unavailable due to insufficient model emission source.
[4] Estimated using AP-42 Factor for Natural Gas Combustion in Section 1.4. This note should generally be applied to emission rate for CO, SO2, VOCs. These are considered to be insignificant.
General note: the indicated numbers are preliminary and worst-case assumptions used for the modelling, it would be tuned based on actual available information during detailed engineering, if required.

Fugitive Emissions

5.2.8 There is a risk of fugitive emissions from:

- potential leaks and/or accidents. This are predicted to be minimal (intermittent and short in duration) through mitigation and leak detection; and
- litter and dust which are also predicted to be low risk.

5.3 Emissions To Water

Point Source Emissions to Controlled Waters

5.3.1 Potential Point source releases to controlled waters from the proposed operations consist of clean surface run off - to be collected and gravity feed via an oil-water separator (OWS) to attenuation ponds – one at East Site and one at the West Site.

5.3.2 Outflow from the drainage system from each site is controlled to the agreed runoff rate generated during a 1 in 1-year event by several Hydrobrake® units. The outflow then enters the ditch network surrounding the sites and eventually discharges to the Humber Estuary.

5.3.3 Surface run-off from the ammonia storage area on east site is collected in a NH_3 sump where it can be sampled and tested. Only clean water will be discharged to the external drainage network, if NH_3 is found then arrangements will be made for collection and transfer to offsite disposal.

Point Source Emissions to Sewer

5.3.4 Point source releases to sewer from the proposed operations consist of:

- Condensate from Equipment Drains;
- Cooling Water Blowdown;
- Boiler Blowdown;
- LHY Compressor Building water,
- Floor washdown, condensate and blowdown; and
- Sewerage from welfare facilities.

Emissions to Groundwater

5.3.5 There are no emissions to groundwater.

Fugitive Emissions to Water

5.3.6 Potential impacts on the surrounding surface watercourses includes potential operational accidental spillages, leaks and potential runoff of hazardous fire-fighting chemicals.

5.4 Emissions to Land

5.4.1 All areas on site, with the exception of any landscaped areas (which will be located away from process areas), will be covered in hardstanding. There will be no soakaways on the site. Consequently, no direct emissions to land will occur as a result of the operation of the proposed installation. Regular inspections of the hardstanding areas and drainage systems will be carried out to identify and repair possible damage and prevent any potential releases to land.

5.5 Noise

5.5.1 Potential noise sources on the site include:

- Motors, pumps and drives;
- Fans from the cooling system;
- Flare stack outlets and vent stacks; and
- Traffic movements of vehicles collecting H_2.

5.6 Odour

5.5.2 The Project is not expected to be a significant source of odour emissions, due to the contained nature of the process system. However, with all such systems, there is the risk of fugitive emissions from potential leaks and/or accidents.

Sources are limited to fugitive emissions of NH_3 from potential leaks and controlled emissions from flare stacks and vents. Emissions from leaks will be intermittent and short in duration. Emissions from flare stacks will be continuous, but the proportion of NH_3 is minimal. An Odour Management Plan is provided in Appendix I.

6. Monitoring

6.1 Process Monitoring

6.1.1 Continuous monitoring using a BPCS system as described in more detail under the header Monitoring Systems within the Section 4 Management Techniques & Accident Management.

6.2 Infrastructure

6.2.1 An infrastructure monitoring plan will be implemented at the proposed installation, so as to protect the soil and groundwater underlying the site. Regular inspection of all site infrastructure associated with bulk storage of oils, chemicals and fuels will be undertaken. The routine infrastructure audits are likely to comprise identification of issues relating principally to:

- Minor leaks;
- Standing water in bunded areas.

6.3 Emissions to Air

Point Source Emissions

6.3.1 To control emissions from flare stacks, emissions are released from such a height that dispersion is encouraged, and combustion temperatures are such that NH_3 emissions are minimised. Flare stacks will be monitored as follows:

- continuous monitoring via the BPCS for parameters such as temperature, pressure and flow.
- Periodic measurement every 6 months in accordance with EN14792 for NOx emissions and EN15058 for CO to demonstrate permit compliance.

6.3.2 The H_2 production units will have SCR technology installed to reduce the amount of NO_X released. The H_2 production units will be monitored as follows:

- continuous monitoring via the BPCS for process control purposes including temperature, pressure, flow, NO_x and CO.
- Periodic measurement every 6 months in accordance with EN14792 for NOx emissions, EN15058 for CO and EN21877 to demonstrate permit compliance.

6.3.3 Monitoring for emission parameters will be completed in line with MCERTs or equivalent standards.

6.3.4 Emissions of NO_x, CO and NH_3 will meet the BAT-AELs specified in the BRef for Common Waste Gas Management and Treatment Systems in the Chemical Sector (see Appendix D1).

6.4 Fugitive Emissions

6.4.1 To control fugitive emissions, a leak detection management system will be in place prior to commissioning, ensuring that leaks can be identified and repaired quickly.

6.5 Odour

6.5.1 Mitigation and monitoring of odour emissions will be implemented through the Odour Management Plan (Appendix H). The plan:

- Sets out additional odour control requirements beyond those embedded in the Project design.
- Establish best practice processes.
- Assign responsibilities, including record keeping.
- Set out the odour monitoring regime, including the frequency of sniff tests, the monitoring of meteorological conditions, maintaining an odour diary and logging and investigating complaints.

6.6 Emissions to Water

Point Source Emissions

6.6.1 Monitoring of the outflow from the drainage system will be carried out. Run-off from the process area will go through an Oily Water Separator (OWS) where oil is skimmed off and collected by a third party.

6.6.2 Run-off from possible NH_3 contaminated areas will be collected in a separate ammonia treatment sump where the outlet is blocked so ammonia contaminated water is not routed to the retention pond. When NH_3 is detected using an online analyser, the waste water will be trucked out from the sump to the third party treatment facility.

6.6.3 The potential for surface water to have any contamination either in the form of chemicals, oil or ammonia will be due to spillages or during an emergency only.

Fugitive Emissions

6.6.4 Potential impacts associated with the accidental spillage of polluting materials during the operational phase will be mitigated by way planned preventative maintenance. This will include plant inspections including containment and related checks.

6.6.5 Site maintenance operations will be carried out in accordance with local work instructions and risk assessment and permit to work systems such that any fugitive emissions will be minimised.

6.6.6 Due to the nature of the operation at the Site, no other parameters are considered to require monitoring.

7. Impact Assessment

7.1 Introduction

7.1.1 This section discusses the potential impact on sensitive receptors and the surrounding area and shows how the emissions from the proposed installation have been assessed and minimised.

7.1.2 Guidance contained in the EA guidance – 'Risk assessments for your environmental permit', has been used to scope and assess the emissions from the proposed installation.

7.1.3 Where necessary, baseline impact assessments have been completed to ensure that any predicted significant effects on sensitive receptors can be avoided/ mitigated.

7.2 Site Location and Sensitive Receptors

7.2.1 Potential receptors which could be impacted by the operations of the proposed facility include:

- Residential, commercial and industrial human receptors;
- Habitat receptors associated with designated and other sensitive sites; and
- Location related receptors associated with site geology, hydrogeology and hydrology.

Human Receptors

7.2.2 The receptors are selected to be representative of residential dwellings and recreational areas around the proposed installation and are shown in Table 9.

Table 9. Human Health Sensitive Receptors (from ES Air Quality Chapter)

Receptor ID	X	Y	Description
R1	519388	414955	Residential Property on Kings Road A1173 approximately 0.4km from West Site
R2	519228	414998	Residential Property on Chestnut Avenue approximately 0.5km from West Site
R3	519015	414537	Residential Property on Talbot Road approximately 0.7km from West Site
R4	519141	414353	Residential Property on Somerton Road approximately 0.5km from West Site

Receptor ID	X	Y	Description
R5	519223	414220	Residential Property on Somerton Road approximately 0.5km from West Site
R6	518477	414778	Residential Property on Pelham Road approximately 1.3km from West Site
R7	518237	414294	Residential Property on Margaret Street approximately 1.5km from West Site
R8	519203	413222	Residential Property on Mauxhall Farm/Immingham Road approximately 1.1km from West Site
R9	521279	413116	Residential Property on North Moss Lane approximately 1.9km from West Site
R10	520827	412115	Residential Property on South Marsh Road approximately 2.4km from West Site
R11	519552	411773	Residential Property on Church Lane approximately 2.6km from West Site
R12	527773	410446	Residential Property on Cleethorpe Road approximately 8km from the East Site
R13	523712	418883	Residential Property on Stone Creek approximately 3.1km from the vessel berth
R14	525590	417457	Residential Property on Stone Creek approximately 3.7km from the vessel berth
R15	525030	418688	Residential Property on South Farm Road approximately 3.6km from the vessel berth
R16	524551	418946	Stone Creek Farm approximately 3.6km from the vessel berth
R17	523456	420121	Salthaugh Sands Estate approximately 4.2km from the vessel berth

Sensitive Environmental Habitats

7.2.3 EA guidance requires that the effects of stack emissions on designated ecological sites be assessed where they fall within set distances of the source, up to 10km for European designated sites and up to 2km for nationally designated sites.

7.2.4 Statutory designated sites have been identified through a desk study of the Defra Magic mapping website, which identifies Sites of Special Scientific Interest (SSSIs), RAMSAR sites, Special Protection Areas (SPAs) and Special Areas for Conservation (SACs). The part of the Site boundary within the Humber is within the boundary of the Humber Estuary EMS, which is a statutory designated site that encompasses the Humber Estuary SPA, SAC, RAMSAR and Site of Special Scientific Interest (SSSI) designations.

7.2.5 Laporte Road Brownfield Site Local Wildlife Site (LWS) is located approximately 150m south-east of the Site. The site is also sits on a Wild Bird General Licence Protected Sites Condition Zone.

7.2.6 One otter was recorded within the proposed site and one water vole recorded approximately 55m from the site boundary.

7.2.7 Sensitive nature conservation receptors within 10km of the site boundary used in the ES Air Quality assessment are listed within Table 10 and shown in Appendix A Figure 3 and 4.

Table 10. Sensitive Ecological Receptors (from ES Air Quality Chapter)

Receptor ID	X	Y	Description
E1	523254	418899	Saltmarsh habitat within the Humber Estuary SAC, approximately 2.7km from Vessel Berth
E2	523857	418287	Saltmarsh habitat within the Humber Estuary SAC, approximately 2.9km from Vessel Berth
E3	526249	416864	Saltmarsh habitat within the Humber Estuary SAC, approximately 4.1km from Vessel Berth
E4	527141	416671	Saltmarsh habitat within the Humber Estuary SAC, approximately 5km from Vessel Berth
E5	523790	413174	Saltmarsh habitat within the Humber Estuary SAC, approximately 3.5km from East Site
E6	518347	417802	Saltmarsh habitat within the Humber Estuary SAC, approximately 3.4km from East Site
E7	529069	416859	Saltmarsh habitat within the Humber Estuary SAC, approximately 6.9km from Vessel Berth
E8	525956	411375	Saltmarsh habitat within the Humber Estuary SAC, approximately 6km from Vessel Berth
E9	526333	411086	Saltmarsh habitat within the Humber Estuary SAC, approximately 6.4km from Vessel Berth
E10	527136	410868	Saltmarsh habitat within the Humber Estuary SAC, approximately 7.2km from Vessel Berth
E11	517001	419691	Saltmarsh habitat within the North Killingholme Haven Pitts SSSI, approximately 5.7km from East Site
E12	516492	420321	Saltmarsh habitat within the Humber Estuary SAC, approximately 6.5km from East Site
E13	519830	421761	Saltmarsh habitat within the Humber Estuary SAC, approximately 6km from Vessel Berth

Receptor ID	X	Y	Description
E14	514553	422884	Saltmarsh habitat within the Humber Estuary SAC, approximately 9.7km from East Site
E15	514550	422998	Saltmarsh habitat within the Humber Estuary SAC, approximately 9.7km from East Site
E16	521516	415056	Grassland habitat within an LWS, approximately 0.1km from East Site
E17	518057	415529	Woodland and freshwater habitat within an LWS, approximately 1.8km from West Site
E18	521300	412583	Woodland and freshwater habitat within an LWS, approximately 2.3km from West Site
E19	522057	412228	Grassland habitat within an LWS, approximately 3km from East Site and West Site

Hydrology

7.2.8 The Humber Estuary includes the marine areas required for the proposed Terminal and lies approximately 0.3km from the East Site of the proposed Site.

7.2.9 North Beck Drain, Middle Drain and Habrough Marsh Drain are all located in the vicinity of the Site.

7.2.10 An Anglian Water foul sewer main and the Immingham Sea Outfall are located in proximity to the Site. Surface water from hard standing areas is generally discharged directly to the adjacent watercourses and ultimately to the Humber Estuary, or directly to the Humber Estuary.

7.2.11 The EA 'Flood map for planning' indicates the whole of the Site is located in a Flood Zone 3a (high risk of flooding) that is defined as 'land that has a high probability of flooding (1 in 100 year or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%)'.

7.2.12 Environment Agency groundwater mapping indicates that the Site falls within a Groundwater Source Protection Zone III ("SPZ"). Groundwater SPZs indicate the level of risk to groundwater sources of drinking water from contamination from any activities that may cause pollution to the surrounding area.

Geology

7.2.13 Made Ground is anticipated to be present across the majority of the Site. Made Ground (Undivided) is shown on the BGS GeoIndex in the western half of the East Site and is described as "an area where the pre-existing (natural or artificial) land surface is raised by artificial deposits. The purpose of the made ground is unspecified. Variable composition".

7.2.14 BGS maps show the Site to be underlain by three types of Superficial Deposits; Beach and Tidal Flat Deposits, Tidal Flat Deposits and Devensian Till.

7.2.15 The maps also show the bedrock geology underlying the Site to be Flamborough Chalk Formation underlain by the Burnham Chalk Formation.

Hydrogeology

7.2.16 The EA Groundwater Protection Policy adopts aquifer designations consistent with the Water Framework Directive. According to this system the Beach and Tidal Flat Deposits are classified as Secondary (Undifferentiated) aquifers. The Tidal Flat Deposits are Unproductive Aquifers. The Flamborough Chalk Formation and Burnham Chalk Formation are Principal Aquifers; these are layers of sedimentary rock deposit that have high fracture permeability as a result of the presence of a network of interconnected joints and fissures in the chalk strata. They may support water supply and/ or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifers. There are no licensed surface water abstractions inside, or within 1km of, the Site boundary.

7.2.17 The East Site and West Site have been identified to be on areas of Low groundwater vulnerability from the combination of the productive bedrock aquifer and an unproductive superficial aquifer

7.2.18 The northeast area of the East Site – Hydrogen Production site (Work No. 5) is designated as Medium – High groundwater vulnerability on Defra's MAGIC Maps and as High vulnerability in the Groundsure Report.

7.2.19 As stated above in section 7.2.12, the Site falls within a Groundwater SPZ III.

7.2.20 There are no Drinking Water Safeguard Zones (Surface Waters) in the vicinity of the Site.

7.3 Pathways for Pollution

7.3.1 In order for a pollution risk to occur, there has to be a source – pathway – receptor (S-P-R) linkage.

7.3.2 Pathways to sensitive receptors primarily include, but are not limited to, the following:

- Chemicals required for the operation of the proposed installation might leach into the ground and be washed into surface water or groundwater through the underlying soils.
- Chemicals required for the operation of the proposed installation could be accidentally released and discharged into surface water.
- Emissions to air from the proposed installation will be dispersed in the air to sensitive receptors.

7.3.3 In order to prevent and minimise the risk of pollution, the Site will have dedicated chemical storage areas within appropriate containment to prevent loss of materials to soil as well as controlled waters.

7.3.4 The emissions to air from the HPUs will be controlled via SCR and combustion control and stack heights for HPU flue stacks, flares and H_2 vent have been optimised to a level that dispersion is encouraged.

7.4 Impact Assessment

7.4.1 The following sections provide an assessment of the impact of releases from the Site, so as to underpin and justify the measures that will be put in place for their control and that will adequately protect the environment.

7.4.2 The risk assessment approach has been based on the following four sequential stages:

- Identify risks from the activity;
- Assess the risks and check that they are acceptable;
- Justify appropriate measures to control the risks, if necessary;
- Present the assessment as detailed in the EA's Guidance 'Risk assessments for your environmental permit'.

7.4.3 Activities with the potential to impact on the surrounding environment have been identified in line with guidance provided by the EA, and include the following assessments:

- Amenity and accidents;
- Emissions to surface water;
- Emissions to air;
- Noise
- Site waste;
- Global warming potential;

Amenity and Accidents

7.4.4 A qualitative environmental risk assessment in accordance with EA guidance has been completed and is presented in Appendix J and includes the proposed mitigation measures. A summary of the conclusions is presented below.

Odour

7.4.5 A copy of the air quality assessment undertaken for the ES completed for the DCO application for the whole IGET development is included in Appendix E. An Odour Management Plan is in Appendix H. It is concluded that odour emissions will be minimal during the operation of the proposed installation and therefore do not require further mitigation.

Fugitive Emissions

7.4.6 Based on the various controls placed on the site plant and equipment, it is expected that fugitive emissions from the site, particularly process emissions to air and water will be negligible. The sources reviewed were:

- Windblown dust and particulates from external roads and surfaces;
- Leaks from valves and flanges
- Spillage on surface run-off from pavements, roads and hardstanding

7.4.7 Planned preventative maintenance and inspections are a primary control for fugitive releases. All maintenance activities will be controlled under a permit to work system and will follow a Risk Assessment and Method Statement (RAMS). The RAMS will define the necessary mitigating measures to minimise fugitive emissions from maintenance work.

Visible Plumes

7.4.8 Due to the nature of the operations at the proposed installation, the generation of visible plume from the proposed installation will be unlikely and therefore does not require further assessment.

Accidents

7.4.9 An assessment of major accidents and disasters was carried out for the whole IGET development and is presented in the Major Accidents and Disasters chapter of the ES. It details the main hazards within the proposed installation and identifies appropriate precautionary actions, to prevent or mitigate potentially significant risks.

7.4.10 For the management of accidents with lower environmental risk, an Accident Management Plan (AMP) will be developed to include the proposed installation and all associated equipment.

7.4.11 A number of environmental protection measures will be implemented on site via the EMS to prevent and control spill events, including but not limited to:

- Plans to deal with accidental pollution and any necessary equipment (e.g. spill kits) will be held on site and site personnel will be trained in their use. The EMS will incorporate details on how to appropriately deal with accidental spillages to ensure they are not released into any surface water system.
- Implementation of containment measures, including bunding or double-skinned tanks for oils. All chemicals will be stored in accordance with their COSHH assessments.
- Incorporation of interceptors into the drainage system to prevent spilled fuel entering the surface water drainage system or local water bodies.

7.4.12 In line with BAT, a management plan will be developed as part of the EMS in order to reduce emissions to air and/ or to water during other than normal operating conditions (OTNOC) that includes the following elements:

- set-up and implementation of a specific preventive maintenance plan for these relevant systems;
- review and recording of emissions caused by OTNOC and associated circumstances and implementation of corrective actions if necessary;
- periodic assessment of the overall emissions during OTNOC (e.g. frequency of events, duration, emissions quantification/ estimation) and implementation of corrective actions if necessary.

Flood Risk Assessment

7.4.13 The Environment Agency Flood Map for Planning (FMfP) identifies that the landside part of the Site is located entirely within Flood Zone 3a (due to the presence of flood defences along the Port of Immingham and estuary frontage). Flood Zone 3a is defined by the National Planning Policy Framework (NPPF) and Planning Policy Guidance: Flood risk and coastal change (PPG) as land with a high probability of flooding (>1% Annual Exceedance Probability (AEP) (1 in 100 or greater annual chance of river flooding), or a >0.5% AEP (1 in 200 or greater annual chance) of flooding from the sea.

7.4.14 The following mitigation measures were considered to protect the proposed installation from flood in accordance with the legislative and regulatory authority requirements:

- Flood resistance and resilience measures;
- Flood warnings and alerts;
- Emergency access and egress; and
- Place of Safe Refuge
- Flood emergency response plans; and
- Design capacity exceedance.

7.4.15 The flood risk assessment undertaken as part of the DCO Environmental Statement and is presented as Appendix L.

7.5 Point Source Emissions to Air

H1 Screening

7.5.1 According to the EA's Risk Assessment Guidance, it is possible to screen out 'insignificant' emissions and those emissions where further assessment is not required, based on the National Air Quality Standard (AQS) or National Water Environmental Quality Standards (EQS) for each pollutant.

7.5.2 A H1 screen (Appendix E) was completed on the emissions to air and Emissions to Water.

7.5.3 The output of the screening assessment for point source emissions to air identified that:

- Emissions of carbon monoxide, sulphur dioxide and non-methane volatile organic carbons as benzene were screened as insignificant;
- Emissions of ammonia could not be screened as insignificant; and
- Emissions of nitrogen oxides could not be screened as insignificant for the installation.

As such an air dispersion assessment was required to be undertaken to assess the impact on local air quality as a result of the anticipated emissions identified in Table 8 above;

- Deposition to land was screened as insignificant; and
- The POCP value for ozone impact was 580.29 T.

7.5.4 The back-up diesel generators have not been included in the assessment as they will only be in use during emergency scenarios to power the site and will be in use <500 hours per year. Therefore, the generators will be exempt from emission limit values set at the site.

7.5.5 Based on the output of the H1 air screen, a detailed dispersion assessment was undertaken and is presented in Appendix F, the key findings of the Air Quality Impact Assessment are summarised below.

Air Quality Dispersion Assessment

7.5.6 Air dispersion modelling has been undertaken as part of the DCO application to assess the impact on local air quality as a result of landside plant emissions.

7.5.7 A copy of the air quality assessment is in Appendix F and key findings are summarised below.

7.5.8 The assessment has made assumptions where there is still flexibility in design, including where there is a possible range in stack heights from which emissions will be released. Modelling has considered the minimum height envelope for each release point and therefore the worst case scenario.

7.5.9 Other assumptions made for the purpose of modelling of onsite plant emissions are as follows:

- Combustion and process emissions associated with the landside hydrogen production units will be operational up to 8760 hours per year.
- Hydrogen plant will be fitted with SCR to reduce emissions of NO_X. It is anticipated that this will cause NH_3 slip and a reasonable worst case of 5ppm has been considered.
- Combustion emissions associated with flares will be operational on pilot mode for 8760 hours per year. The controlled flaring of NH_3 emissions will only occur in the event of an emergency, or when plant requires start-up.

7.5.10 Meteorological data used in the air quality assessment has been sourced from the nearest and most representative meteorological monitoring site, Humberside Airport, which is approximately 13km southwest of the Site. This data is considered the most representative data available close to the Site. Due to the inter-annual variation in meteorological conditions, five years of data have been used in the modelling of point source emissions to account for that variability, in accordance with Environment Agency guidance.

7.5.11 DEFRA and APIS background data have been used to represent background pollutant concentration data in the study area, including nearby industry and the Port of Immingham.

7.5.12 Residential use of a number of mixed residential/commercial properties that currently stand on the West Site will no longer be there during operation and have not been included in the assessment.

7.5.13 For the purpose of the DCO, the modelling was done taking in to account all operational air emissions, including vessel and road traffic emissions that are not relevant to this permit application.

7.5.14 Operational pollutant concentrations at the nearest human health sensitive receptors are presented in Table 11 below.

Table 11. Operational concentrations at nearest human health sensitive receptors for 2028 (also representing 2036) – Assuming MARPOL Tier III Emissions Standards (with SCR) (taken from ES Air Quality Assessment)

Receptor ID	Annual Mean Background Contribution (µg/m3)	Annual Mean Modelled IGET Contribution (µg/m3)	Annual Mean Concentration (µg/m3)						
	NO_2	PM_{10}	$PM_{2.5}$	NO_2	PM_{10}	$PM_{2.5}$	NO_2	PM_{10}	$PM_{2.5}$
R1	13.8	14.1	8.0	0.3	<0.1	<0.1	14.1	14.1	8.0
R2	13.8	14.1	8.0	0.2	<0.1	<0.1	14.1	14.1	8.0
R3	13.8	14.1	8.0	0.2	<0.1	<0.1	14.1	14.1	8.0
R4	13.8	14.1	8.0	0.3	<0.1	<0.1	14.1	14.1	8.0
R5	13.8	14.1	8.0	0.3	<0.1	<0.1	14.2	14.1	8.0
R6	11.11	13.2	7.9	0.1	<0.1	<0.1	11.2	13.2	7.9
R7	11.11	13.2	7.9	0.1	<0.1	<0.1	11.2	13.2	7.9
R8	9.9	15.3	8.2	0.2	<0.1	<0.1	10.0	15.3	8.2
R9	10.1	14.9	8.0	0.1	<0.1	<0.1	10.2	14.9	8.0
R10	9.9	15.3	8.2	0.1	<0.1	<0.1	10.0	15.3	8.2
R11	8.5	14.8	8.0	0.1	<0.1	<0.1	8.6	14.8	8.0
R12	17.5	12.6	8.0	<0.1	<0.1	<0.1	17.5	12.6	8.0
R13	11.3	11.1	7.0	0.3	<0.1	<0.1	11.6	11.1	7.0
R14	10.6	14.3	7.7	0.1	<0.1	<0.1	10.8	14.3	7.7

Receptor ID	Annual Mean Background Contribution (µg/m3)	Annual Mean Modelled IGET Contribution (µg/m3)	Annual Mean Concentration (µg/m3)						
	NO_2	PM_{10}	$PM_{2.5}$	NO_2	PM_{10}	$PM_{2.5}$	NO_2	PM_{10}	$PM_{2.5}$
R15	10.0	14.5	7.7	0.2	<0.1	<0.1	10.2	14.5	7.7
R16	10.6	13.5	7.5	0.2	<0.1	<0.1	10.2	13.5	7.5
R17	9.7	14.5	7.7	0.2	<0.1	<0.1	9.9	14.5	7.7

7.5.15 Operational concentrations and deposition rates at selected nature conservation sensitive receptors are presented in Table 12 below.

Table 12. Operational concentrations and deposition rates at selected nature conservation sensitive receptors for 2028 (also representing 2036) – Assuming MARPOL Tier III Emissions Standards (with SCR)

Rec. ID	Annual Mean Background Contribution (µg/m³)[1]				Annual Mean Modelled IGET Contribution (µg/m³)[3]				Annual Mean Concentration/ Deposition Rate (µg/m³)[4]			
	NO_x	SO_2	NH_3	N-dep	NO_x	SO_2	NH_3	N-dep	NO_x	SO_2	NH_3	N-dep
	µg/m³			kgN/ ha/yr	µg/m³			kgN/ ha/yr	µg/m³			kgN/ ha/yr
E1	15.1	2.1	1.5	**14.6**	0.5	<0.1	0.01	0.10	15.6	2.1	1.6	**14.7**
E2	15.1	2.1	1.5	**14.6**	0.5	<0.1	0.01	0.11	15.7	2.1	1.6	**14.7**
E3	14.9	1.8	1.6	**13.9**	0.2	<0.1	<0.01	0.04	15.1	1.8	1.6	**13.9**
E4	13.8	1.7	1.6	**13.9**	0.2	<0.1	<0.01	0.03	13.9	1.7	1.6	**13.9**
E5	16.6	3.9	1.5	**14.7**	0.1	<0.1	<0.01	0.03	16.7	3.9	1.5	**14.7**
E6	19.1	3.4	1.6	**16.0**	0.1	<0.1	<0.01	0.02	19.2	3.4	1.6	**16.0**
E7	12.6	1.6	1.6	**13.9**	0.1	<0.1	<0.01	0.02	12.7	1.6	1.6	**13.9**
E8	14.6	2.2	1.5	**14.7**	<0.1	<0.1	<0.01	0.01	14.6	2.2	1.5	**14.7**
E9	15.8	1.9	1.5	**14.7**	<0.1	<0.1	<0.01	0.01	15.8	1.9	1.5	**14.7**
E10	25.1	2.8	1.6	**13.5**	<0.1	<0.1	<0.01	0.01	25.2	2.8	1.6	**13.5**
E11	21.1	3.4	1.6	**16.0**	<0.1	<0.1	<0.01	0.01	21.2	3.4	1.6	**16.0**
E12	36.5	3.0	1.6	**16.0**	<0.1	<0.1	<0.01	0.01	**36.5**	3.0	1.6	**16.0**
E13	13.6	2.0	1.5	**14.6**	0.1	<0.1	<0.01	0.01	13.7	2.0	1.5	**14.6**
E14	11.6	1.7	2.1	**16.1**	<0.1	<0.1	<0.01	0.01	11.7	1.7	2.1	**16.1**
E15	11.6	1.7	2.1	**16.1**	<0.1	<0.1	<0.01	0.01	11.7	1.7	2.1	**16.1**

Rec. ID	Annual Mean Background Contribution (µg/m³)[1]				Annual Mean Modelled IGET Contribution (µg/m³)[3]				Annual Mean Concentration/ Deposition Rate (µg/m³)[4]			
	NO_x	SO_2	NH_3	N-dep	NO_x	SO_2	NH_3	N-dep	NO_x	SO_2	NH_3	N-dep
	µg/m³			kgN/ ha/yr	µg/m³			kgN/ ha/yr	µg/m³			kgN/ ha/yr
E16	18.4	3.2	1.5	**14.7**	0.8	<0.1	0.02	0.20	19.2	3.2	1.6	**14.9**
E17	16.2	3.53	1.6	**25.5**	0.1	<0.1	<0.01	0.03	18.5	3.5	1.6	**25.5**
E18	13.1	1.75	1.5	**26.0**	0.1	<0.1	<0.01	0.03	18.5	1.8	1.5	**26.1**
E19	15.1	2.1	1.5	**14.6**	0.5	<0.1	0.01	0.10	15.6	2.1	1.6	**14.7**

7.5.16 In Table 12 above, receptor E12 experiences an annual mean NO_X concentration in excess of the Critical Level for that pollutant. However, the contribution from the Project account for less than 1% of the Critical Level at that location.

7.5.17 Also the contribution to annual mean NO_X concentrations from the Tier III vessel emissions accounts for around 70% of the impact and site emissions around 30% of the impact at the worst affected receptors in the SAC (E1 and E2). Elsewhere, there is a relatively even split between the contribution from vessels and site. The contribution to nitrogen deposition from the Tier III vessel emissions accounts for around 58% of the impact and site emissions around 42% of the impact at those worst affected receptors. Elsewhere, site emissions account for a greater proportion of the nitrogen deposition impact.

7.5.18 The contribution to site-wide process contribution from site emissions alone are in Tables 14 – 17. Table 14 and Table 15 assume MARPOL Tier II standards and Table 16 and Table 17 assume MARPOL Tier III standards.

Table 13. Percentage contribution to site-wide PC from Site Emissions (MARPOL Tier II Standards)

Receptor ID	Contribution to site-wide PC from Site Emissions (%)		
	Annual Mean NO_x PC	Annual Mean NH_3 PC	N Deposition Rate PC
E1	11	100	26
E2	9	100	22
E3	14	100	32
E4	16	100	36
E5	20	100	42
E6	20	100	43
E7	18	100	39

Receptor ID	Contribution to site-wide PC from Site Emissions (%)		
	Annual Mean NO_x PC	Annual Mean NH_3 PC	N Deposition Rate PC
E8	23	100	47
E9	23	100	47
E10	24	100	48
E11	19	100	41
E12	19	100	40
E13	28	100	53
E14	20	100	42
E15	20	100	42
E16	37	100	63
E17	29	100	54
E18	18	100	40
E19	20	100	43

Table 14. Contribution to site-wide PC from Site Emissions (MARPOL Tier II Standards)

Receptor ID	Contribution to site-wide PC from Site Emissions (µg/m3)		
	Annual Mean NO_x PC	Annual Mean NH_3 PC	N Deposition Rate PC
E1	0.16	0.01	0.05
E2	0.15	0.01	0.04
E3	0.08	0.00	0.02
E4	0.07	0.00	0.02
E5	0.05	0.00	0.02
E6	0.04	0.00	0.01
E7	0.05	0.00	0.01
E8	0.02	0.00	0.01
E9	0.02	0.00	0.01
E10	0.02	0.00	0.01

Receptor ID	Contribution to site-wide PC from Site Emissions (µg/m3)		
	Annual Mean NO_x PC	Annual Mean NH_3 PC	N Deposition Rate PC
E11	0.02	0.00	0.01
E12	0.02	0.00	0.01
E13	0.03	0.00	0.01
E14	0.01	0.00	0.00
E15	0.01	0.00	0.00
E16	0.54	0.02	0.16
E17	0.08	0.00	0.02
E18	0.06	0.00	0.02
E19	0.05	0.00	0.01

Table 15. Percentage contribution to site-wide PC from Site Emissions (MARPOL Tier III Standards)

Receptor ID	Contribution to site-wide PC from Site Emissions (%)		
	Annual Mean NO_x PC	Annual Mean NH_3 PC	N Deposition Rate PC
E1	32	56	45
E2	28	50	39
E3	38	62	51
E4	42	66	55
E5	49	72	62
E6	50	73	63
E7	46	70	59
E8	54	76	66
E9	54	76	66
E10	55	76	67
E11	47	71	62
E12	47	71	60
E13	59	80	71

Receptor ID	Contribution to site-wide PC from Site Emissions (%)		
	Annual Mean NO_x PC	Annual Mean NH_3 PC	N Deposition Rate PC
E14	48	72	61
E15	48	72	62
E16	70	86	80
E17	61	81	73
E18	47	70	60
E19	50	73	63

Table 16. Contribution to site-wide PC from Site Emissions (MARPOL Tier III Standards)

Receptor ID	Contribution to site-wide PC from Site Emissions (ug/m3)		
	Annual Mean NO_x PC	Annual Mean NH_3 PC	N Deposition Rate PC
E1	0.16	0.01	0.05
E2	0.15	0.01	0.04
E3	0.08	0.00	0.02
E4	0.04	0.00	0.02
E5	0.05	0.00	0.02
E6	0.04	0.00	0.01
E7	0.05	0.00	0.01
E8	0.02	0.00	0.01
E9	0.02	0.00	0.01
E10	0.02	0.00	0.01
E11	0.02	0.00	0.01
E12	0.02	0.00	0.01
E13	0.03	0.00	0.01
E14	0.01	0.00	0.00
E15	0.01	0.00	0.00

Receptor ID	Contribution to site-wide PC from Site Emissions (ug/m3)		
	Annual Mean NO_x PC	Annual Mean NH_3 PC	N Deposition Rate PC
E16	0.55	0.02	0.16
E17	0.08	0.00	0.02
E18	0.06	0.00	0.02
E19	0.05	0.00	0.01

7.5.19 The future baseline conditions in 2028 (also representing 2036) can be summarised as follows:

- At the human health sensitive receptors, air quality is of a good standard and there is considered no risk of an exceedance of an air quality objective,
- At the sensitive nature conservation receptors, annual mean NO_X concentrations exceed the Critical Level at the location of receptor E12 but are below or well below the Critical Level at all other locations considered. Concentrations appear to be elevated at E12 because of emissions associated with the Humber Sea Terminal,
- Annual mean concentrations of SO_2 and NH_3 are well below their respective Critical Levels,
- Nitrogen deposition rates are in excess of the lower Critical Load value for saltmarsh habitat (10 kg/ha/yr) but also less than the upper Critical Load value at all receptors considered.

7.6 Point Source Emissions to Water

7.6.1 The EA guidance for assessing releases to controlled waters sets out a sequential assessment methodology for discharges to estuaries or coastal waters.

7.6.2 The discharge from the installation will be to sewer and it is anticipated that the Immingham wastewater treatment plant will discharge to the Humber Estuary. The first step of the screening assessment is to identify if the discharge pollutants exceed the EQS – those pollutants below the EQS can be screened out at this stage.

7.6.3 The predicted quality of the water discharged to sewer from the site is presented below and the stage 1 screen is presented against each parameter.

Table 17. Quality of Discharges to Sewer

Parameter	Unit	EQS	Discharge Quality	Above EQS
Total suspended solids	Mg/l	15.21	N/A	N/A
Turbidity NTU	Mg/l	30.41	N/A	N/A
Calcium	Mg/l	1,948.55	N/A	N/A
Magnesium	Mg/l	80.38	N/A	N/A

Sodium	Mg/l	607.82	N/A	N/A
Ammonium	Mg/l	0.79	0.021	Yes
Iron	Mg/l	15.62	1	Yes
Copper	Mg/l	0.27	0.00376	Yes
Chlorides	Mg/l	1,045.69	N/A	N/A
Sulfates	Mg/l	4,052.66	N/A	N/A
Fluoride	Mg/l	3.96	5	No
Total Phosphorous	Mg/l	4.48	N/A	N/A
Phosphate	Mg/l	13.44	N/A	N/A
Total Dissolved Solids	Mg/l	8,239.51	N/A	N/A
Conductivity	µs/cm	10,702.6	N/A	N/A
pH	-	8.2	N/A	N/A
Alkalinity	mEq/l	7.53	N/A	N/A
Total Hardness	mEq/l	104.13	N/A	N/A
COD	ppm	<500	N/A	N/A

7.6.4 Based on the stage 1 screen, copper, iron, phosphates and ammonium have been identified as requiring to be screened using the H1 tool. This is presented in Appendix E and showed that potential impacts for water discharges passed the H1 screening tests and could be considered insignificant.

7.6.5 Sewage from the welfare on site is not included in the H1 assessment

7.7 Noise

7.7.1 An assessment of the potential noise impacts was completed as part of the Noise Assessment undertaken for the Environmental Statement completed for the Development Consent Order (DCO) application for the whole IGET Development. A Noise Impact Assessment and Noise Management Plan also accompany this application (Appendix G and H).

7.7.2 Operational noise at residential noise sensitive receptors (NSR) was assessed, using the highest predicted noise levels. Several models were created using different layouts and orientations of HPUs and Hydrogen Liquefier units across the Work Plan areas without additional noise mitigation that is considered as embedded or standard, therefore considered a reasonable worst-case assessment scenario.

7.7.3 The operational noise modelling comprises two main scenarios: Phase 1 operation of the associated development, potentially representative of the first three years after opening, and then full operation of Phases 1-6 thereafter.

7.7.4 The assessment has assumed that potential noise of a tonal, impulsive or intermittent nature (according to BS4142: 2014) will be designed out of the Project during the detailed design phase by the selection of appropriate plant, building cladding, louvres and silencers/ attenuators as necessary. However, inclusion of a +3 dB correction for other distinctive character has been included at this stage as a conservative approach for NSR with the potential to identify the new sound source in their existing acoustic environment.

7.7.5 For NSRs on the eastern edge of Immingham to the west (NSR3 and NSR 4), predicted effects range between negligible/minor adverse, minor/moderate adverse (potentially significant, with some NSRs being at or above the LOAEL and approaching the SOAEL) to major adverse (significant, and above the SOAEL) depending upon time period and phase of Project buildout.

7.7.6 Based on the worst-case results above, additional mitigation would be required to achieve the operational daytime and night-time LOAEL criterion of a rating level no greater than +5 dB above the defined representative background sound level at each NSR.

7.7.7 Flaring has not been included in the noise assessment as it is not considered as part of the standard day-to-day operations and will be used only in emergency scenarios, as stated in Section 3.2.11.

7.7.8 The back-up diesel generators have also not been included in the assessment as they will only be in use during emergency scenarios to power the site and will be in use <500 hours per year. Usage will be recorded as part of Air Products' management systems and procedures.

7.8 Site Waste

7.8.1 Operational wastes from the operation of the proposed installation include:

- Waste from the control room, workshop e.g. general wastes.
- Waste from the operation of hydrogen production units and liquefiers.

7.8.2 The expected operational waste arisings are presented in the table below.

Table 18. Operation Waste Arisings

<table>
<tr><th>Waste Type</th><th>Waste Description</th><th>Frequency of Disposal</th><th>Waste Classification</th><th>Estimated Quantity (tonnes)</th><th>Estimated Quantity (m3)</th></tr>
<tr><td>Catalyst (hazardous)</td><td>Solid</td><td>2-3 years</td><td>Hazardous</td><td rowspan="2">Not applicable (n/a), assessed in m^3 only</td><td>2</td></tr>
<tr><td>Catalyst (non-hazardous)</td><td>Solid</td><td>5-6 years</td><td>Non-hazardous</td><td>15</td></tr>
<tr><td>Diesel</td><td>Liquid</td><td>Annual total</td><td>Hazardous</td><td>1</td><td>n/a, assessed in tonnes only</td></tr>
<tr><td>Ammonia solution</td><td>Liquid</td><td>1-2 years</td><td>Hazardous</td><td>228</td><td>n/a, assessed in tonnes only</td></tr>
<tr><td>Compressor oil</td><td>Liquid</td><td>Annual total</td><td>Hazardous</td><td>1</td><td>n/a, assessed in tonnes only</td></tr>
<tr><td>General waste</td><td>Solid</td><td>Annual total</td><td>Non-hazardous</td><td rowspan="3">n/a, assessed in m^3 only</td><td>95</td></tr>
<tr><td>Packaging</td><td>Solid</td><td>Annual total</td><td>Non-hazardous</td><td>48</td></tr>
<tr><td>Scrap metals</td><td>Solid</td><td>Annual total</td><td>Non-hazardous</td><td>24</td></tr>
<tr><td>Total liquid hazardous</td><td>Liquid</td><td>Annual total</td><td>Hazardous</td><td>230</td><td></td></tr>
</table>

Waste Type	Waste Description	Frequency of Disposal	Waste Classification	Estimated Quantity (tonnes)	Estimated Quantity (m3)
waste (tonnes)					
Total solid hazardous waste (m^3)	Solid	Annual total	Hazardous		7
Total solid non-hazardous (m^3)	Solid	Annual total	Non-hazardous		182

7.8.3 All operational waste, likely to comprise minor quantities of waste generated by maintenance activities, will be dealt with in accordance with the site's waste management procedures, with appropriate designated storage areas for hazardous and non-hazardous wastes, and consigned via a registered waste carrier for treatment or disposal at a suitably licenced waste facility.

7.8.4 It is therefore considered that further assessment of the waste from the proposed site operations is not required.

7.9 Global Warming Potential

7.8.5 To understand the global warming potential of the proposed installation, the H1 methodology has been utilised. The current version of the tool is not fully operational at the time of writing. This section is based on guidance presented in the EA guidance – "Assess the impact of air emissions on global warming".

7.8.6 The proposed installation will not produce direct greenhouse gas emissions and carbon dioxide emissions are linked to the energy and fuel use at the site.

7.8.7 Details of the global warming potential are presented in the table below.

Table 19. Global Warming Potential

Fuel	Use (MWh)	Conversion factor: tonnes per megawatt hour	Global warming potential factor for carbon dioxide	Total carbon dioxide (tonnes)
Electricity(1)	31,000	0.166	1	5,145
Natural gas	134,816.4	0.19	1	25,615.12
Hydrogen rich Gas	202,225	0	1	0
Diesel (emergency generator)	600	0.25	1	150
It should be noted that electricity supply will be via a power purchase agreement to secure electricity from renewable sources.				

7.10 Climate Risk Assessment

7.8.8 The Environment Agency's "*Adapting to Climate Change: Risk Assessment for Your Environmental Permit*" guidance identifies that a climate change risk assessment should be completed for a bespoke installation which is expected to operate for more than 5 years.

7.8.9 The guidance also outlines the general approach to completing the risk assessment which comprises:

a. Complete a screening assessment which is normally completed at the time of application – this is summarised in Table 20. EA Screening Assessment below;

b. Where the screening score is greater than 5 then a full risk assessment is required – this involves completion of the relevant EA climate change risk assessment worksheet associated with the river basin area in which the site is located.

c. Identification of the controls and management measures that will be applied for potentially any significant risks that may be identified.

Screening Assessment

7.8.10 The screening assessment is summarised in Table 20. EA Screening Assessment below.

Table 20. EA Screening Assessment

Category	Screening Questions	Score	Site Score
Timescales	***How long will a permit be required for the facility?***		
	5 years or less (no need to complete rest of screening and no requirement for a risk assessment)	0	
	<20 years operation	1	
	Until between 2040 and 2060 (between 20 – 40 years from now).	3	✓
	Until 2060 or beyond (>40 years from now)	5	
Flooding	***What is your site's risk of flooding from the sea?***		
	Not in a flood-risk zone	0	
	Very low or low	1	
	Medium	3	✓
	High	5	
Water Use	***If you use water for your site operations or fire prevention, what is the source of the water.***		
	Water not required	0	

	Mains water	1	✓
	Surface water or groundwater abstraction	5	
TOTAL SCORE			**7**

7.8.11 The screening assessment confirmed that a risk assessment should be completed which considers how vulnerable the site is in current and future climates taking into consideration in site specific aspects. It has been completed on the EA risk assessment worksheet for the river basin where the site is located. The installation will be situated in the Humber River basin district and the completed risk assessment worksheet is presented in Appendix K.

7.8.12 The proposed controls and mitigation measures are detailed on the completed risk assessment, and these will be reviewed and managed as part of the EMS.

8. Decommissioning and Closure

8.1.1 A plan for appropriate decommissioning and closure of the proposed installation at the end of its operating life will be developed by the operator. The plan will ensure that the site is returned to the baseline condition.

8.1.2 Decommissioning would be undertaken safely, in line with specific procedures and subject to risk assessment and permit to work schemes, and with regard to the environmental legislation at the time of decommissioning. The required licences and permits would also be acquired.

8.1.3 Decommissioning of the H_2 production facility would likely involve leaving underground infrastructure such as pipelines, piles, foundations, culverts and drainage in situ and making them safe. All above ground infrastructure associated with the Project would likely be dismantled and all materials removed would be reused or recycled where possible or disposed of in accordance with relevant waste disposal regulations at the time of decommissioning. Land would be restored to a satisfactory state.

8.1.4 When the installation is decommissioned and taken permanently out of service, the following steps will be taken:

1. Reduce waste inventory to zero by treating or shipment off site.
2. Shut and cool down the process equipment and make safe
3. Purge all plant piping and equipment with nitrogen to assure that the atmosphere in the vessels is below the lower explosive limits (LEL).
4. Close battery limit valves for all connecting services, including natural gas, cooling water supply, cooling water return, nitrogen, wastewater and demineralised water.
5. Drain all water streams (cooling water) to the sump.
6. Remove a spool section or install blind flanges on all connecting services, including natural gas, cooling water supply, cooling water return, nitrogen, wastewater, and demineralised water.
7. Drain all chemicals and lubricants for all machinery items (compressor) and reclaim for re-use or dispose of in a legal manner.
8. Remove all process catalysts and absorbents, drum properly, transport for reclaim for re-use or dispose of in a legal manner.
9. Remove all remaining wastes, by-products and raw materials from site to either reuse or dispose of in legal manner according to the site waste management plan.
10. Lock out, tag out and disconnect all electrical sources.
11. Dismantle all interconnecting process piping.
12. Remove process modules and enclosures and transport for re-use at another site, or for dismantling and reclaim in a legal manner. In some cases, for example tanks for reuse, may constitute large loads

13. At end of plant life the plant may be dismantled in-situ and transported for disposal from the facility. Plant may also remain at site for a period of time until a new location has been determined.
14. Document the presence of underground piping and cut and cap at ground level.
15. Take samples of soil and groundwater as necessary to show site is in a 'satisfactory state'.
16. Perform any additional close out requirement documentation as may be outlined in the final EPR permit.
17. Document in site condition report.

Appendix A Figures

- Figure 1 – Site Location Plan
- Figure 2 – Installation Boundary
- Figure 3 – Indicative Site Layout
- Figure 4 – Emissions Points
- Figure 5 – Human Health Receptors
- Figure 6 – Human and Ecological Receptors
- Figure 7 – Ammonia Tank Design
- Figure 7b – Hydrogen Tank Design

Appendix B Site Condition and Baseline Report

Appendix C Shadow Habitats Regulations Assessment

Appendix D BAT Assessments

Appendix E H1 Screening Assessment

Appendix F ES Air Quality Assessment

Appendix G Noise Impact Assessment

Appendix H Noise Management Plan

Appendix I Odour Management Plan

Appendix J Environmental Risk Assessment

Appendix K Climate Change Risk Assessment

Appendix L Flood Risk Assessment

Appendix M DCO Environmental Statement

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