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22. Major Accidents and Natural Disasters

22.1 Introduction

22.1.1 This chapter of the Environmental Statement (ES) presents an assessment of the Major Accidents and Natural Disasters (MA&NDs) that have the potential to arise during the construction, operation and decommissioning of the Proposed Development. This includes an assessment of the reasonably foreseeable worst case environmental consequences (i.e. the expected significant effects), the measures envisaged to prevent or mitigate the significant adverse effects of such events on the environment, and details of the preparedness for and proposed response to MA&ND hazards and threats relevant to the construction, operation and decommissioning of the Proposed Development.

22.1.2 The main objective of this assessment is to identify appropriate precautionary actions, to prevent or mitigate potentially significant risks associated with MA&NDs.

22.1.3 This Chapter is accompanied by Figure 22-1: HSE Consultation Zones (ES Volume II, Document 6.3).

22.2 Legislation and Planning Policy Context

22.2.1 Regulation 5, Part 4 of The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 states that:

"The significant effects to be identified, described and assessed include, where relevant, the expected significant effects arising from the vulnerability of the proposed development to major accidents or disasters that are relevant to that development."

22.2.2 Schedule 4, Part 8 requires an ES to provide:

"A description of the expected significant adverse effects of the development on the environment deriving from the vulnerability of the development to risks of major accidents and/or disasters which are relevant to the project concerned."

22.2.3 The Proposed Development is anticipated to be subject to the Control of Major Accident Hazards (COMAH) Regulations 2015 and the Environmental Permitting Regulations (EPR) 2016.

22.2.4 In accordance with the EIA Regulations, an assessment of the risk of MA&NDs relevant to the Proposed Development is therefore required, together with the measures envisaged to prevent or mitigate the significant adverse effects of such events on the environment and details of the preparedness for and proposed response to such emergencies.

22.2.5 This assessment is a preliminary review, based on the current engineering design documentation. This assessment does not seek to duplicate the

assessment of matters covered by other regulatory regimes such as COMAH or EPR, instead it provides a summary of the types of MA&ND hazards and threats anticipated by these regimes, the potential worst case environmental consequences these could pose and the required mitigation. Further detailed hazard and risk analysis will be undertaken throughout the Proposed Development lifecycle, in accordance with the requirements of the EPR and COMAH Regulations.

22.3 Methodology

Definitions

22.3.1 The COMAH Regulations (2015) define major accidents as:

"Major accidents are defined as those that could result in multiple fatalities and serious injuries and/or widespread damage to property and the environment as a result of a single incident. The impact of major accidents can be significant, with the potential to impact people both on and off-site, assets and property on and off-site, and the surrounding environment".

22.3.2 Disasters can be natural, such as earthquakes, landslides and flooding or can be caused by accidental loss of containment, such as leaks which may lead to asphyxiation, toxic exposure, fires and/or explosions.

22.3.3 Both natural and accidental causes are considered in this assessment to determine the potential impact of any major accidents or disasters on:

a. population and human health;

b. biodiversity, with particular attention to species and habitats protected under The Conservation of Habitats and Species Regulations 2017 (the Habitats Regulations);

c. land, soil, water, air and climate; and

d. property and material assets, cultural heritage and the landscape.

Guidance

22.3.4 There is no specific guidance available which sets out the approach for undertaking a MA&NDs assessment within an EIA. However, there is a considerable amount of information and guidance available to developers on the identification and control of major hazards associated with the design and operation of gas fired power stations, the storage and use of chemicals, and major accident hazard pipelines conveying hazardous fluids. Comparable facilities have been in operation for many years and employ conventional, established technology to produce electrical power from the combustion of natural gas. The Health and Safety Executive (HSE) publish a number of applicable guidance notes on their website relating to these assets, including

- Emergency planning for major accidents: Control of Major Accident Hazards Regulations 2015 (COMAH), (HSE, 2015); and
- Further guidance on emergency plans for major accident hazard pipelines (HSE, 1996).

22.3.5 Carbon dioxide is not flammable and will not support combustion and compared with many other materials conveyed via major pipelines in the UK, such as natural gas and ethylene, the risks to human health and the environment from events such as explosion are relatively low. However, as the concentration of CO_2 in ambient air or water rises, the hazardous effects on people and the environment increase. The key risks to people relate to its potential to act as a toxic material by inhalation at concentrations in excess of 5%v/v and as an asphyxiant at concentrations in excess of 50%v/v where it displaces oxygen in air to dangerously low levels. High levels of dissolved CO_2 in water can also result in impacts from acidification and subsequent effects on shell-forming species.

22.3.6 Guidance and best practice information for carbon capture technology and transport via pipeline is available from the Health and Safety Executive (HSE), who have published a number of documents and which are available on a dedicated page on their website. The guidance includes the following:

- Guidance on conveying carbon dioxide in pipelines in connection with carbon capture and storage projects (HSE, 2020);
- CO_2 Pipelines Good Practice Guidelines – Technical Report (HSE, 2013); and
- Assessment of the major hazard potential of Carbon Dioxide (HSE, 2011).

22.3.7 The HSE does not currently provide Land Use Planning (LUP) advice for CO_2 capture, transport or storage, and the status of the Proposed Development relating to the Control of Major Accident Hazards (COMAH) Regulations has not been confirmed. However, the HSE is a statutory consultee for all Nationally Significant Infrastructure Projects (NSIPs), such as the Proposed Development, therefore consultation with the HSE has been ongoing and will continue throughout the design and planning process.

22.3.8 Other guidance that is of relevance to the assessment of MA&NDs includes:

- Chemicals and Downstream Oil Industries Forum Guidelines, Environmental Risk Tolerability for COMAH Establishments (CDOIF, 2017);
- Chapter 4 of the Cabinet Office's Emergency Preparedness guidance on part 1 of the Civil Contingencies Act 2004 (hereafter referred to as the 'CCA risk assessment framework') (HM Government, 2012); and
- Reducing Risks, Protecting People: HSE's decision making process, (HSE, 1999).

Approach to Assessment

22.3.9 As discussed above, the MA&NDs assessment approach differs from the generic EIA methodology in which assessments broadly consider the magnitude of impacts and value/sensitivity of resources/receptors that could be affected in order to classify effects. The MA&NDs assessment identifies the reasonably foreseeable worst case environmental consequence of a hazard or a threat (i.e. the likely significant effect) on the basis of its potential severity of harm and duration. However as by definition, all MA&ND hazards

and threats could result in some form of serious damage and therefore, in significant environmental effect(s), the assessment then considers the likelihood of that hazard or threat occurring. Therefore, the MA&NDs assessment focuses on determining the tolerability of the identified risks, whilst taking into account any proposed embedded mitigation measures. The assessment is conducted using a staged approach:

- Identification of hazards and threats based on the concept design work completed to date and in accordance with industry standard approaches to hazard identification;
- Screening of hazards and threats, including those which are likely to give rise to a significant effect;
- Identification of prevention, minimisation and/or mitigation measures; and
- Identification of residual risks and a conclusion on the tolerability and significance of the residual risk.

22.3.10 This assessment has applied the Rochdale Envelope principles, which assesses credible, worst case MA&NDs associated with the Proposed Development. This conservative methodology establishes the worst case scenarios, the risk of which would be reduced to a level as low as reasonably practicable by the design and operation of the facilities. At this stage in the project, safety and control systems have not yet been designed for the Proposed Development. However, standard industry approaches to managing risk will be used. In addition, equipment such as process monitoring and safeguarding systems and embedded mitigation such as fire, flammable gas, toxic gas and leak detection, fire protection systems and emergency shutdown systems will be installed as required.

Assessment Criteria

22.3.11 Assessment criteria have been developed in accordance with the Chemical and Downstream Oil Industries Forum Guidelines on Environment Risk Tolerability for COMAH Establishments (CDOIF, 2017), which is a common approach adopted in MA&ND assessments in recent applications for NSIPs. Reference is also made to the criteria provided within the CCA risk assessment framework to allow for consistency with future emergency planning at a local level.

22.3.12 In line with Chemical and Downstream Oil Industries Forum Guidelines, the MA&NDs assessment characterises threats or hazards against the following categories in order to assign a tolerability and a risk classification to each hazard or threat:

- severity of harm;
- duration;
- consequence; and
- probability.

22.3.13 Severity of harm, duration, and the consequence of a hazard or threat are determined on the basis of a reasonably foreseeable worst case

environmental effect of the event in the absence of mitigation. However, the probability and magnitude of the hazard or threat occurring is also determined whilst considering the proposed mitigation and whether the proposed embedded mitigation measures need augmenting further. This is because mitigation would reduce the likelihood of the maximum severity of harm, duration, consequence, and the frequency of a hazard or threat occurring.

22.3.14 The tolerability of the residual risk is determined by combining the reasonably foreseeable worst case consequence and probability categories. All residual risks are categorised as 'tolerable' (broadly acceptable), 'tolerable if ALARP' (as low as reasonably practicable) or 'intolerable'.

22.3.15 As a general rule, tolerable and tolerable-if-ALARP risks are considered as 'not significant' and intolerable risks are considered as 'significant'. Depending on materials and volumes on site, risks categorised as 'tolerable-if-ALARP' would generally require submission of a COMAH report (including a Quantitative Risk Assessment in the form of ALARP Assessments) for review by the HSE. This document will demonstrate that the proposed mitigation results in an appropriate level of risk reduction based on reasonable practicability.

Scope of the Assessment

Study Area

22.3.16 The Study Area for individual identified hazards and threats has been considered on an individual basis, and based on the likely impact pathways, distances to receptors, the scale of potential worst case impact from case-study incidents, or on professional judgement if no information on previous events is available.

Scenarios

22.3.17 The assessment for the Proposed Development considers two main scenarios:

- Construction phase, including construction of the Power, Capture and Compression Site (PCC Site) facilities, and the connections within the identified connection corridors; and
- Operational phase of the Proposed Development (including commissioning and start up).

22.3.18 Decommissioning of the Proposed Development is not specifically included at this stage as not enough information is known in relation to decommissioning activities to inform a detailed assessment. However, it is likely that the hazards during the decommissioning stage would be similar to those assessed for the construction and operation phase. No additional decommissioning hazards have been identified at this stage.

Consultation

22.3.19 Consultation for the Proposed Development has been ongoing and commenced at the EIA Scoping Stage with the preparation of the EIA Scoping Opinion Report which was submitted in February 2019 and Scoping Opinion was received from the Planning Inspectorate in April 2019. (Appendix 1A in

ES Volume III, Document Ref. 6.4). The Applicants also undertook a formal Section 42 and Section 47 consultation, which commenced at the same time as the publication of the Preliminary Environmental Information (PEI) Report in early July 2020 and ended in September 2020. The issues that have been raised through consultation, and how these have been considered and addressed within the design evolution of the Proposed Development and the EIA are set out where relevant within each of the topic chapters in the ES and where relevant in Chapter 6: Alternatives and Design Evolution (ES Volume I, Document Ref. 6.2).

22.3.20 Table 22-1 provides an account of how comments raised by stakeholders to date in relation to MA&ND have been considered and actioned where appropriate.

Table 22-1: Key Issues Raised during consultation in Relation to Major Accidents and Natural Disasters

Key issue raised (by whom, ID/page no., theme)	Response to issue raised and action taken where appropriate
EIA Scoping	
Secretary of State Scoping Opinion, 4.10.8: Health and Safety. The Scoping Report identifies the potential for health and safety impacts to arise but does not provide further detail regarding the proposed assessment of these impacts. The ES should set out the proposed methodological approach for assessing these matters.	Health and safety impacts related to MA&NDs are covered within this chapter.
The Scoping Report proposes to scope out a specific assessment for major accidents or disaster vulnerability on the basis that risks of major accidents would be suitably assessed, regulated and controlled by other legislative framework (including through an application of an Environmental Permit and through accordance with the Control of Major Accident Hazards Regulations 2015). The Scoping Report confirms that accidental events such as fuel spillages and abnormal air emissions would be discussed in relevant chapters of the ES and a risk assessment for accidental events would be provided. With regard to major accidents, the Inspectorate is content that provision of the assessments within other relevant ES aspect chapters should not impede the ability of the ES to adhere with the EIA Regulations and welcomes the intention to include a risk assessment. The Applicant should ensure that the introductory sections of the ES contain clear cross referencing to where the assessment of major accidents or disasters is located. There should be sufficient information in the ES regarding Major Accidents and Natural Disasters where likely significant effects could occur.	As a result of the Inspectorate's comments a MA&ND's chapter has been produced in line with available guidance. This assessment includes fires/explosions, toxic exposure, noxious substances, storms, climate change, terrorism/arson, earthquakes, lightning, aeroplane/drone impacts, and domino effects from neighbouring facilities. Embedded mitigation and design impact avoidance measures will be in place for the operational Proposed Development to minimise major accidents and hazards arising from it, including a HAZID, a HAZOP, a COMAH licence if relevant, and an Environmental Permit. The engineering design will accommodate reasonably practicable mitigation measures. Emergency plans will be produced in accordance with the Environmental Permit and COMAH licence, where relevant.

Key issue raised (by whom, ID/page no., theme)	Response to issue raised and action taken where appropriate
Paragraphs 8.4-8.10 of the Scoping Report do not specifically address the issues of disaster vulnerability; therefore, the Inspectorate does not agree that this aspect can be scoped out of the ES.	
PEI Report (Health and Safety Executive- 9th September 2020)	
"The application site fall within the consultation zones of a large number of major hazard sites and major accident pipelines …..it is not clear whether the Applicant has made contact with the relevant operator to inform the assessment or whether or not the proposed development is vulnerable to a possible major accident."	Information provided by HSE indicates that the Site Boundary falls within the consultation zones of the following companies: • South Tees Site Company Ltd. • Chemoxy International Ltd. • CF Fertilisers Ltd. • PX (TGPP) Ltd. • AMOCO CATS • Sabic UK Petrochemicals Ltd. • Dow Chemical Company Ltd. • INEOS Nitriles (UK) Ltd. • Inter Terminals Seal Sands Ltd. • Vertellus Ltd. • Navigator Terminals • British Oxygen Co. Ltd. • INEOS Chlor Ltd. Only STSC's consultation zone associated with the former gas pipeline to the former coke works crosses the PCC Site. STSC have indicated that this former steelworks infrastructure will be decommissioned and an application made to revoke the COMAH licence. All the above operators have been consulted by the Applicants through the statutory consultation process, either at Stage 2 or Stage 3A. A summary of the responses received is provided in the Consultation Report (Document Ref. 5.1) submitted with the Application. No responses have been raised specific to the hazards posed by the Proposed Development.
The HSE refers to the potential need for Hazardous Substances Consent.	Hazardous Substances Consent will be applied for if required once the design has progressed (following the FEED). This has been included within the Other Consents and Licences Document (Document Ref. 5.10) submitted with the Application.
Application of COMAH: The HSE refers to Regulation 6 and Regulation 8 of the COMAH Regulations 2015 and suggests the Applicant discusses matters further with the HSE.	This advice provided by the HSE is noted. The potential need to comply with COMAH is included within the Other Consents and Licences (Document Ref. 5.10) submitted with the Application.

Key issue raised (by whom, ID/page no., theme)	Response to issue raised and action taken where appropriate
The HSE identifies that the Proposed Development (Gas Connection Corridor) is in the vicinity of a licensed explosive site.	This advice provided by the HSE is noted. Mapping of Explosive Safeguarding Zones provided by HSE indicates that this only affects the potential connection to the Trafigura pipeline at Teesport which is no longer within the Site Boundary.
PEI Report (Environment Agency- 30th September 2020)	
Section 22.3.18 states hazards and threats during the decommissioning phase have not been considered. However recent experience of fires on old SSI land from bulk storage tank burning/cutting, and wire stripping indicate that activities associated with this phase are different to the construction and operational phases and do need to be considered within the EIA.	The Environment Agency's (EA) point is noted however in broad terms it is considered that it is appropriate for the assessment (at this stage) to only consider construction and operation. It is not possible to assess decommissioning activities at this stage as there is not enough known at this stage in relation to decommissioning activities that will be required at the site. All decommissioning activities will be subject to the requirements at the time and will be managed appropriately using the licencing and consenting regimes that are relevant at that point in time. The chapter text has been updated in line with the EA's comment.
With regards to section 22.4.2 Natural Hazards, it has not considered the impact of a pandemic reducing availability of competent staff, the low temperature freezing of equipment including the cooling towers or flooding off site, which may impede emergency services response or shift changes.	Measures to mitigate effects on staffing associated with a pandemic will follow workplace guidance from the HSE (e.g. that currently provided for COVID and pandemic flu) and operating procedures will be in place to ensure that the site can operate under minimum staffing arrangements. The design of the development and emergency action plans will include mitigation of risks associated with low temperatures which could be associated with a CO_2 release.
A commitment to comply with the Control of Major Accident Hazards (COMAH) Regulations is confirmed in section 22.5.7. This is welcomed. Table 22-2 states the PCC will be designed to contain firewater runoff. To achieve this the EIA should contain a worst case estimation of firewater runoff production, and a description/plans showing how this quantity of potentially contaminated water can be contained on site/treated/removed off site and include remediation following a fire.	The fire protection strategy for the Proposed Development will be developed to comply with the requirements of the Building Regulations and Fire Safety Procedural Guidelines (Local Authority Building Control, 2020). Appropriate standards will also be referenced to provide the necessary fire safety design. At this early stage in design development, the design is not sufficiently progressed to allow the provision of a detailed firewater containment assessment. The design and provision of required firewater containment provisions will be undertaken as part of the FEED, and the assessment and containment provisions will be developed with due consideration of PPG18, and in compliance with the CIRIA C736 guidance.
Domino Effects are described in section 22.8. A recent announcement of a potential RDF plant [Note: i.e. the Redcar Energy Centre EfW] adjacent to this proposed development needs to be considered in the EIA.	Any relevant developments have been considered and included in the chapter for assessment. Refer to Section 22.8.

Key issue raised (by whom, ID/page no., theme)	Response to issue raised and action taken where appropriate
The applicant has not considered whether there are any potential cumulative events e.g. a minor impact over a prolonged period = a major accident. For example, a slow leak of CO2 causing acidification of the protected slag area within the South Gare SSSI, and subsequent loss of the existing lime-loving flora. This matter should be taken into consideration.	

22.4 Baseline Environment

22.4.1 This section presents a description of the baseline environmental characteristics within the Study Area. The baseline relevant to this topic comprises:

- A description of potential natural hazards which may impact the Site, including meteorological hazards, geological hazards and other types of hazards;
- Existing major accident hazard sources that may impact the Site;
- Other hazards and threats identified within the UK National Risk Register (HM Government, 2020); and
- Sensitive environmental receptors within the study area at risk of MA&ND hazards associated with the Proposed Development.

Natural Hazards

Meteorological Hazards

22.4.2 Hazards resulting from severe weather events which could impact the Proposed Development include:

- flooding, comprising:
  - flooding following heavy rainfall events (including fluvial, surface water, groundwater and sewer flooding);
  - coastal flooding following storm surge (relevant to main development site only);
  - storms and gales;
  - drought;
  - heatwave;
  - cold and snow (low temperatures and heavy snow for prolonged periods);
  - lightning and electrical storms (thunderstorms);
  - events of reduced visibility (e.g. due to volcanic ash, dust sand or fog); and
  - extreme humidity (high and low).

22.4.3 Operating and Emergency Strategies and Procedures will be developed as part of the Project FEED and Execution Phases to address the Facility's Design Capability and Organisational response to a forecast of a developing Natural Hazards event to ensure, as far as reasonably practicable, that the event will not escalate resulting in further environmental impact. This will include defining a minimum safe resourcing level for continuing operations which might be appropriate in the event of a pandemic or local restrictions to site access, e.g. due to flooding, an appropriate basis of design and engineering mitigations to address credible ranges in environmental conditions be that temperature, wind speed, changes in sea level or excess rainfall which could impact continuing safe operations and a range of access routes for the emergency services and site personnel in abnormal conditions. The strategies will define design criteria and the procedures will provide guidance on the actions to be taken at certain threshold levels, including in advance of the event occurring where practicable which may include plant partial or full shutdown, lockdown of the facility or the temporary reduction in activities across the site to ensure the continuing safety of personnel and protection of the environment.

Geological Hazards

22.4.4 As outlined in Chapter 10: Geology, Hydrogeology and Contaminated Land (ES Volume I, Document Ref. 6.2) the geology underlying the Site is of no risk or very low to low risk of hazards associated with ground stability, such as landslides, ground collapse, ground compression, sinkholes, running sand and shrinking or swelling of clay.

Seismic Hazards

22.4.5 Based on the information provided in Chapter 10: Geology, Hydrogeology and Contaminated Land (ES Volume I, Document Ref. 6.2) the geology underlying the Site is of no risk or very low risk of seismic hazards.

Existing Major Accident Hazards

22.4.6 Existing major accident hazard sources include industrial sites (such as those operated under COMAH and Hazardous Substances Consents (HSC)), waste management sites, electricity, gas and fuel infrastructure which may pose a risk of fire, explosion or an industrial accident, such as chemical release, airfields, as well as residual risk from unexploded ordnance (UXO).

22.4.7 Onsite UXO risks both on-shore and off-shore will be managed in accordance with the Construction Industry Research and Information Association (CIRIA): guidance documents:

- Unexploded ordnance (UXO) risk management guide for land-based projects (C785) (CIRIA, 2019); and
- Assessment and management of unexploded ordnance risk in the marine environment (C754) (CIRIA, 2016).

22.4.8 Firstly, by conducting a detailed desk-based risk assessment and then, if required, by on-site risk management, including a geophysical survey.

22.4.9 Industrial sites that could be the source of, or increase the risk or consequences of, a major accident and/or domino effect have been identified

and assessed in Section 22.8: Domino Effects, of this chapter. The sites considered include:

- Bran Sands Wastewater Treatment Plant;
- Teesport;
- Teesside Renewable Energy Power Station (Tees REP); and
- The proposed Redcar Renewable Energy Centre (REC).
- Seal Sands and North Tees, Billingham and Wilton Industrial Areas including:
- Chemoxy International Ltd.
- CF Fertilisers Ltd.
- PX (TGPP) Ltd.
- AMOCO CATS
- Sabic UK Petrochemicals Ltd.
- Dow Chemical Company Ltd.
- INEOS Nitriles (UK) Ltd.
- Inter Terminals Seal Sands Ltd.
- Vertellus Ltd.
- Navigator Terminals
- British Oxygen Co. Ltd.
- INEOS Chlor Ltd.

Sensitive Environmental Receptors

22.4.10 Chapter 3: Description of the Existing Environment (ES Volume I, Document Ref. 6.2) sets out the closest environmental receptors to the Site. These include residential receptors, ecological receptors, controlled waters and Public Rights of Way and permissive paths.

22.5 Development Design and Impact Avoidance

22.5.1 The following impact avoidance measures will either be incorporated into the design or are standard construction or operational measures. These measures have therefore been taken into account during the impact assessment process described in this chapter:

Detailed Design

22.5.2 A number of design philosophies will be prepared with regard to process safety and safeguarding, isolation, emergency shutdown and if required, depressurisation. The design engineers will also review the layout and give due consideration both to the on-Site location of facilities as well as the off-Site receptors.

22.5.3 A design hazard management plan will be prepared and a number of hazard identification and evaluation assessments (HAZID and HAZOP reviews) have been and will continue to be carried out on the Proposed Development during the design process. This is a standard approach for the identification of hazards and the development of risk mitigation measures for preventing or otherwise minimising hazardous scenarios through appropriate design during the FEED studies.

22.5.4 Major accident assessments and studies will be prepared over the course of the design development and a Major Accident Prevention Plan (MAPP) will be prepared to inform the application for COMAH Licence, if required for the operational facility. The Construction (Design and Management) (CDM) Regulations 2015 will be followed as required.

Construction

22.5.5 The use of suitably experienced and competent contractors, risk assessments, working method statements, operating procedures, competency assessment and personnel training will provide the basis for reducing the potential for accidental scenarios occurring during construction of the Proposed Development.

22.5.6 A Construction Environmental Management Plan (CEMP) will be prepared to set out how construction activities are to be managed and controlled in compliance with accredited health and safety and environmental management systems, relevant legislation and environmental permits, consents and licences. The final CEMP will be based on Appendix 5A: Framework CEMP (ES Volume III, Document Ref. 6.4).

Operation

22.5.7 As outlined previously, a COMAH Licence from the HSE and an Environmental Permit from the EA will likely to be required for the operation of the Proposed Development. It is assumed that a lower-tier COMAH Licence will be required as a minimum at this stage pending finalisation of which hazardous substances will be handled on site and the inventories involved. Both permissions require a number of stipulations and requirements to be fulfilled to the satisfaction of the regulators including use of appropriate control and monitoring procedures, risk assessments, management systems and control measures to minimise the risk of accidents occurring and to minimise the effects of any such accidents on off-site receptors as well as the operational workforce. The permit requires the approach to managing accidents and emergencies to be in accordance with the use of Best Available Techniques (BAT).

22.5.8 Any specific Consents or Licences and their relevant timescales in relation to the above are presented in the Other Consents and Licence's (Document Ref. 5.10) submitted with the DCO Application.

Decommissioning

22.5.9 The use of suitably experienced and competent contractors, risk assessments, working method statements, operating procedures, competency assessment and personnel training will provide the basis for

reducing the potential for accidental scenarios occurring during decommissioning of the Proposed Development.

22.5.10 On closure and cessation of operations at the Proposed Development, a Decommissioning Environmental Management Plan (DEMP) will eventually be prepared to set out how decommissioning activities would be managed and controlled in compliance with accredited health and safety and environmental management systems, relevant legislation and environmental permits, consents and licences.

22.6 Assessment

Construction and Decommissioning

22.6.1 A number of potential accident scenarios could occur during construction of the Proposed Development including:

- Fire or explosion including through disturbance of UXO;
- Ground instability including collapse of excavations; and
- Leaks and spillages of chemicals or fuels resulting in contamination or the release of potentially hazardous substances to the environment.

22.6.2 Table 22-2 lists the potential MA&NDs relevant to the construction of the Proposed Development and the storage and handling of potentially hazardous substances present on site.

22.6.3 At this stage in design development, risks associated with eventual decommissioning and demolition of the plant are unknown. However, it is envisaged that chemical inventories will be removed prior to decommissioning works being commenced and it is confirmed that hazardous materials such as asbestos will not be used in the plant construction. Other environmental effects associated with decommissioning and demolition are expected to be the same or less than those associated with construction.

Operation

22.6.4 The assessment of MA&NDs considers operations on the PCC Site, the High-Pressure CO_2 Export Pipeline to Mean Low Water Springs and along the associated low/medium pressure CO_2 Gathering Network and Natural Gas Connection Corridor plus the Electrical Connection Corridor. There are no specific risks in relation to the Water Supply or Discharge Corridors therefore these are not considered further.

22.6.5 Table 22-3 lists the potential MA&NDs relevant to the operation of the Proposed Development and the storage and handling of potentially hazardous substances present on site. The information summarised in Table 22-3 has been based on the Preliminary Hazard and Environmental Assessments (PHEA) undertaken for the Proposed Development.

22.6.6 There will be hazardous and potentially harmful substances present on the PCC Site, the CO_2 Export Pipeline, the Natural Gas Connection and in the CO_2 Gathering Network in quantities which, if released, have the potential to cause a major accident.

22.6.7 The hazardous substances on the operational PCC Site will include:

- Low, medium and high pressure CO_2 – an asphyxiant which is toxic dependant on exposure concentration and duration;
- Natural gas, a highly flammable gas comprising mainly of methane supplied via a dedicated pipeline and to be used as primary fuel in the CCGT;
- Hydrogen, a highly flammable gas, to be used as a coolant in the electrical generator and as a reagent in the oxygen removal system. Hydrogen will be stored on-site in compressed gas cylinders and/or a tube trailer;
- Diesel fuel oil, a flammable and environmentally harmful liquid, to be used to provide fuel for emergency standby plant; Lube oils for use with the mechanical equipment;
- Aqueous amine solutions, which are harmful liquids to be used in the carbon capture CO_2 absorption and regeneration system;
- Reclaimer sludge from the absorber which is likely to be classed as hazardous waste;
- Sulphuric acid for use in Acid Wash if required;
- Acid Wash effluent (if used) which is likely to be classified as a hazardous waste;
- Urea solution or potentially aqueous ammonia, a toxic liquid, which may be used in the treatment of exhaust gas emissions from the CCGT and in the treatment of water within the Heat Recovery Steam Generator (HRSG); and
- Other treatment chemicals as may be required for water treatment, wastewater treatment, solvent reclamation or other on-site processes.

22.6.8 Diesel fuel, urea solution/aqueous ammonia, sulphuric acid and fresh/dilute and waste amine based solutions will be stored in dedicated above ground bulk tanks mounted within containment bunds to contain spillages.

22.6.9 Smaller quantities of other potentially dangerous and/or hazardous materials will also be present on site. These substances would not be expected to initiate or exacerbate major accidents or disasters but could be harmful in the event of a major accident that causes loss of containment. For example, if hazardous substances were released during a fire event, due to the failure of storage vessels, which resulted in the hazardous substances being present in the firewater runoff. These hazardous materials, present in small quantities, include nitrosamines and nitramines, which are present within the CO_2 absorption/regeneration system. Water and effluent treatment chemicals used on-site in smaller quantities will include sodium hydroxide and hydrochloric acid. Smaller inventories of synthetic oils will be present in transformers and rotating equipment.

22.6.10 Design and operational controls will be in place to manage the risks associated with the smaller inventories of the above hazardous substances including use of dedicated bunded above ground storage areas, segregation

of incompatible materials, dedicated filling points and management procedures for the handling, storage and use of the materials. An assessment will be made of balancing the risks presented by the storage of small volumes of hazardous substances and the risks associated with increased transportation and off-loading.

22.6.11 Additional information is presented in Section 22.7: Potential for Major Accidents Associated with carbon Dioxide Releases, on the risks associated with a release of CO_2, and a description of the potential for large scale “knock-on” accidents, referred to as Domino Effects, is presented in Section 22.8: Domino Effects.

Table 22-2: Potential Major Accident and/ or Disaster Events during Construction grouped by Risk Event

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
C-1	Fire/ explosion and risk of release of harmful gas.	Natural gas - disturbance of existing gas pipeline (e.g. CATS) during construction results in loss of containment from third party supply pipeline.	Risk of fire/ explosion and release of harmful gas leading to fatality/ injury to member of public. Risk of fire/ explosion causes irreversible damage to environmental receptor (listed building, ecological site, watercourse etc.); or structural damage to buildings and/ or infrastructure. Firewater run-off containing contaminants could be potentially harmful to the Teesside and Cleveland Coast Ramsar/ SPA/ SSSI designations and/ or Secondary A aquifer within superficial deposits.	Consultation with appropriate stakeholders such as National Grid Gas, the operator of the Central Area Transmission System (CATS) Pipeline and the EA will be undertaken to manage interfaces and define appropriate control measures when working close to live pipelines. The DCO Application is accompanied by a Gas Connection and Pipelines Statement (Document Ref. 5.6). A CEMP will be in place to control potential environmental impacts of construction works. Control measures will be implemented to prevent fires and procedures will be prepared and implemented to respond to fires, in the event that they were to arise.	Yes	Yes
C-2	Spillage/ leak of pollutants into groundwater/ surface water due to construction activities	Risk of contamination of water resources.	Irreversible damage to watercourse and dependant species/ habitats (see also risk related to fire water in C1). Loss of water supply	Impact avoidance measures related to leaks and spills are presented in Chapter 9: Surface Water, Flood Risk and Water Resources (ES Volume I, Document Ref. 6.2).	Yes	Yes

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
				A CEMP will be implemented to manage storage of construction materials and potential environmental impacts of construction works.		
C-3	Extreme weather (e.g. flooding, drought) which is exacerbated by the construction of the Proposed Development and leads to release of stored construction related material, equipment and potential contaminants.	Tidal sources: The PCC Site is at a 'low' risk of flooding from tidal and fluvial sources. There is therefore a low risk of floodwaters mobilising construction materials and potential contaminants on the PCC Site. Laydown Areas at Haverton Hill and Saltholme are partially in land in protected Flood Zone 3, Flood Zone 2 or at low risk of flooding (Flood Zone 1).	Irreversible damage to environmental receptor (listed building, ecological site, watercourse etc.). Worsened extreme weather impact leads to fatality /injury to members of public.	Low risk of flooding at the PCC Site. Existing flood defences expected to continue to protect the land in Haverton Hill and Saltholme, mitigating the overtopping risk. Refer to Appendix 9A: Flood Risk Assessment (ES Volume III, Document Ref. 6.4) for design and impact avoidance measures that would be implemented by the contractor during construction to reduce this risk which would include location of stockpiles away from flood zones and sensitive watercourses as far as reasonably practicable. Measures to be agreed with EA.	Yes	Yes
C-4	Vandalism (trespass)	Risk of vandalism/ arson leading to fires/ explosions.	Fatality/ injury to member of public off site from fire/ explosions; and/ or irreversible damage to environmental receptor (listed building, ecological site, watercourse etc.).	Appropriate security measures will be installed at the construction site, including site security and fencing to prevent trespassers and mitigate this risk to ALARP.	Yes	Yes

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
C-5	Ground collapse	Risk of construction resulting in disturbance of manmade or naturally occurring ground related hazards. Vibration causes ground instability/ collapse/ settlement.	Localised collapse and subsidence of ground at the surface/ surface settlement could lead to uncontrolled movement affecting objects/ people/ materials/ plant/ equipment which could cause injury/ fatality to persons on site and/ or lead to secondary impacts e.g. damage to utilities leading to explosion.	There will be a ground investigation with appropriate testing to understand the ground collapse risks (amongst others). This will inform the construction methods used. To reduce risks associated with ground instability, there will be use of industry standard construction methods/ design features appropriate to the context of the PCC Site.		Yes
C-6	Major road traffic accident	Movement of construction vehicles on local roads leading to increased risk of road traffic accidents.	Fatality/ injury to members of public.	Controls will be implemented including a Construction Traffic Management Plan (CTMP) and construction workers' travel plan (CWTP) – A Framework CTMP and Framework CWTP has been prepared and submitted with the Application (see Appendix 16B and 16C, ES Volume III, Document Ref. 6.4). Risks to road users have been assessed in Chapter 16: Traffic and Transportation (ES Volume I, Document Ref. 6.2) and are not considered significant.	Yes	Yes
C-7	Release of asbestos	Risk of uncontrolled release of asbestos present on site, if	Risk of uncontrolled release of asbestos containing materials	There will be a ground investigation with appropriate	Yes	Yes

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
		disturbed during construction of the Proposed Development.	(ACM) during excavation works leading to short term exposure to construction personnel, and possibly members of the public in surrounding areas.	testing to understand the risks presented by asbestos. A watching brief will be adopted during the construction works and an asbestos management plan developed as part of the final CEMP. If identified, risks will be managed to ensure legal compliance through the Control of Asbestos Regulations 2012 (HM Government, 2012) governing the handling and disposal of ACM.		
C-8	Aircraft/ drone impact	Risk of collision between aircraft and tall construction machinery, e.g. cranes. Construction lighting and tall structures have the potential to present a visual distraction to pilots, causing aircraft incident. Potential risk of asset damage and subsequent fires/ explosions.	Aircraft incident results in fatality/ injury to member of public and/ or irreversible damage to environmental receptor (listed building, ecological site, watercourse etc.).	The Proposed Development is located in an area which does not have a high density of air traffic. Consultation with relevant airports/ Civil Aviation Authority (CAA) to manage interfaces and define appropriate control measures including need for aviation warning lighting to be fitted to tall construction machinery. The final CEMP will include vigilance and security systems to safely shutdown the plant in	Yes	Yes

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
				the event of any aircraft related incident.		
C-9	Pandemic	Risk of pandemic causing civil emergency.	Risk of pandemic occurring which may cause civil emergency and large numbers of people to fall ill, including construction workers. Risk of loss of control of construction site.	If a pandemic was to disrupt the construction of the Proposed Development, measures would be adopted taking into account experience at other sites in which the COVID 19 pandemic required construction works to temporarily cease. The final CEMP would be followed to ensure no adverse environmental effects occurred during this time.	Yes	Yes
C-10	Domino effects from incidents at neighbouring facilities	Risk of accidental release of dangerous substances (if such substances are present), resulting in fire and/ or explosion at neighbouring industrial facilities.	Fire/ explosion impact upon the construction of the Proposed Development.	It is expected that existing safety precautions at neighbouring industrial sites, along with the implementation of a CEMP at the Proposed Development Site, will mitigate the risk of domino effects occurring.	Yes	Yes

Table 22-3: Potential Major Accident and/ or Disaster Events during Operation grouped by Risk Event

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
O-1	Fire/explosion	Natural gas – loss of containment from supply pipeline and/or power plant equipment. Immediate ignition of the gas would lead to a localised fireball or jet fire depending on release size. Delayed ignition could lead to an explosion and/or flash fire burning back to a jet fire. Hydrogen – loss of containment from storage cylinders, pipework and/or process equipment (cooling equipment and oxygen removal equipment) Whilst the volume of hydrogen stored on the site will be low, a release of flammable gas could be caused by mechanical failure or impact damage resulting in a loss of containment. Immediate ignition of the gas would lead to a localised flash or jet fire depending on gas volume and pressure. Delayed ignition could lead to an explosion and/or fire.	Fire and/or explosion could result in significant harm to people on Site, with the potential for fatal injuries and damage to industrial property. There is also the potential for harm to people and businesses off-site, such as radiant heat burns and impact injuries from explosions. A release from the natural gas supply pipeline could result in offsite impacts which would be dependent on its final routing The environmental impact of a major fire could affect the Teesmouth and Cleveland Coast SPA/Ramsar site and the Teesmouth and Cleveland Coast SSSI, as a result of thermal radiation and run-off of firewater. It is unlikely that this type of accident could impact listed buildings or other heritage sites based on distance. Firewater run-off reaching areas of unmade ground could contain contaminants which	Design of the natural gas systems to recognised industry codes and standards. Compliance with the Pressure Equipment (Safety) Regulations 2016 and the Pipelines Safety Regulations (PSR) (HSE, 1996). Selection of natural gas pipeline routes, depth of cover in areas of higher risk, and the construction of safety systems to prevent pipeline damage, such as the installation of barriers. Pipeline safety systems and gas/liquid pressure regulation to be installed along with operational controls and monitoring. Gas Detection systems at the Site and in the vicinity of high hazard areas. Managing the storage volumes of high hazard materials (e.g.	Yes	Yes

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
			would be potentially harmful to groundwater.	design and maintenance of off-loading equipment and volumes of hydrogen stored.). This will need to take into consideration the balance of risk associated with smaller volumes of storage against risks associated with additional transportation and off-loading operations. Use of a competent supplier of hydrogen with appropriate procedures in place for assuring the continuing integrity of cylinders and trailer tubes supplied for the storage of hydrogen. Fire detection and fire protection systems will be installed on the Site. The PCC would be designed to contain firewater runoff and prevent material reaching unsurfaced ground or other environmental receptors. Detailed emergency plans will be produced for the site and pipeline corridors in accordance with the		

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
				Environmental Permit and all applicable Regulations.		
O-2	Fire	Diesel fuel oil, lube oil – release of flammable liquid from storage, pipework or operating equipment Whilst the volume of diesel stored on the site is not expected to be large when compared to other chemical sites, the ignition of diesel, released due to failure of primary containment, could result in a localised pool fire if the vapour found a source of ignition.	A local diesel pool fire could result in harm to people on-site and damage to assets but would be unlikely to escalate to a major accident affecting areas off-site as diesel fuel would only be used in relatively small quantities as start-up fuel or for back-up generators located in close proximity to the main generating station or compression equipment, some distance from the Site boundary.	Design of the storage tanks to industry codes and standards. Installation of the storage tanks within a secondary containment system (bund) designed in accordance with CIRIA C736 guidance (CIRIA, 2014). Instrumentation and control systems will be installed to monitor tank contents and prevent overfill. Minimising the storage volumes of high hazard materials as far as reasonably practicable. Depending on the inventory of diesel and other dangerous substances, the PCC may be regulated through the Control of Major Accident Hazards (COMAH) Regulations (HSE, 2015). It will also be regulated though an Environmental Permit.	Yes	Yes

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
				Fire detection and fire protection systems will be installed on the Site. The PCC would be designed to contain firewater runoff and prevent material reaching unsurfaced ground or other environmental receptors. Detailed emergency plans will be produced for the site and pipeline corridors in accordance with the Environmental Permit and all applicable Regulations.		
O-3	Toxic/asphyxiant gas release	Accidental release of CO_2 at high pressure on the PCC or from a low, medium or high pressure pipeline.	CO_2 is toxic and an asphyxiant, depending on the concentration in air. It is also odourless and heavier than air. A leak or rupture of a system containing high pressure (dense phase) CO_2 will be noisy and will be observed with the naked eye due to the transition between the phases. There will be an associated large reduction in temperature from a high pressure release A release of CO_2 could be caused by mechanical failure,	Monitoring and detection of CO_2. Detailed standards and codes of practice written specifically for the design and operation of dense phase or supercritical CO_2 plant and pipelines are still being developed, therefore industry codes and standards for gas and chemical pipelines will be applied where appropriate. According to the HSE, "*ongoing work suggests that the hazards involved with the bulk transport of CO_2 are similar to the hazards*	Yes	Yes

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
			corrosion or impact damage resulting in a loss of containment. The impact of the release on people and the environment depends on the pressure, temperature and mass of material that is lost, however there is the potential for a major accident resulting in significant harm and potential fatalities, both on-site and off-site. Further details of the hazards associated with a CO_2 release are contained in Section 22.7.	*transporting natural gas*". (HSE 2008). The PCC has been deliberately sited close to the shoreline to maximise distance from sensitive human receptors so as to prevent the harmful consequences of any major accidents. In particular, the siting of the high-pressure CO_2 system close to the shoreline minimises the risk of any high-pressure CO_2 release from impacting off-site receptors, particularly given the prevailing wind direction. The CO_2 Gathering Network is not routed in the immediate vicinity of residential areas. It is predominately routed through industrial areas. Compliance with Pipeline Safety Regulations (1996) and additional specific safety measures for CO_2 pipelines will apply, including the monitoring of fluid composition and the prevention of water ingress, which could accelerate corrosion and premature failure.		

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
				Pressure monitoring and pressure relief systems to prevent over pressurisation situations. Leak detection systems. Use of containment measures and barriers to prevent damage to pipelines. Detailed emergency plans will be produced for the installation in accordance with the Environmental Permit and all applicable Regulations.		
O-4	Toxic/asphyxiant gas release	Release of medium pressure CO_2. From the CO_2 Gathering Network.	CO_2 is toxic and an asphyxiant, depending on the concentration in air. It is also odourless and heavier than air. A leak or rupture from a system containing low or medium pressure (gas phase) CO_2 from the CO_2 Gathering Network is unlikely to be seen as it is an odourless and transparent gas. Depending on the energy of the gas there may be reduced air entrainment close to the release point leading to larger dispersion distances to safe	Monitoring and detection of CO_2. Compliance with Pipeline Safety Regulations (HSE,1996) and additional specific safety measures for CO_2 pipelines will apply, including the monitoring of gas composition and pressure and the prevention of water ingress, which could accelerate corrosion and premature failure. Leak detection systems.	Yes	Yes

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
			concentrations. The risk is that in some circumstances a low/medium pressure CO_2 release is not dispersed rapidly and not visible with a risk of toxic impacts and subsequent harm to human health and protected species. A release of low/medium - pressure gaseous CO_2 would be caused by mechanical failure or impact damage resulting in a loss of containment. The impact of the release on people and the environment depends on the pressure, temperature and mass of gas that is released and in the case of humans the subsequent toxic load that they are exposed to; however there is the potential for a major accident resulting in significant harm and potential fatalities, both on-site and off-site.	Isolation valves in the pipeline system at emitter battery limits to limit the continuing inflow of material to the pipeline network. Use of containment measures and barriers to prevent damage to pipelines.		
O-5	Toxic release (liquid or gaseous amine solvent)	Release of amine from CO_2 absorption/regeneration system.	Amine- based solvents used in the CO_2 absorption/ regeneration system are non-flammable, toxic solvents	Bunded Amine storage tank(s), process equipment and pipework design and	Yes	Yes

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
			which can pose a health hazard to people due to toxicity and hazardous to the environment. An abnormal release of amines could occur from failure in process equipment, pipework, the offloading (road tanker import) system and storage vessels and could be caused by mechanical failure or impact damage. Loss of this material into surface water drains could reach local watercourses including the River Tees or the adjacent Teesmouth SPA. Therefore, this would be a major accident with the potential to harm the local environment as a result of the toxicity of amines, and by an increase in the pH of the environment and by the reduction in the dissolved oxygen concentration within the river.	construction to industry standards. Site process water to be segregated from surface water drains and routed to holding tanks or wastewater treatment plant for treatment and testing prior to discharge. Surface water drains and attenuation system to have isolation valves installed to be closed in the event of accidental spillage into the uncontaminated surface water drainage system. Design of site containment facilities and drainage systems to industry standards (e.g. CIRIA C736) and operated in accordance with the Environmental Permit. Process monitoring systems to monitor releases with alarms and other process monitoring and trip systems in place to inform operatives of elevated release levels and interlocks to automatically isolate or shut		

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
				down systems in the event of an abnormal release.		
O-6	Toxic release (N-amine degradation products)	Release of N-amine from absorber stack above normal operational concentrations.	N-amines formed as by-products within the capture plant are non-flammable, toxic solvents which are considered to be harmful to people and hazardous to the environment. An abnormal release of N-amines could occur from process abnormalities giving rise to elevated release concentrations from the absorber emissions stack.	Process equipment and pipework design and construction to industry standards including lessons learned from Technology Centre Mongstad (TCM) operations in Norway. Gas sensors and emissions and process monitoring systems to monitor plant performance and amine degradation with alarms to inform operatives of elevated release levels and interlocks Facilities will be included to minimise, isolate or shut down systems in the event of an abnormal plant performance.	Yes	Yes
		Release from N-amine reclaimer waste.		Wastes from the CO_2 capture system to be collected for off-site disposal via a licensed hazardous waste management contractor.		
O-7	Toxic and/or environmentally harmful release (including aqueous ammonia solution and diesel)	Release of aqueous ammonia or diesel through loss of containment.	Aqueous ammonia solution which may be used in the emissions abatement system, is harmful to people, causing burns, eye damage and respiratory irritation. It is toxic	Ammonia and diesel storage tank(s), process equipment and pipework design and construction to industry standards.	Yes	Yes

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
		Associated with the aqueous liquid loss would be ammonia vapours from the liquid. Diesel may be stored in bulk tanks, to be used as fuel in back-up emergency power generators and/or firewater pumps.	to aquatic life in the environment. Diesel is harmful and toxic to both humans and animal species A release of these substances could occur from failure in process equipment, pipework, the offloading (road tanker import) system and storage vessels and could be caused by mechanical failure or impact damage. Loss of these material into storm drains could reach local water courses including the River Tees or Teesmouth SPA. Therefore, this would be a major accident with the potential to harm the local environment as a result of the toxicity of the chemicals.	Minimising the storage volumes of high hazard materials Site process water to be segregated from surface water drains and routed to holding tanks or wastewater treatment plant for treatment and testing prior to discharge. Surface water drains and attenuation system to have isolation valves installed to be closed in the event of accidental spillage into the uncontaminated surface water drainage system. Design of site containment facilities and drainage systems to industry standards (e.g. CIRIA C736) and operated in accordance with the Environmental Permit.		
O-8	Domino effects from incidents at neighbouring facilities	Fire and/or explosion, toxic release, discharges to air and water.	The location of the PCC is on a former industrial site with no active industrial operations in the immediate vicinity with the exception of buried high pressure gas pipelines.	Further details of the potential hazards associated with domino effects to and from neighbouring industrial sites are contained in Section 22.8.	Yes	Yes

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
			The PCC lies within the consultation distances for these pipelines. There are no COMAH installations or high hazard installations in the immediate vicinity of the PCC. The CO_2 Gathering Network and Natural Gas Connection Corridor do pass through the Seal Sands complex which includes COMAH installations and close to Bran Sands WWTW and pipelines along Dabholm Gut. These installations have the potential for major accident hazards such as fires, explosions and toxic releases. The proximity of these sites to the Proposed Development is such that they could have an impact on the Proposed Development pipelines.	Based on current operations in the vicinity of the PCC the risk of domino effect is considered acceptable and this position will be agreed with the operators of the respective pipelines. Should new developments take place near to the PCC in the future these would need to be sited to prevent domino effects from occurring by following the HSE standard land use planning methodology (PADHI assessment). But if the PCC does not come under LUP there will be no consultation zone. NZT Power Ltd. and NZNS Storage Ltd. would be consultees for planning applications for local developments with the potential for domino effects. The proposed CO_2 Gathering Network and Natural Gas Connection Corridor routes pass through the consultation zones for a number of existing COMAH facilities and lie within existing pipeline corridors.		

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
				Consultation has been undertaken during the DCO process with the relevant COMAH Licence holders (see Table 22-1). NZT Power Ltd. and NZNS Storage Ltd. will need to consult with relevant parties to agree on/inform mitigation and emergency response arrangements as part of final route selection and detailed design.		
O-9	Domino effects to neighbouring facilities	Fire and/or explosion, toxic release, discharges to air and water.	Neighbouring facilities include a wastewater treatment plant, port facilities and logistics centres. A major accident such as a fire, explosion or toxic release from the Proposed Development could potentially impact the operation of these facilities depending on plant locations. Release of CO_2 from the Gathering Network could lead to cold temperature jet impingement onto other hazardous pipelines within the wayleave leading to other pipeline failures A CO_2 plume from a release from the gas gathering	The PCC has been deliberately sited so as to maximise distance from sensitive receptors and other industrial operations so as to prevent the harmful consequences of any major accidents. In particular, the siting of the high-pressure CO_2 Compressor close to the shoreline minimises the risk of any high-pressure CO_2 release from impacting off-site receptors, particularly given the prevailing wind direction. Further details of the potential hazards associated with domino effects to and from neighbouring industrial sites is contained in Section 22.8: Domino Effects.	Yes	Yes

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
			network could disperse over neighbouring facilities. Whilst this will not result in domino impacts it could pose potential impacts to persons on these sites and impact tasks that they are undertaking. An ignited natural gas release could result in impacts to facilities which are in vicinity to its routing leading to personnel and equipment damage.	Whilst impacts as a result of a failure in the gas gathering network or natural gas pipeline are credible the likelihood means that the risk of a domino impact is small. We will need to consult with relevant parties to agree on/inform mitigation and emergency response arrangements as part of final route selection and detailed design as well as understanding the condition of these pipelines and the potential for failure due to cold temperatures.		
O-10	Natural disaster - severe weather	Rainfall and storm surges could cause flooding from the River Tees.	The PCC is located in a Flood Zone 1 therefore there is a low risk of flooding which could be caused by storms increasing the height of the River Tees. The consequences of water flooding the PCC could include contamination with polluting substances, destabilising assets and compromising the integrity of plant and equipment.	A flood risk assessment is presented in Appendix 9A (ES Volume III, Document Ref. 6.4). This will be used to inform the detailed design of the Proposed Development in terms of surface water management and selection of finished floor levels to mitigate flood risk. Electrical equipment such as transformers and switchgear	Yes	Yes

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
				are to be located above predicted flood levels. Flooding guidance is provided by the EA for sites regulated under the Environmental Permitting Regulations.		
O-11	Natural disaster - climate change	Ambient temperature extremes, high windspeeds. Flooding extremes associated with rising water levels and climate change are covered under Scenario Ref. 9 above.	The impact of climate change causing extremes of temperature and winds may affect process operation of the PCC such as the cooling systems and structural stability. This could potentially impact the operation and efficiency of the Proposed Development.	The engineering design will take into account the predicted ambient temperatures and wind speeds over the operational lifecycle of the Proposed Development. This includes consideration of suitable materials of construction and the design of utility systems such as cooling water.	Yes	Yes
O-12	Terrorism/arson	Fires, explosions.	Fires and explosions at the Proposed Development could be caused by acts of vandalism, arson and/or terrorism. The worst case risks and effects are as described in Scenario Ref. 1.	Security measures will be installed at the PCC Site and along pipeline routes, including site security, CCTV and fencing to prevent intruders and cyber security measures to prevent hacking. Security advice for high hazard sites is provided within documents published by the National Counter Terrorism Security Office and Association of Chief Police Officers (NaCTSO, 2014) as well as the Centre for the	Yes	Yes

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
				Protection of National Infrastructure (CPNI) https://www.cpni.gov.uk/resources		
O-13	Earthquake / seismic event	Asset damage, potential subsequent fires, explosions.	The impact of an earthquake of significant magnitude could cause a major accident and damage to site infrastructure and harm to people both on-site and off-site.	Although minor earthquakes have occurred in the area of the Proposed Development site (including a magnitude 3.1 earthquake on 23 January 2020), it is not located within an area which has a high risk of earthquakes and/or seismic activity. However, the risk of earthquakes will be taken into consideration during the civil and structural engineering design, which will utilise the appropriate design codes and standards.	Yes	Yes
O-14	Lightning	Asset damage, potential subsequent fires, explosions.	A lightning strike could cause a major accident, harm to people on-site and damage to site infrastructure. Lightning could also present a source of ignition to flammable materials. A subsequent major fire could harm people both on-site and off-site.	The engineering design of the Proposed Development will include appropriate electrical earthing and bonding systems. The design and maintenance of these systems will reduce the likelihood of a major accident being initiated by a lightning strike to a very low level. Guidance is provided by the HSE on the management of	Yes	Yes

Scenario Ref.	Risk Event (High Level)	Risk Description	Risks and Consequence before Mitigation	Embedded Mitigation Measures and References	Mitigated to ALARP?	Tolerability
				potential ignition caused by lightning (HSE, 2014).		
O-15	Aircraft/drone impact	Asset damage, potential subsequent fires, explosions	The nearest airport to the Proposed Development is Durham Tees Valley, located approximately 20 miles in a south-westerly direction. This is a relatively small airport; however, expansion is planned to follow the recent change of ownership in 2019 with a number of new routes recently announced. A military airport base is located at RAF Leeming, approximately 50 miles from the Proposed Development in a south-westerly direction. The impact of an aircraft crash on the Proposed Development would be a major accident with the potential for significant injuries to people and damage to assets, both on-site and off-site. Aircraft warning lights would be included on the top of the stacks.	The Proposed Development is located in an area which does not have a high density of air traffic and facilities are not designed to withstand such an impact. Consequently, vigilance and security systems are the key mitigation measures, with shutdown and interlocks installed as part of the plant operating philosophy to safely shut down the plant in the event of an abnormal incident. Use of bunding and impermeable surfacing will minimise the risk of chemical releases to ground or controlled waters in the event of any incident.	Yes	Yes

22.7 Potential for Major Accidents Associated with Carbon Dioxide Releases

22.7.1 The HSE publication on the major hazards associated with CO_2 (HSE, 2011) states that this gas is an asphyxiant when it displaces oxygen in air at a concentration of 50%v/v. However, even at lower concentrations, CO_2 creates an immediate threat to life at a concentration of only 15% in air due to the toxicological impact it has on the body when inhaled at this concentration. Releases of CO_2 also have the potential to impact on protected species and other ecological receptors.

22.7.2 The HSE has undertaken a Dangerous Toxic Load assessment for CO_2 which concludes a significant danger to humans through toxicological impacts associated with an excess of CO_2 in the blood stream which could lead to a loss of consciousness if they inhale CO_2 at concentrations above around 7% in air (i.e. > 70,000 ppm). The HSE has derived and published Specified Level of Toxicity (SLOT) and Significant Likelihood of Death (SLOD) Levels for hazardous substances

22.7.3 The HSE has defined SLOT as the toxic dose causing:

- severe distress to almost everyone in the area;
- a substantial fraction of exposed population requiring medical attention;
- some people seriously injured, requiring prolonged treatment; and
- highly susceptible people possibly being killed

22.7.4 SLOD concentrations are those at which affected people would be exposed to an LD_{50} dose (i.e. 50% risk of death). The HSE concluded that available data for CO_2 indicates it does not meet the criteria for classification as a dangerous substance on this basis.

22.7.5 However, in addition to the hazard posed by CO_2 if inhaled, there are additional hazards associated with dense phase CO_2 that are likely to occur when CO_2 is handled in large quantities and at high pressure (dense phase). These can arise when a release occurs, and the pressure suddenly falls or is lost completely resulting in cryogenic burns to living creatures and damage to assets such as embrittlement of metallic structures and pipework.

22.7.6 HSE (2011) describes historical accidents involving CO_2, including a release of 15 tonnes of CO_2 from a facility in Germany which resulted in the hospitalisation of 107 people in the local area. The inventory involved in this accident provides an indicative estimate of the potential harm caused by a CO_2 release from a pipeline fitted with isolation valves.

22.7.7 A number of research projects have been undertaken to refine and validate the software used for modelling dense phase CO_2 releases and to further understand the potential hazards of a major release. NZT Power and NZNS Storage are planning to utilise accepted dispersion modelling tools to model the dispersion of CO_2 releases. The outcomes of this modelling will be reviewed by the project team and incorporated into the design of the Proposed Development.

22.7.8 The Proposed Development has been deliberately sited so as to maximise distance from sensitive receptors and other industrial operations, to prevent the harmful consequences of any CO_2 releases. In particular, the siting of the high-pressure CO_2 Compressor on the steelworks site towards the shoreline minimises the risk of any high-pressure CO_2 release from impacting off-site receptors, particularly given the prevailing wind direction.

22.7.9 Where the CO_2 Gathering Network is located close to potential receptors, the design of the pipeline will incorporate embedded mitigation to ensure risks are reduced to as low as reasonably practicable, such as thickened pipe walls, concrete coating, cathodic protection or additional protection, which may be used to minimise the impacts on receptors in the event of a failure.

22.8 Domino Effects

22.8.1 As outlined in Table 22-3, no neighbouring installations have been identified that could be the source of, or increase the risk or consequences of, a major accident and/or domino effect from the PCC, while there are several nearby facilities that could be affected by a major accident associated with the Proposed Development, it has been deliberately sited to minimise such an effect.

22.8.2 Where the CO_2 Export pipeline or other connections run close to the existing gas pipelines coming on shore at Coatham Sands, additional measures such as thickened pipe walls may be used where appropriate to minimise the risk of any domino effect with existing infrastructure in the event of a failure.

22.8.3 Neighbouring facilities that have been considered in more detail include:

- The CATS gas pipeline:
  - The buried CATS pipeline runs along the eastern boundary of the PCC Site and shares the electrical connection corridor and the connection corridors for Natural Gas (Sembcorp connection option) and CO2 Gathering Network (HDD crossing option).
  - A rupture of the CATS pipeline could pose a risk to personnel on the PCC and associated corridors, but the risk is considered to be tolerable given it would require the equivalent of a full bore failure.
  - The main risk to the CATS pipeline from the Proposed Development would be during the remediation phase, early construction and piling, as well as the gas and electrical connection construction phases. The Final CEMP will put measures in place to ensure that risks to the CATS pipeline will be minimised.
  - Consultation with the operator of the CATS pipeline has been undertaken.
  - York Potash Harbour Facilities and Conveyor.
  - There are no predicted domino effects on either the York Potash Harbour Facilities or conveyor.

- Bran Sands Wastewater Treatment Plant located approximately 500 m from the PCC Site and potentially close to the CO_2 Gathering Network and potentially the Natural Gas connection:
  - the Bran Sands works processes domestic and industrial effluent and sludge for the Teesside area and the wider north-east region;
  - operation of the Proposed Development will have design and operational safeguards so as not to impact on the operation of the Bran Sands facility (e.g. by fire or gas release) through process monitoring and controls, alarms and interlocks. In addition, any effluent which is sent to Bran Sands will be within agreed specifications so as not to disrupt Bran Sands operations; and
  - an accident, such as a major fire at the Proposed Development, may restrict Bran Sands operations, such as preventing operators working outside, however recovery from the impact should have a negligible long-term impact on the Bran Sands site. The plant is located sufficiently far from the PCC so as to minimise the risk of fire spreading from one facility to the other. In the event of a major accident at Bran Sands, precautionary measures would be applied such as closing valves on the CO_2 Gathering Network to isolate the inventory.
- Billingham, Seal Sands and North Tees Industrial Area:
  - the Billingham and Seal Sands industrial areas on the north bank of the River Tees lie approximately 2.2 km from the PCC Site. They contain a number of major industrial installations, including chemical manufacturing and oil storage facilities. Many of these facilities are regulated under the COMAH legislation. Consequently, they will have assessed their impact upon neighbours, in the event of a major accident and domino effects. The Proposed Development pipelines (including the CO_2 Gathering Network and Natural Gas Connection) will be designed and routed so as to minimise the potential for domino effects in the event of a major incident; and
  - an accident, such as a major fire at the Proposed Development, could restrict operations at Seal Sands and North Tees, such as preventing operators working outside, however recovery from the impact should have a negligible long-term impact on the sites. The plants are located sufficiently far from the PCC Site (and up-wind of the prevailing wind direction) so the risk of fire spreading from one facility to the other is minimal. However, under certain wind speeds and direction, there could be a risk of smoke impacting on operations at the PCC Site.
- Redcar Renewable Energy Centre (REC):
  - This facility is proposed on part of the Redcar Bulk Terminal on the south bank of the River Tees approximately 1 km west of the PCC Site. When operational, it will generate electrical power from the combustion of waste. The site may be located close to the CO_2 Gathering Network if it is routed to the PCC Site via a tunnel. In this case, in the event of a major accident precautionary measures may need to be applied to isolate the natural gas and/or CO_2 inventory. The

Redcar REC plant will be located sufficiently far from the PCC Site so as to minimise the risk of fire spreading from one facility to the other. However, under certain wind speeds and direction, there could be a risk of smoke impacting on operations as the PCC Site (and the wider operation of the Teesworks site).

22.8.4 The high concentration of industrial facilities in the local area provides a wealth of experience in the management of major accidents. The Cleveland Emergency Planning Unit (CEPU) provides an emergency planning service to ensure the local authorities are prepared to respond to emergencies and to support the emergency services and the community. This organisation provides information to businesses and has many years' experience working with COMAH sites and operators of major pipelines in Hartlepool, Middlesbrough, Stockton on Tees and Redcar and Cleveland.

22.8.5 It is a requirement of the COMAH Regulations that neighbouring upper tier sites should review and update their off-site emergency plans and Safety Reports to take into consideration potential impact of domino sites, which could potentially include this Proposed Development. This ensures that domino effects are assessed in detail by major accident installations.

22.9 Mitigation and Monitoring

Assessment Conclusions

22.9.1 The assessment has identified the potential MA&NDs which could be applicable to the Proposed Development, associated with the substances present and operations to be undertaken. Principally, these could include fires, explosions and the release of CO_2 gas. These incidents have an extremely low probability of occurrence but could have significant impacts on people and the environment without mitigation.

22.9.2 The Proposed Development will be within an area of Teesside where similar facilities such as power plants and chemical works have been in operation for decades. Consequently, these hazards are well understood by plant operators and controlled by the Regulatory Authorities and the Applicant will draw on this expertise plus that of its own heritage of designing, building and operating potentially hazardous installations globally to reduce the risk of major accidents occurring to be as low as reasonably practicable.

22.9.3 The engineering design of the Proposed Development will incorporate the appropriate standards, proven design methods and control measures necessary to reduce the risks of such accidents to an acceptable level, i.e. ALARP, which is the standard expected by the Regulatory Authorities (HSE and EA).

22.9.4 The Proposed Development will require appropriate permissions to be in place for its operation including COMAH Licence and Environmental Permit, and these regulatory controls will stipulate a number of requirements that must be demonstrated to prevent or minimise the effects of major accidents.

22.9.5 With the implementation of these measures in addition to those described in Table 22-2 and Table 22-3 above, the MA&ND risks are considered to have

been mitigated to 'tolerable' or 'tolerable if ALARP' and therefore the effects are considered as 'not significant' for both plant construction and operation.

Secondary Mitigation

22.9.6 At this stage no secondary mitigation measures (i.e. additional to the embedded mitigation within the Proposed Development) have been identified as being required to further mitigate any significant effects for Major Accidents and Hazards. Detailed emergency plans will be produced for the installation in accordance with the Environmental Permit and all applicable Regulations.

22.10 Limitations or Difficulties

22.10.1 This assessment is based on the preliminary design (i.e. the design at the DCO Application stage) of the Proposed Development and early appraisal of potential hazards that will be refined and reappraised during detailed design.

22.11 Residual Effects

22.11.1 No residual effects have been identified.

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