

Viking CCS pipeline

Preliminary Environmental Information Report Volume II

Main PEIR

Applicant: Chrysoar Production (U.K.) Limited,
a Harbour Energy Company

PINS Reference: EN070008

November 2022

Chapter 20

Major Accidents and Disasters



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20 Major Accidents and Disasters

20.1 Introduction

20.1.1 This chapter of the Preliminary Environmental Information Report (PEIR) presents a preliminary assessment of the Major Accidents and Disasters that have the potential to arise during the construction, operation and decommissioning of the Viking CCS Pipeline (hereafter 'the Project'). This includes an assessment of the reasonably foreseeable worst-case environmental consequences, 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 the hazards and threats relevant to the construction, operation and decommissioning of the Project.

20.1.2 In the context of EIA for major accidents and disasters, the following definitions have been applied:

- A **major accident** is an event (for instance, a major road traffic accident) that threatens immediate or delayed serious effects to human health, welfare and/or the environment and may require the use of resources beyond those of the client or its appointed representatives (i.e., contractors) to manage; and
- A **disaster** is an external hazard that can be man-made (such as an act of terrorism) or natural (such as an earthquake) with the potential to cause an event or situation that meets the definition of a major accident.

20.1.3 This chapter of the PEIR will:

- Identify the major accidents and disasters topics and events to be considered in the environmental assessment and thus included within the Environmental Statement (ES);
- Define the approach and methodology for identifying potential major accidents and disaster events and their assessment, in the context of the Project;
- Assess the reasonably foreseeable worst-case environmental consequences;
- Outline the preliminary measures envisaged to prevent or mitigate such events on the environment; and
- Detail the preparedness for and proposed response to major accidents and disasters relevant to the Project.

20.2 Legislation, Policy and Guidance

20.2.1 Regulation 5 of The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (Ref 20-1) 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.*"

20.2.2 Schedule 4 paragraph 8 requires an Environmental Statement (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.*"

20.2.3 A list of additional national legislation, policy and guidance relevant to the major accidents and disasters assessment is provided below:

Legislation

- Health and Safety at Work etc. Act 1974 (Ref 20-3);
- Construction (Design and Management) Regulations 2015 (CDM) (Ref 20-4);
- Control of Major Accident Hazards Regulations 2015 (COMAH) (Ref 20-5);
- The Planning (Hazardous Substances) Regulations 2015 (Ref 20-6);
- The Supply of Machinery (Safety) Regulations 2008 (Ref 20-7);
- The Dangerous Substances and Explosive Atmospheres Regulations 2002 (Ref 20-8);
- The Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 2016 (Ref 20-9);
- The Pipelines Safety Regulations 1996 (Ref 20-10); and
- The Control of Substances Hazardous to Health Regulations 2002 (Ref 20-11).

Policy

- Overarching National Policy Statement for Energy (EN-1) (Ref 20-12);
- National Policy Statement for Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4) (Ref 20-13);
National Planning Policy Framework (Ref 20-14); and
- Associated Planning Practice Guidance (Ref 20-15).

Guidance

20.2.4 There is no published guidance for the application of the legal requirements to assess major accidents and disasters, but there are published guideline documents relating to major accidents and disasters and risk assessments which have been considered in this chapter. In 2020, IEMA released guidance document '*Major Accidents and Disasters in EIA: A Primer*' (Ref 20-16) to increase awareness of major accidents and disasters in EIA and its application, outlining a methodology and key terminology. There is also other guidance and information available on the identification and control of major hazards including:

- Guidelines for Environmental Risk Assessment and Management (Ref 20-17);
- Guideline – Environmental Risk Tolerability for COMAH Establishments (Ref 20-18);
- ISO 31000: 2018 Risk Management – Guidelines (Ref 20-19);
- A guide to the Control of Major Accident Hazards Regulations (COMAH) (Ref 20-20);
and
- Further guidance on emergency plans for major accident hazard pipelines (Ref 20-21);
and
- A Guide to the Pipelines Safety Regulations 1996 (HSE) (Ref 20-20)

20.2.5 The following data sources have also been reviewed to identify potential major accidents and disasters:

- Chemicals and Downstream Oil Industries Forum Guidelines, Environmental Risk Tolerability for COMAH Establishments (CDOIF, 2017) (Ref 20-30);
- The National Cabinet Office's Emergency Preparedness guidance on part 1 of the Civil Contingencies Act 2004 (hereafter referred to as the 'CCA risk assessment framework') (Ref 20-31);

- The International Federation of Red Cross & Red Crescent Societies Early Warning, Early Action (Ref 20-24);
- The International Disaster Database (Ref 20-25); and
- Reducing Risks, Protecting People: HSE's decision making process, (HSE, 1999) (Ref 20-32).

20.2.6 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, which are available on a dedicated page available on their website. The guidance includes the following:

- Guidance on conveying carbon dioxide in pipelines in connection with carbon capture and storage projects (Ref 20-33); and
- CO₂ Pipelines Good Practice Guidelines – Technical Report (Ref 20-34).

20.2.7 Carbon Dioxide (CO₂) is not currently defined as a dangerous fluid under Pipeline Safety Regulations and, as such, CO₂ pipelines are not classified as Major Accident Hazard Pipelines (MAHPs). Consequently, developments around CO₂ pipelines are not currently formally subject to the HSE's Land Use Planning advice.

20.2.8 As outlined in *Chapter 3*, safety is paramount to the Applicant and to Harbour Energy (the Applicant's parent company). To ensure a robust and futureproofed assessment, the Project team has had regard to HSE's Land Use Planning methodology in designing the Project and its assessment work. The Applicant will consult with HSE through the design and planning process.

20.3 Scoping Opinion and Consultation

20.3.1 A scoping exercise was undertaken in early 2022 to establish the content of the major accidents and disasters assessment and the approach and methods to be followed.

20.3.2 The Scoping Report recorded the findings of the scoping exercise and detailed the technical guidance, standards, best practice and criteria to be applied in the assessment to identify and evaluate the risk of major accidents and disasters.

20.3.3 Following receipt of the Scoping Opinion (*PEIR Volume IV - Appendix 5.2*), the following items were confirmed by the Planning Inspectorate to be scoped out of the major accidents and disasters assessment:

- Earthquakes, volcanic activity; tsunamis; pluvial flooding; groundwater flooding; avalanches; cyclones/ hurricanes/ typhoons/ storms/ gales; thunderstorms; extreme temperatures; droughts; severe space weather; fog; wildfires; poor air quality; public demonstrations; widespread damage to societies and economies; and the need for largescale humanitarian assistance.

20.3.4 In addition to the items that were scoped into the assessment within the Scoping Report, Avian flu was requested by the Environment Agency to be added for further assessment.

20.3.5 A summary of the elements scoped in and out is presented in **Table 20-1**, with the full Long List of all topics originally considered presented in *PEIR Volume IV - Appendix 20.1*.

Table 20-1: Summary of Elements Scoped In and Out of Major Accidents and Disasters Assessment

Element and Event	Scoped In	Scoped Out
Natural Hazards - Geophysical		
Earthquakes		✓
Volcanic Activity		✓
Landslides	✓	
Sinkholes	✓	
Tsunamis		✓
Natural Hazards - Hydrology		
Tidal Flooding	✓	
Fluvial Flooding	✓	
Pluvial Flooding		✓
Groundwater Flooding		✓
Avalanches		✓
Natural Hazards - Climatological and Meteorological		
Cyclones, hurricanes, typhoons, storms and gales		✓
Thunderstorms		✓
Wave surges	✓	
Extreme temperatures: Heatwaves Low (sub-zero) temperatures and heavy snow		✓
Droughts		✓
Severe Space Weather: Solar Flares		✓
Severe Space Weather: Solar Energetic Particles		✓
Severe Space Weather: Coronal Mass Ejections (CMEs)		✓
Fog		✓
Wildfires: Forest fire, Bush/brush, pasture		✓
Poor Air Quality		✓
Natural Hazards - Biological		
Disease epidemics		✓
Animal diseases	✓	

Element and Event	Scoped In	Scoped Out
Plants		✓
Technological or Manmade Hazards – Societal		
Extensive public demonstrations		✓
Widespread damage to societies and economies		✓
The need for largescale multi-faceted humanitarian assistance		✓
The hindrance or prevention of humanitarian assistance by political and military constraints		✓
Significant security risks for humanitarian relief workers in some areas		✓
Famine		✓
Displaced population		✓
Technological or Manmade Hazards - Industrial and Urban Accidents		
Major Accident Hazard Chemical sites	✓	
Major Accident Hazard Pipelines	✓	
Nuclear		✓
Fuel storage		✓
Dam breaches		✓
Mines and storage caverns		✓
Fires	✓	
Technological or Manmade Hazards - Transport accidents		
Road		✓
Rail		✓
Waterways		✓
Aviation		✓
Technological or Manmade Hazards – Pollution accidents		
Air	✓	
Land		✓
Water		✓
Technological or Manmade Hazards - Utilities failures		
Electricity		✓
Gas		✓

Element and Event	Scoped In	Scoped Out
Water Supply		✓
Sewage system		✓
Technological or Manmade Hazards - Malicious Attacks		
Unexploded Ordnance	✓	
Chemical / Biological /Radiological / Nuclear		✓
Transport systems		✓
Crowded places		✓
Technological or Manmade Hazards - Engineering accidents and failures		
Cyber	✓	
Infrastructure		✓
Bridge failure		✓
Flood defence failure	✓	
Mast and tower collapse		✓
Property or bridge demolition accidents		✓
Tunnel failure/fire		✓

20.4 Assessment Method

General Approach

- 20.4.1 The major accidents and disasters assessment method differs from that described in *Chapter 5: PEIR Assessment Methodology* as it identifies the reasonably foreseeable, worst-case consequence of a hazard on human health and the environment and bases it on the potential severity of harm and duration. By definition, all major accidents and disasters could result in some form of damage, the assessment therefore considers the likelihood, or risk, of the event occurring and a key focus is on the prevention of any incidents happening in the first place.
- 20.4.2 This preliminary assessment of major accidents and disasters has been conducted using a staged approach as outlined here:
- Identifying potential risk events related to the scoped in major event types (source / pathways and receptors);
 - Defining the reasonable worst-case consequence if the event did occur;
 - Identifying any possible prevention, minimisation and / or mitigation measures;
 - Assessing the likelihood; and then
 - Determining whether the risk has been mitigated to ‘as low as reasonably practicable’ (ALARP) and identification of any residual risks and their significance.

20.4.3 Likelihood as it is used in this preliminary assessment is qualitatively defined in **Table 20-2**. These qualitative definitions will be further defined, where possible quantitatively, in the full assessment.

Table 20-2: Likelihood Definitions

Probability	Very Low	Low	Medium	High	Very high
Qualitative definition	Should virtually never occur but is theoretically possible	Very unlikely to occur	Unlikely to occur during the total operational life of the system, or the construction period	May occur once during total operational life of the system, or the construction period	May occur several times during operational life, or the construction period

20.4.4 The ES will include a detailed methodology for the assessment of all major accidents and disasters considered, based on the guiding principles outlined above. Any limitations of the assessment of major accidents and disasters will also be clearly presented in the ES chapter.

20.4.5 This preliminary assessment of major accidents and disasters also considers the vulnerability of the Project to natural disasters using the findings of the climate change chapter (*Chapter 15: Climate Change*). The full assessment, reported in the ES, will also consider the findings of other assessments such as the flood risk assessment.

20.4.6 As is stated in HSE Guidance on Conveying Carbon Dioxide in Pipelines in connection with carbon capture and storage projects, *“operators of CO₂ pipelines can demonstrate compliance with Pipeline safety regulations by making sure that the risks from their pipelines are reduced as low as is reasonably practicable (ALARP). In particular, the application of good practice at the design stage is an essential part of this demonstration. However, to support their ALARP justifications, and until detailed standards become available, operators of CO₂ pipelines should use sound engineering and empirical evidence to support un-validated or partially validated probabilistic modelling”*.

20.4.7 The incidents considered in the assessment are rare events. All low consequence events, whatever their likelihood, do not meet the definition of a major accident or disaster, as defined in IEMA’s Major Accidents in EIA: A Primer (Ref 20-16). For example, minor spills which may occur during construction, but will be limited in area and volume, and temporary in nature, do not meet the definition of a major accident. Such minor events will be assessed within the technical assessments (where applicable) included in chapters 6 to 19 of this PEIR and assessed further in the ES.

20.4.8 The consequence of a hazard or threat is 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.

20.4.9 The tolerability of the residual risk is determined by combining the reasonably foreseeable worst-case consequence and probability categories (with engineering design solutions sought to reduce risks and probabilities). All residual risks are categorised as 'tolerable', 'tolerable if ALARP' (as low as reasonably practicable) or 'intolerable'. As a general rule, 'tolerable' and 'tolerable if ALARP' risks are considered as 'not significant' and intolerable risks are considered as 'significant'.

Scope of Assessment

20.4.10 This preliminary assessment covers the construction phase, including ground enabling work and the Operational phase of the Project.

20.4.11 Decommissioning of the Project is not specifically included as the hazards are anticipated to be encompassed by those assessed for the construction and operation phase, and no additional decommissioning hazards have been identified. The current premise is that when the CO₂ Pipeline reaches the end of its useful life it will be decommissioned and then left in situ, in accordance with best industrial practice. The associated AGIs are anticipated to be dismantled.

20.4.12 Decommissioning will be in accordance with the Environmental Protection Act 1990 (Ref 20-35), Construction Design and Management Regulations 2015 (Ref 20-4), the Health and Safety at Work etc. Act 1974 (Ref 20-3) and the Management of Health and Safety at Work Regulations 1999 (Ref 20-36) (or subsequent replacement legislation). Details of the decommissioning will be included in the management plans which will be required under the aforementioned legislation to make the risk of a major accident and disaster event as low as reasonably possible (ALARP).

20.4.13 The Short List of potential major accident and disaster events has been reviewed and refined and is detailed in **Table 20-1**. The Long List is provided in *PEIR Volume IV: Appendix 20.2 – Major Accidents and Disasters Long List*.

20.5 Baseline Environment and Study Area

Establishing the Baseline

20.5.1 The baseline relevant to major accidents and disasters primarily comprises:

- Features external to the Project that contribute a potential source of hazard to the Project itself;
- Sensitive environmental receptors at risk of significant effect; and
- Identified major accident and disaster risks which currently exist within the local area.

20.5.2 The baseline conditions described for major accidents and disaster events are derived from the following desk study sources:

- Technical chapters of this PEIR (Chapters 6 to 19);
- National Risk Register 2020 (Ref 20-23);
- British Geological Survey 'Onshore GeoIndex' (Ref 20-26);
- The Coal Authority Interactive Map (Ref 20-27);
- Health and Safety Executive's Planning Advice Web App (Ref 20-28);
- COMAH 2015 Public Information Search (Ref 20-29);
- Aerial photography; and

- Google street view maps covering the Draft Order Limits.

20.5.3 The baseline would be further refined during the main environmental impact assessment (EIA) and outlined within the ES.

The Study Area

20.5.4 The Study Area for major accidents and disasters has been initially developed based on professional judgement as there is no regulatory guidance or standardised methodology.

20.5.5 The following factors and associated distances were taken into consideration for setting the initial Study Area, in order to capture the adverse consequences caused by other events, on the Project and relate to distances from the Draft Order Limits within which the pipeline route will be located:

- *Manmade features:*
 - Airports and airfields within 10 km, including Humberside Airport and Strubby Airfield;
 - Petrol stations within 1 km, of which there are approximately eight;
 - Rail infrastructure within 1 km including railway lines between Ulceby and Immingham; Grimsby and Habrough; and the Lincolnshire Wolds Railway;
 - Utilities (gas, electrical, water, telecommunication, oil/fuels) crossing the Draft Order Limits, which include approximately 52 different utility crossings; and
 - Onsite unexploded ordnance (UXO) as identified within the initial desk based risk assessment (see *PEIR Volume IV: Appendix 20.2*).
- *Natural features* with the potential to create risks within:
 - Hydrological and geological features such as dam failure and seismic activity within 5km and hydrological and geological feature such as flood risk and unstable ground conditions within 1km;
 - Information provided in *Chapter 9: Geology and Hydrogeology* underlying the Study Area is of no risk or very low risk of seismic hazards. There are also low risks associated with ground stability, such as landslides, ground collapse, ground compression, sinkholes, running sand and shrinking or swelling of clay; and
 - Information provided in *Chapter 11: Water Environment* identifies that whilst the majority of the Draft Order Limits lies outside of a flood risk zone, a portion within the north, and a larger section within the south do lie within Flood Zones 2 and/or 3 as well as a few other isolated areas in the immediate vicinity of watercourses.
- *Existing Major Accident Hazards:*
 - COMAH sites within 5km such as the Phillips 66 Humber Refinery (P66) and VPI Immingham (combined Heat and Power Station in Immingham); and
 - Major accident hazard pipelines within 1 km including gas and condensate pipelines;

Sensitive Receptors

20.5.6 Receptors are features of the environment that may be affected and thus are subject to assessment under Section 5 (2) of the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (Ref 20-1), namely biodiversity, land, soil, water, air and climate, material assets, cultural heritage and landscape. Key receptors also include human populations.

20.5.7 These have been identified through a review of base mapping and aerial photography as well as consultation with the other EIA topics (Chapters 6-19). **Table 20-3** identifies the key major event receptors within the Study Area.

Table 20-3: Identified Key Receptors for Major Events

Major Event Receptor	Type	Description
Members of the public and local communities	Human health	The Draft Order Limits pass by a number of villages, including Immingham, Stallingborough, Keelby, Healing, Aylesby, Laceby, Irby upon Humber, Barnoldby le Beck, Brigsley, Ashby cum Fenby, Grainsby, North Thoresby, Ludborough, Covenham St Bartholomew, Covenham St Mary, Utterby, Yarburgh, Fotherby, Little Grimsby, Alvingham, South Cockerington, North Cockerington; Grimoldby, Theddlethorpe All Saints, Theddlethorpe St Helen and Mablethorpe.
Eastfield Industrial Estate and Immingham Docks	Land	A number of COMAH sites, industrial uses.
Railways	Land	Two cross the Draft Order Limits
Main rivers, ordinary watercourses, canals	Water	A number cross the Draft Order Limits.
Lincolnshire Wolds Area of Outstanding Natural Beauty (AONB)	Landscape	An area of outstanding natural beauty (AONB) is land protected by the Countryside and Rights of Way Act 2000 (CROW Act).
Designated Sites	Biodiversity	There are five European designated sites within 10 km of the Draft Order Limits, and 14 nationally designated sites within 10 km of the Draft Order Limits.
Protected Species	Biodiversity	Ecological surveys undertaken to date show there may be protected species within the Draft Order Limits.
Heritage assets and archaeology	Cultural Heritage	There are designated and non-designated heritage assets within the Draft Order Limits and the 1 km Study Area for this topic.

20.5.8 In addition to external receptors that could be affected by the project, the Project itself is a potential receptor, in that it could be impacted by major accidents or disasters.

Future Baseline

20.5.9 The future baseline is not anticipated to differ significantly from the current baseline.

Assumptions and Limitations

20.5.10 This assessment is based on the preliminary design of the Project and early appraisal of potential hazards. A more detailed assessment will be provided within the ES.

20.6 Development Design and Impact Avoidance

Design

- 20.6.1 The Project will be designed, constructed, operated and maintained in line with the Pipeline Safety Regulations (1996), PD8010 Code of Practice for pipelines – part 1 steel pipelines on land (Ref 20-34) and with current best practice standards.
- 20.6.2 The following impact avoidance measures have already, or will be, either 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.
- 20.6.3 Safety has been key to the design of the Project. The engineering team has undertaken a number of initial technical studies which have helped to influence the pipeline routing and the location of key above ground installations including the block valves (which act as emergency shutdown valves). Additional detailed engineering work will also be undertaken relating to process safety and safeguarding, isolation, venting, emergency shutdown and if required, depressurisation. The engineers will also review the layout of the current plans and give due consideration both to the on-site location of facilities as well as the off-site receptors.
- 20.6.4 As part of the ongoing optimisation of the project, the Applicant has taken the decision to construct the entire pipeline using thick wall pipe. This exceeds the design requirements set out in the Pipeline Design code – PD8010 (Ref. 20-34), bringing additional security and safety benefits to the Project by helping to reduce the probability of any major incidents from happening. This approach ensures an inherently safer design is developed with potential risks mitigated and appropriately managed.

Construction

- 20.6.5 During the construction phase of the project risks will be mitigated through the use of appropriately trained and qualified contractors selected following a thorough tender process. Work will be controlled with risk assessments, work method statements and operating procedures in order to reduce the likelihood of incident.
- 20.6.6 A Construction Environmental Management Plan (CEMP) will be prepared to set out how construction activities would be managed and controlled in compliance with the Harbour Energy health and safety and environmental management systems (including ISO 14001), relevant legislation and environmental permits, consents and licences. A preliminary Draft CEMP is included in *PEIR Volume IV Appendix 5.1*.

Operation

- 20.6.7 Once operational appropriate control and monitoring procedures, management systems and control measures will be in place to minimise the risk of incidents occurring and to minimise the effects of any such incidents on off-site receptors as well as the operational workforce.

20.7 Preliminary Assessment of Effects

General overview

20.7.1 Based on the information known at this stage of the Project's development, a preliminary assessment of the major event types was completed and is presented in **Table 20-3** below. This preliminary assessment will be reviewed after Statutory Consultation and updated to reflect the comments received as appropriate and updated again as the EIA progresses. The full assessment will be included within the ES.

20.7.2 The assessment identifies potential risks and whether these are able to be managed to be ALARP or whether further mitigation would be required. The key element of determining whether a potential risk is ALARP rests on the term 'reasonably practicable'. The HSE define 'reasonably practicable' as follows:

"The definition set out by the Court of Appeal (in its judgment in Edwards v. National Coal Board, [1949] 1 All ER 743) is:

"'Reasonably practicable' is a narrower term than 'physically possible' ... a computation must be made by the owner in which the quantum of risk is placed on one scale and the sacrifice involved in the measures necessary for averting the risk (whether in money, time or trouble) is placed in the other, and that, if it be shown that there is a gross disproportion between them – the risk being insignificant in relation to the sacrifice – the defendants discharge the onus on them."

In essence, making sure a risk has been reduced ALARP is about weighing the risk against the sacrifice needed to further reduce it. The decision is weighted in favour of health and safety because the presumption is that the duty-holder should implement the risk reduction measure. To avoid having to make this sacrifice, the duty-holder must be able to show that it would be grossly disproportionate to the benefits of risk reduction that would be achieved. Thus, the process is not one of balancing the costs and benefits of measures but, rather, of adopting measures except where they are ruled out because they involve grossly disproportionate sacrifices. Extreme examples might be:

To spend £1m to prevent five staff suffering bruised knees is obviously grossly disproportionate; but

To spend £1m to prevent a major explosion capable of killing 150 people is obviously proportionate."

20.7.3 CO₂ is not flammable and will not support combustion. The principal human health risk from CO₂ is the potential for it to be toxic or act as an asphyxiant due to it being denser than air. High levels of CO₂ in water can result in acidification and cause subsequent effects on shell-forming species.

20.7.4 As outlined in the section on "scope of assessment", the assessment includes an overview of events that may happen during both construction and operational phases of the Project. This chapter has used the potential short listed major accidents and disasters agreed during the scoping process as a guide to structure the assessment.

Potential Impacts of Major Accidents Associated with Carbon Dioxide Releases

20.7.5 The HSE has undertaken a Dangerous Toxic Load assessment for CO₂ which concludes a significant danger to humans through loss of consciousness if they inhale CO₂ 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 and concluded that CO₂ data indicates it does not meet the criteria for classification as a dangerous substance.

- 20.7.6 The HSE publication on the major hazards associated with CO₂ (Ref 20-38) states that this gas is an asphyxiant which displaces oxygen in air at a concentration of 50% volume per volume (v/v). However, even at lower concentrations, CO₂ 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 (Ref 20-35).
- 20.7.7 There are specific hazards associated with handling CO₂ in dense phase (this is when large quantities of CO₂ are conveyed at high pressures). These can arise when a release occurs, and the pressure suddenly falls or is lost completely and result in cryogenic burns to living creatures and damage to assets such as embrittlement of metallic structures and pipework.
- 20.7.8 The Project team has reviewed historical accidents involving CO₂ and has given this due consideration when designing the Project.
- 20.7.9 A number of research projects have been undertaken to refine and validate the software used for modelling dense phase CO₂ releases and to further understand the potential hazards of a major release. Harbour Energy commissioned their own technical assessment using industry standard tools to model CO₂ releases. The outcomes of the modelling were reviewed by the team and have been used to help further refine the preferred pipeline route.

20.8 Mitigation Measures

- 20.8.1 As outlined in the Development Design section above, the Applicant intends to construct, manage and operate the Project in accordance with a number of standards and systems in order to ensure the likelihood of any major hazard or accident is reduced to ALARP.
- 20.8.2 In addition, Project specific operating documentation in line with the Harbour Energy HSES management systems, will be developed to help reduce risks and ensure adequate planning and preparation is in place in the event of a major incident occurring. Key documents/systems of note include:
- Risk management system and adherence to all applicable HSE guidelines;
 - Adherence to the Construction Environmental Management Plan (CEMP);
 - Undertaking additional studies, where required, to produce an inherently safer design and to ensure residual risks are managed to be ALARP; and
 - Preparation of bespoke incident response plans to ensure reasonably foreseeable incidents can be managed appropriately; and
 - Developing detailed emergency plans for dealing with potential major incidents.

Table 20-4: Preliminary Assessment of Short-Listed Major Accident and Disasters

Major Event Group	Major Event Category	Major Event Type	Project Phase	Risk Description	Receptors	Hazard sources and pathways	Reasonable worst consequence if event did occur	Mitigation	Likelihood	Is this ALARP? Y/N	Tolerability
Natural Hazards	Geophysical	Landslides and Sinkholes	Construction and Operation	The risk of a natural landslide event occurring or sinkhole opening up along the pipeline route, causing damage to the Viking CCS Pipeline, during either construction or operation. Damage to the pipeline caused by a landslide or sink hole has the potential to lead to a significant release of CO ₂ .	Construction workers; Construction plant and materials; Local residents; Property and land; General Public; and Ecology and Biodiversity.	The superficial geology underlying the Project include the following: Glacial Till, Tidal Flat Deposits, Glaciofluvial Deposits, Alluvium, Lacustrine Deposits. The bedrock geology that underlies the Project includes various chalk formations. Construction and development modifying surface drainage or altering the loads imposed on the ground without adequate support can cause sinkholes to develop. No historic landslides have been identified within the Draft Order Limits from a review of the BGS National Landslide Database Index. However one incident has been located	Mass CO ₂ release leading to a toxicity and fogging hazard affecting those people in the immediate area. Potential death and/ or injury to construction workers or members of the public. Loss of construction materials and plant / built infrastructure. Delays to the Project programme if occurs during construction phase Total shutdown of Project if occurs during operation	Compliance with the Pressure Equipment (Safety) Regulations 2016 and the Pipelines Safety Regulations (PSR) (HSE, 1996); Appropriate selection of pipeline routes, depth of cover in areas of higher risk and use of thick wall pipe and the construction of safety systems to prevent pipeline damage, such as the installation of barriers; Pipeline safety systems and leak detection system to be installed along with operational controls and monitoring. Detailed emergency plans will be produced for the installation in accordance with all applicable Regulations. Construction methods would include risk assessments.	Very Low	Y	Tolerable (not significant)

Major Event Group	Major Event Category	Major Event Type	Project Phase	Risk Description	Receptors	Hazard sources and pathways	Reasonable worst consequence if event did occur	Mitigation	Likelihood	Is this ALARP? Y/N	Tolerability
						within 50m of the Draft Order Limits at West Laceby (Landslide ID 14387).					
Natural Hazards	Hydrology	Tidal Flooding	Construction and Operation	Risk of tidal flooding in Sections 1 and 5 of the Viking CCS Pipeline.	Construction workers; Construction plant and materials; Local residents; Property and land; and General Public.	A review of the Environment Agency Flood Map for Planning (Rivers and Sea) (Environment Agency, 2020) indicates that some parts of Sections 1 and 5 of the Draft Order Limits are at risk of tidal flooding. Tidal flooding has the potential to impact upon construction activities, in those areas which are outlined above. Tidal flooding has limited potential to impact the Viking CCS Pipeline once operational.	Flooding of sections of the pipeline route during construction; Potential harm to construction workers; Potential damage to infrastructure; A flood risk assessment is contained in PEIR Volume IV: Appendix 11.2 which provides more details.	Suitable mitigation measures are set out in the Flood Risk Assessment (PEIR Volume IV Appendix 11.2) A commitment in the Draft CEMP includes the production of an Emergency Flood Plan	Low	Y	Tolerable (not significant)

Major Event Group	Major Event Category	Major Event Type	Project Phase	Risk Description	Receptors	Hazard sources and pathways	Reasonable worst consequence if event did occur	Mitigation	Likelihood	Is this ALARP? Y/N	Tolerability
Natural Hazards	Hydrology	Fluvial Flooding	Construction and Operation	Risk of fluvial flooding in Sections 1 and 5 of the Viking CCS Pipeline.	Construction workers; Construction plant and materials; Local residents; Property and land; and General Public.	A review of the Environment Agency Flood Map for Planning (Rivers and Sea) (Environment Agency, 2020) indicates that there are numerous locations associated with main rivers or water courses along the pipeline route which are located in flood zone 2 or 3. Fluvial flooding has the potential to impact upon construction activities, in those areas which are outlined above. Fluvial flooding has limited potential to impact the Viking CCS Pipeline once operational.	Flooding of sections of the pipeline route during construction. Potential harm to construction workers Potential damage to infrastructure. Impacts on property and people if the project exacerbated flood risk. A flood risk assessment is contained in PEIR Volume IV: Appendix 11.2 which provides more details.	Suitable mitigation measures are set out in the Flood Risk Assessment (PEIR Volume IV Appendix 11.2). A commitment in the Draft CEMP includes the production of an Emergency Flood Plan	Low	Y	Tolerable (not significant)
Natural Hazards	Climatological and Meteorological	Wave surges	Construction and Operation	Risk of tidal wave surges affecting the Project at Immingham and Theddlethorpe	Construction workers;	The Project is located in an area at risk of tidal flooding. The floodplains	Potential damage to infrastructure. Potential Flooding at the	Existing Flood defences in Immingham and Theddlethorpe mean that there is no significant risk to the site from wave surges.	Very Low	Y	Tolerable (not significant)

Major Event Group	Major Event Category	Major Event Type	Project Phase	Risk Description	Receptors	Hazard sources and pathways	Reasonable worst consequence if event did occur	Mitigation	Likelihood	Is this ALARP? Y/N	Tolerability
					<p>Construction plant and materials;</p> <p>Local residents;</p> <p>Property and land; and</p> <p>General Public.</p>	<p>of the Humber Estuary and North Sea are at risk of tidal flooding. The pipeline is below ground and therefore would not be subject to the direct hydraulic forces of a wave surge.</p> <p>The AGI's proposed would largely be sited far enough inland so as not to be subject to wave surges. However a further review of the Dune Isolation Valve on the existing LOGGS Pipeline will be reviewed further within the ES.</p>	<p>Immingham Facility.</p> <p>Potential Flooding at the Theddlethorpe Facility.</p> <p>Potential Flooding of the Dune Isolation Valve on the existing LOGGS pipeline.</p>				
Technological or Manmade Hazards	Industrial and Urban Accidents	Major Accident Hazard Chemical sites	Construction and Operation	Risk of an incident at the Project (e.g. fire/explosion) affecting COMAH sites during either construction or operation	<p>Construction and Operational workers;</p> <p>Construction plant and materials;</p> <p>Local residents;</p> <p>Property and land; and</p> <p>General Public.</p>	<p>There are approximately 17 establishments within the Immingham Docks area, within proximity of Section 1 of the Draft Order Limits, which are covered by the Control of</p>	<p>Death and/ or injury to workers or members of the public.</p> <p>Loss of construction materials and plant.</p>	<p>Compliance with the Pressure Equipment (Safety) Regulations 2016 and the Pipelines Safety Regulations (PSR) (HSE, 1996);</p> <p>The Project has been designed and located with due consideration of other facilities. This includes the appropriate selection of pipeline routes, depth of cover</p>	Very Low	Y	Tolerable (not significant)

Major Event Group	Major Event Category	Major Event Type	Project Phase	Risk Description	Receptors	Hazard sources and pathways	Reasonable worst consequence if event did occur	Mitigation	Likelihood	Is this ALARP? Y/N	Tolerability
						<p>Major Accident Hazard (COMAH) Regulations 2015.</p> <p>The Immingham Facility covers only a small area of land (just over 1 hectare) and is located remotely from the main operational areas of neighboring facilities at VPI and P66.</p> <p>During construction there is no realistic potential for an incident to occur which could affect other sites within the Immingham area.</p> <p>During operation, a pipeline full bore breach could result in significant harm to people on Site, if they</p>	<p>Delays to the Project programme and congestion in surrounding area.</p> <p>Knock-on impact to other industrial sites and their operations.</p> <p>Firewater run-off reaching areas of unmade ground could contain contaminants which would be potentially harmful to groundwater.</p>	<p>in areas of higher risk, the thickness of the pipe and the construction of safety systems to prevent pipeline damage, such as the installation of barriers.</p> <p>Compliance with Pipeline Safety Regulations (HSE, 1996) and additional specific safety measures for CO₂ pipelines will apply.</p> <p>Instrumented protection systems provided to mitigate pressure and temperature excursions outside design limits. Leak detection systems and pressure monitoring. Isolation valves in the pipeline system to minimise inventory release to the atmosphere.</p> <p>Project will follow the safety lifecycle requirements demanded by industry best practices such as IEC 61508/61511 standards (implemented in the UK as BS EN 61508/61511). Detailed emergency plans will be produced for the installation in accordance with all applicable Regulations;</p> <p>Construction methods would include risk assessments. Implementation of a permit to work system</p>			

Major Event Group	Major Event Category	Major Event Type	Project Phase	Risk Description	Receptors	Hazard sources and pathways	Reasonable worst consequence if event did occur	Mitigation	Likelihood	Is this ALARP? Y/N	Tolerability
						<p>were present at the time.</p> <p>There is extremely limited potential for harm to people and businesses off-site, such as radiant heat burns and impact injuries from explosions associated with the Project.</p> <p>The potential for an incident on the Project to have an impact on adjacent facilities will be investigated further in the ES.</p>					
Technological or Manmade Hazards	Industrial and Urban Accidents	Major Accident Hazard Chemical sites	Construction and Operation	Risk of an incident (e.g. fire /explosion) at other sites affecting the Project	<p>Construction and Operational workers;</p> <p>Construction plant and materials;</p> <p>Local residents;</p> <p>Property, businesses and land; and</p> <p>General Public.</p>	<p>The Immingham Facility would have the potential to be affected by incidents occurring at other sites.</p> <p>There are approximately 17 establishments within the Immingham Docks area, within proximity</p>	<p>Death and/ or injury to workers or members of the public;</p> <p>Loss of construction materials and plant;</p> <p>Delays to the Project programme and congestion</p>	<p>All other projects will be designed and operated in line with applicable regulations (e.g. COMAH). Consequently, all will have specific plans and procedures in place to avoid and/or minimise the potential for and impacts of unplanned events</p> <p>The Project has been designed and located with due consideration of other facilities;</p>	Very Low	Y	Tolerable (not significant)

Major Event Group	Major Event Category	Major Event Type	Project Phase	Risk Description	Receptors	Hazard sources and pathways	Reasonable worst consequence if event did occur	Mitigation	Likelihood	Is this ALARP? Y/N	Tolerability
						<p>of Section 1 of the Draft Order Limits, which are covered by the Control of Major Accident Hazard (COMAH) Regulations 2015. These include the sites located at P66 and VPI, which are located in relatively close proximity to the Immingham Facility and are of a much more significant scale as to the components of our Project.</p> <p>Fire and/or explosion at other sites could, result in significant harm to people on the Project Site (if present), with the potential for fatal injuries.</p> <p>There is also the potential for an offsite explosion to damage the Immingham Facilities or buried pipeline (though this is less likely),</p>	in surrounding area.	Close coordination and communication between other nearby operators would be undertaken to ensure all relevant emergency procedures are made available to our Project.			

Major Event Group	Major Event Category	Major Event Type	Project Phase	Risk Description	Receptors	Hazard sources and pathways	Reasonable worst consequence if event did occur	Mitigation	Likelihood	Is this ALARP? Y/N	Tolerability
						<p>leading to harm to people and businesses off-site</p> <p>The potential for an incident at other sites affecting the Project will be investigated further in the ES.</p>					
Technological or Manmade Hazards	Industrial and Urban Accidents	Major Accident Hazard Pipelines	Construction	Damage to a major accident hazard pipeline causing loss of containment	<p>Construction workers;</p> <p>Construction plant and materials;</p> <p>Local residents;</p> <p>Property, businesses and land;</p> <p>General Public;</p> <p>Ecology and Biodiversity; and</p> <p>Water Environment.</p>	<p>There are Major Accident Hazard (MAH) pipelines within or close to the Draft Order Limits.</p> <p>There is therefore the potential for damage to occur during construction activities.</p> <p>The extent of the release of contaminant would depend upon how severe the incident was, but could lead to pollution incidents to the local surface and groundwater and /or releases to the atmosphere.</p>	<p>Contamination of ground and/or water supply;</p> <p>Potential dispersion to air</p>	<p>The preferred pipeline route has been designed to avoid other buried infrastructure where reasonably possible</p> <p>Detailed design engineering will seek precise details on presence and location of other potential pipelines;</p> <p>Site surveys and scans along with localised trial trenching;</p> <p>Close coordination and communication between other pipeline operators to ensure the project can be constructed safely; and</p> <p>Construction methods would include risk assessments and would be in compliance with the CEMP.</p>	Very Low	Y	Tolerable (not significant)

Major Event Group	Major Event Category	Major Event Type	Project Phase	Risk Description	Receptors	Hazard sources and pathways	Reasonable worst consequence if event did occur	Mitigation	Likelihood	Is this ALARP? Y/N	Tolerability
Technological or Manmade Hazards	Pollution accidents	Release to Air	Operation	An accident or natural hazard could lead to an incident by which part of the Project's CO ₂ inventory is released to the air	Local residents; Local property, businesses and land; General public; and Ecology and Biodiversity.	<p>A significant loss of containment event involving the pipeline would result in a large-scale release of CO₂ to the environment.</p> <p>CO₂ is an odourless and transparent gas which can, in certain circumstances be toxic and act as an asphyxiant, depending on the concentration in air. It is also heavier than air.</p> <p>A leak or rupture of a system containing high pressure (dense phase) CO₂ will likely be noisy and will be observed with the naked eye due to the transition between the phases.</p> <p>There will be an associated large</p>	CO ₂ toxicity, asphyxiation and fogging hazard affecting those people in the immediate area.	<p>The pipeline route has been deliberately sited away from more densely populated areas.</p> <p>Detailed standards and codes of practice written specifically for the design and operation of dense phase or supercritical CO₂ 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, <i>“ongoing work suggests that the hazards involved with the bulk transport of CO₂ are similar to the hazards transporting natural gas”</i>.</p> <p>Compliance with Pipeline Safety Regulations (HSE, 1996) and additional specific safety measures for CO₂ pipelines will apply.</p> <p>Instrumented protection systems provided to mitigate pressure and temperature excursions outside design limits. Leak detection systems and pressure monitoring. Isolation valves in the pipeline system to minimise inventory release to the atmosphere.</p> <p>Project will follow the safety lifecycle requirements demanded by industry best practices such as IEC</p>	Very Low	Y	Tolerable (not significant)

Major Event Group	Major Event Category	Major Event Type	Project Phase	Risk Description	Receptors	Hazard sources and pathways	Reasonable worst consequence if event did occur	Mitigation	Likelihood	Is this ALARP? Y/N	Tolerability
						<p>reduction in temperature from a high pressure release. There is also a risk that a medium pressure CO₂ release is not dispersed and not seen immediately.</p> <p>A release of CO₂ could be caused by mechanical failure or impact damage resulting in a loss of containment.</p> <p>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.</p>		<p>61508/61511 standards (implemented in the UK as BS EN 61508/61511).</p> <p>Use of containment measures and barriers to prevent damage to pipelines.</p>			

Major Event Group	Major Event Category	Major Event Type	Project Phase	Risk Description	Receptors	Hazard sources and pathways	Reasonable worst consequence if event did occur	Mitigation	Likelihood	Is this ALARP? Y/N	Tolerability
Technological or Manmade Hazards	Malicious Attacks	Unexploded Ordnance (UXO)	Construction	Risk of encountering a Unexploded Ordnance (UXO) during ground investigation or construction activities	Construction workers; Construction plant and materials; Local residents; Property, businesses and land; General Public.	The Draft Order Limits contain a UXO moderate to high risk area. Measures would be undertaken during the construction phase to raise awareness of this issue to construction site staff and operatives, and to define the appropriate response strategies should any be discovered during the works. Further assessment of UXO would be included within the ES and how they can link to major incidents.	Death and/ or injury to construction workers or members of the public. Fire/explosion affecting the construction works and neighbouring property.	An initial desk based UXO assessment has been commissioned for the Project. This has identified any significant sources of UXO hazard and has been used as part of the design process. A copy of this initial report is included in <i>PEIR Volume IV: Appendix 20.1</i> . A more detailed UXO desk study and risk assessment will be commissioned to confirm the exact UXO hazard level along the route. A copy of this will be included within the ES. A series of procedures, protocols and training required during the construction phase will be detailed within the CEMP.	Low	Y	Tolerable (not significant)
Technological or Manmade Hazards	Engineering accidents and failures	Cyber	Operation	Potential for cyber interference of sabotage of the Project once operational	Maintenance operators; Local residents; Property, businesses and land; General Public.	The Block Valve Stations, Immingham Facility and Theddlethorpe Facility would be remotely monitored rendering the Project vulnerable to a cyber-attack.	A cyber attack could hinder the standard operating procedures or lead to a temporary shut down of all activities.	The Applicant is accountable to the Secretary of State (SoS) for Business, Energy and Industrial Strategy for ensuring resilience of their operations, including from terrorism, cyber-attack, natural hazards and other risks. The Project will be designed using the latest technology and controls which will be specifically designed to	Very Low	Y	Tolerable (not significant)

Major Event Group	Major Event Category	Major Event Type	Project Phase	Risk Description	Receptors	Hazard sources and pathways	Reasonable worst consequence if event did occur	Mitigation	Likelihood	Is this ALARP? Y/N	Tolerability
								manage vulnerability to cyber attack.			
Technological or Manmade Hazards	Engineering accidents and failures	Flood defence failure	Construction Operation	Potential for flood defences to fail (e.g. due to extreme weather events)	Construction workers; Construction plant and materials; Property, businesses and land.	There are locations within the Draft Order Limits that benefit from flood defences. If this was to occur, flooding could lead to problems predominantly during construction, but also at a number of AGI's during operation	Loss of construction materials and plant. Delays to the Project programme and congestion in surrounding area.	The design of the Project is being developed to include allowances for future climate change predicted effects on flooding. The potential risk of breach events will be considered in the EIA, specifically the Flood Risk Assessment which would accompany the ES. This will be explored as part of the FRA to see if there could be any major incidents which would need to be considered within the major accidents and disasters assessment. A preliminary Flood Risk Assessment is presented in <i>PEIR Volume IV – Appendix 11.2</i> .	Very Low	Y	Tolerable (not significant)
Natural Hazards	Biological	Avian Influenza	Construction and Operation	Potential for construction activities to cause the spread avian influenza	Birds.	According to DEFRA, as of early October 2022, the risk of incursion of highly pathogenic (HPAI) avian influenza H5 in wild birds in Great Britain remains at medium (that is,	Avian Influenza would become more widespread amongst the wild bird population, causing more fatalities. Avian Influenza would also become more	Adherence to good construction practices and measure set out in the CEMP will help reduce the risk of spreading infection. This includes adherence to applicable legislation (such as The Avian Influenza (H5N1 in wild Birds (England 2006 and amended in 2021) Additionally, the construction contractors will follow the	Low	Y	Tolerable (not significant)

Major Event Group	Major Event Category	Major Event Type	Project Phase	Risk Description	Receptors	Hazard sources and pathways	Reasonable worst consequence if event did occur	Mitigation	Likelihood	Is this ALARP? Y/N	Tolerability
						<p>event occurs regularly). The risk to poultry with stringent biosecurity is maintained at low (with low uncertainty). However, the risk to poultry exposure to HPAI H5 in Great Britain with suboptimal biosecurity has been increased to medium in light of the increased number of infected premises observed during September.</p> <p>Following a number of detections of avian influenza in poultry and wild and captive birds across east of England a regional Avian Influenza Prevention Zone (AIPZ) was declared on 27 September in Norfolk, Suffolk and parts of Essex. There is now a legal</p>	widespread amongst poultry farms, especially those with suboptimal biosecurity.	<p>current guidelines in place with regards to notification of finding dead birds, including notifying DEFRA (via their helpline 03459335577).</p> <p>Additional information is also provided within the “<i>Stop the Spread</i>” webinars, located at:</p> <p>https://www.gov.uk/government/publications/avian-influenza-bird-flu-stop-the-spread-webinars/stop-the-spread-webinars</p>			

Major Event Group	Major Event Category	Major Event Type	Project Phase	Risk Description	Receptors	Hazard sources and pathways	Reasonable worst consequence if event did occur	Mitigation	Likelihood	Is this ALARP? Y/N	Tolerability
							requirement for all bird keepers to implement enhanced biosecurity measures to help protect their flocks				

20.9 Residual Effects

20.9.1 Based on the embedded design measures and additional mitigation outlined above and in the supporting technical chapters of this PEIR, it is considered that the identified potential major accident and disaster events identified during the construction and operation of the Project will all be managed to be ALARP and will be classed as being not significant. Consequently, no significant residual effects have been identified.

20.10 Summary and Next Steps

20.10.1 This preliminary assessment has identified the potential major accidents and disasters that could be applicable to the Project. Principally, these have included natural hazards related to geophysical (i.e. landslides and sinkholes); hydrology (tidal and fluvial flooding); climatology and meteorology (wave surges); biological (animal diseases); as well as technological or manmade hazards such as Industrial and urban accidents (COMAH sites and major accident hazard pipelines); pollution accident (release to air); malicious attacks (unexploded ordnance); engineering accidents or failures (cyber and flood defence).

20.10.2 The consequences of these events happening could include fires, explosions, physical damage and the release of CO₂ gas. These incidents have an extremely low probability of occurrence but could have significant impacts on people and the environment without mitigation.

20.10.3 The engineering design of the Project will incorporate 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 Environment Agency). Reducing the probability of an incident occurring has been a key focus for the engineering design of the Project. Additionally, a set of plans and procedures will be developed and implemented should any incident occur, further controlling and mitigating the impact.

20.10.4 With the implementation of these measures, risks are considered to have been mitigated to a 'tolerable' level and therefore the effects are considered as '**Not Significant**' for both construction and operation.

20.11 References

- Ref 20-1** The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017. Available at: <https://www.legislation.gov.uk/ukxi/2017/572/contents/made>
- Ref 20-2** European Union (EU) Directive 2014/52/EU. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0052&from=FR>
- Ref 20-3** Health and Safety at Work etc. Act 1974. Available at: <https://www.legislation.gov.uk/ukpga/1974/37/contents>
- Ref 20-4** Construction (Design and Management) Regulations 2015 (CDM). Available at: <https://www.legislation.gov.uk/ukxi/2015/51/contents/made>
- Ref 20-5** Control of Major Accident Hazards Regulations 2015 (COMAH). Available at: <https://www.legislation.gov.uk/ukxi/2015/483/contents/made>
- Ref 20-6** The Planning (Hazardous Substances) Regulations 2015. Available at: <https://www.legislation.gov.uk/ukxi/2015/627/contents/made>
- Ref 20-7** The Supply of Machinery (Safety) Regulations 2008. Available at: <https://www.legislation.gov.uk/ukxi/2008/1597/contents/made>
- Ref 20-8** The Dangerous Substances and Explosive Atmospheres Regulations 2002. Available at: <https://www.legislation.gov.uk/ukxi/2002/2776/contents/made>
- Ref 20-9** The Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 2016. Available at: <https://www.legislation.gov.uk/ukxi/2016/1107/contents/made>
- Ref 20-10** The Pipeline Safety Regulations 1996. Available at: <https://www.legislation.gov.uk/ukxi/1996/825/contents/made>
- Ref 20-11** The Control of Substances Hazardous to Health Regulations 2002. Available at: <https://www.legislation.gov.uk/ukxi/2002/2677/regulation/7/made>
- Ref 20-12** Overarching National Policy Statement for Energy (EN-1). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47854/1938-overarching-nps-for-energy-en1.pdf;
- Ref 20-13** National Policy Statement for Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47857/1941-nps-gas-supply-oil-en4.pdf;
- Ref 20-14** National Planning Policy Framework (2021). Available at: <https://www.gov.uk/government/publications/national-planning-policy-framework--2>
- Ref 20-15** Associated Planning Practice Guidance. Available at: <https://www.gov.uk/government/collections/planning-practice-guidance>
- Ref 20-16** IEMA Major Accidents and Disasters in EIA: A Primer, September 2020. Available at: <https://www.iema.net/resources/blog/2020/09/23/iema-major-accidents-and-disasters-in-eia-primer>

Ref 20-17 Guidelines for Environmental Risk Assessment and Management. Available at: <https://www.gov.uk/government/publications/guidelines-for-environmental-risk-assessment-and-management-green-leaves-iii>

Ref 20-18 Guideline – Environmental Risk Tolerability for COMAH Establishments. Available at:

https://www.sepa.org.uk/media/219154/cdoif_guideline_environmental_risk_assessment_v2.pdf

Ref 20-19 ISO 31000: 2018 Risk Management – Guidelines. Available at: <https://www.iso.org/standard/65694.html>

Ref 20-20 A guide to the Control of Major Accident Hazards Regulations (COMAH) (2015). Available at: <https://www.hse.gov.uk/pubns/books/l111.htm>

Ref 20-21 Further guidance on emergency plans for major accident hazard pipelines. Available at: <https://www.hse.gov.uk/pipelines/emergencyplanpipe.pdf>

Ref 20-22 A Guide to the Pipeline Safety Regulations 1996, HSE. Available at: <https://www.hse.gov.uk/pubns/books/l82.htm>

Ref 20-23 National Risk Register 2020. Available at: <https://www.gov.uk/government/publications/national-risk-register-2020>

Ref 20-24 The International Federation of Red Cross & Red Crescent Societies Early Warning, Early Action. Available at: <https://www.ifrc.org/early-warning-early-action>

Ref 20-25 The International Disaster Database. Available at: <https://www.emdat.be/>

Ref 20-26 British Geological Survey 'Onshore GeoIndex'. Available at: <https://www.bgs.ac.uk/map-viewers/geoindex-onshore/>

Ref 20-27 The Coal Authority Interactive map. Available at: <https://mapapps2.bgs.ac.uk/coalauthority/home.html>

Ref 20-28 Health and Safety Executive's Planning Advice Web App. Available at: <https://www.hse.gov.uk/landuseplanning/planning-advice-web-app.htm>

Ref 20-29 COMAH 2015 Public Information Search. Available at: <https://notifications.hse.gov.uk/COMAH2015/Search.aspx>

Ref 20-30 Chemicals and Downstream Oil Industries Forum Guidelines (CDOIF) (2017) Environmental Risk Tolerability for COMAH Establishments. Available at: https://www.sepa.org.uk/media/219154/cdoif_guideline_environmental_risk_assessment_v2.pdf

Ref 20-31 The National Cabinet Office (2006) Emergency Preparedness guidance on part 1 of the Civil Contingencies Act 2004. Available at: <https://www.gov.uk/government/publications/emergency-preparedness>

Ref 20-32 Health and Safety Executive (1999). Reducing Risks, Protecting People: HSE's decision making process. Available at: <https://www.hse.gov.uk/risk/theory/r2p2.pdf>

Ref 20-33 Health and Safety Executive (2021). Guidance on conveying carbon dioxide in pipelines in connection with carbon capture and storage projects. Available at: <https://www.hse.gov.uk/pipelines/co2conveying-full.htm>

Ref 20-34 Health and Safety Executive (2013). CO₂ Pipelines Good Practice Guidelines – Technical Report Available at:

https://www.hsl.gov.uk/media/396859/co2pipehaz_good%20practiceguidelines.pdf

Ref 20-35 Environmental Protection Act 1990. Available at:

<https://www.legislation.gov.uk/ukpga/1990/43/contents>

Ref 20-36 Management of Health and Safety at Work Regulations 1999. Available at:

<https://www.legislation.gov.uk/uksi/1999/3242/contents/made>

Ref 20-37 British Standard Code of Practice for Pipelines: BS PD 8010 Part 1: Steel Pipelines on Land.

Ref 20-38 Health and Safety Executive (2011). Assessment of the major hazard potential of carbon dioxide (CO₂). Available at:

<https://www.hse.gov.uk/carboncapture/assets/docs/major-hazard-potential-carbon-dioxide.pdf>