VikingCCS

Viking CCS Pipeline

9.35 Venting Technical Note

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a Harbour Energy Company
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1. Introduction

1.1 General

1.1.1 This technical note has been prepared by Chrysaor Production (U.K.) Limited (the "Applicant") in relation to an Application for a Development Consent Order ("DCO") for the Viking Carbon Capture and Storage Pipeline (the "Proposed Development").

1.1.2 In its first written questions, the Examining Authority (ExA) asked amongst other things for further information on air quality during operation of the proposed development including information about venting of CO_2 (see WQ1.2.1). In response to the ExA's first written questions [REP1-045, Q1.2.1], the Applicant stated it would provide a technical note on venting, which would include an estimate of venting requirements at all locations, including venting noise, vent emissions, timings and notifications.

1.1.3 The ExA issued a Rule 17 letter on 24 May 2024, which also asked that the technical note consider:

1. Points raised in the Deadline 1 submission by Vince Loy [REP1-144]; and
2. The following questions:
    a) If the quantities of carbon dioxide passing through the pipeline were to be vented at any one time, why this is not accounted for in the Environmental Statement in terms of air quality or climate change?
    b) What options, if any, were considered for capturing the venting gases at each block valve station to minimise the losses?

1.1.4 This technical note provides further information on venting, as requested in the ExA's first written questions, and to address the matters raised under Issue 1 of the Rule 17 letter dated 24 May 2024.

1.2 Key Components of the Viking CCS Pipeline

1.2.1 As part of the Proposed Development, the following elements contain provision for a permanent vent to allow for the venting of CO_2:

- The Immingham Facility
- The Theddlethorpe Facility
- Block valve stations*

1.2.2 The permanent vent stack at both the Immingham Facility and the Theddlethorpe Facility would be a maximum height of 25m.

1.2.3 Drawings showing indicative layouts and elevations for each component were submitted with the Application [APP-019; APP-020; APP-021; APP-027*; APP-028*; APP-029*]

*Under the ongoing work on detailed design, it is considered very likely that the need for a permanent vent at each of the block valve stations can be removed.

1.3 Basis of Venting Design

1.3.1 The primary aim of venting gas from equipment at the above ground facilities is to remove stored energy from the systems, rendering them safe to be worked on for maintenance purposes. The stored energy is in the form of pressurised CO_2. This is effectively drained from the pipeline system and expanded to atmospheric pressure. The now gaseous CO_2 flows up a chimney (or vent stack) where it discharges at a sufficient height to allow the CO_2 to disperse in the atmosphere without posing a risk to people or the environment.

1.3.2 Venting is not planned to be a regular occurrence. Venting at the Immingham and Theddlethorpe facilities will only be undertaken when planned maintenance is required on the installed equipment.

1.3.3 As part of the ongoing work on a detailed design, it is considered very likely that the requirement for a permanent vent at each of the block valve stations can be removed. The Immingham and Theddlethorpe vents will be permanent structures, used for planned maintenance venting only.

1.3.4 The final height of the permanent vents at both the Immingham and Theddlethorpe facilities will be confirmed during the Front-End Engineering Design (FEED) process. The dispersion plot which was completed during preliminary design indicates a vent stack height of between 20m and 25m will be suitable. The Applicant has identified the potential need for a 50m temporary vent stack in exceptional circumstances (i.e. not planned maintenance). This is only anticipated to be necessary in the event that venting at the Theddlethorpe or Immingham facilities was undertaken at decommissioning. (The current expectation is that venting for decommissioning purposes will take place offshore.) Whether a stack of this height was necessary would be determined at the time following further atmospheric modelling.

1.3.5 Any venting that does take place will comply with prevailing legislation and associated guidance in place at that time (e.g. the Control of Substances Hazardous to Health Regulations 2002 relating to exposure of employees to hazardous substances, such as CO_2).

1.3.6 Through compliance with relevant legislation, associated guidance and operational mitigation measures, any potential significant effects on human and ecological receptors would be avoided.

2. Emissions from Operations

2.1 Description of Venting

2.1.1 As stated, venting at the Immingham and Theddlethorpe facilities will only be undertaken when planned maintenance is required on the installed equipment. This will allow control of timing according to weather conditions, should this be required.

2.1.2 Maintenance activities will include:

- Maintenance and calibration of flow meters: Flow meters will record the volumetric flow of CO_2 within the pipeline. In order to ensure they remain accurate they will require periodic calibration. In order to complete this the flow meter will be isolated by closing a valve on either side of it. The small volume of CO_2 contained within the flow meter will be vented to make the meter safe to remove.
- Pipeline inspection activities: These activities are commonly known as “pigging” and involve passing an “Intelligent Pig” through the pipeline. The “Intelligent Pig” carries sensors that record the condition of the inside of the pipeline and allow for the monitoring of corrosion rates. Pigs are placed into the pipeline using a launcher, which is essentially a slightly expanded section of pipeline which can be isolated to allow the pig to be safely loaded. Once the pig has passed along the length of the pipeline it is collected in a receiver, which is essentially a mirror image of the launcher, and allows the pig to be safely removed. Both the launcher and the receiver will require venting to make them safe either following a launch or to allow retrieval. A typical arrangement is illustrated in Figure 1 overleaf.

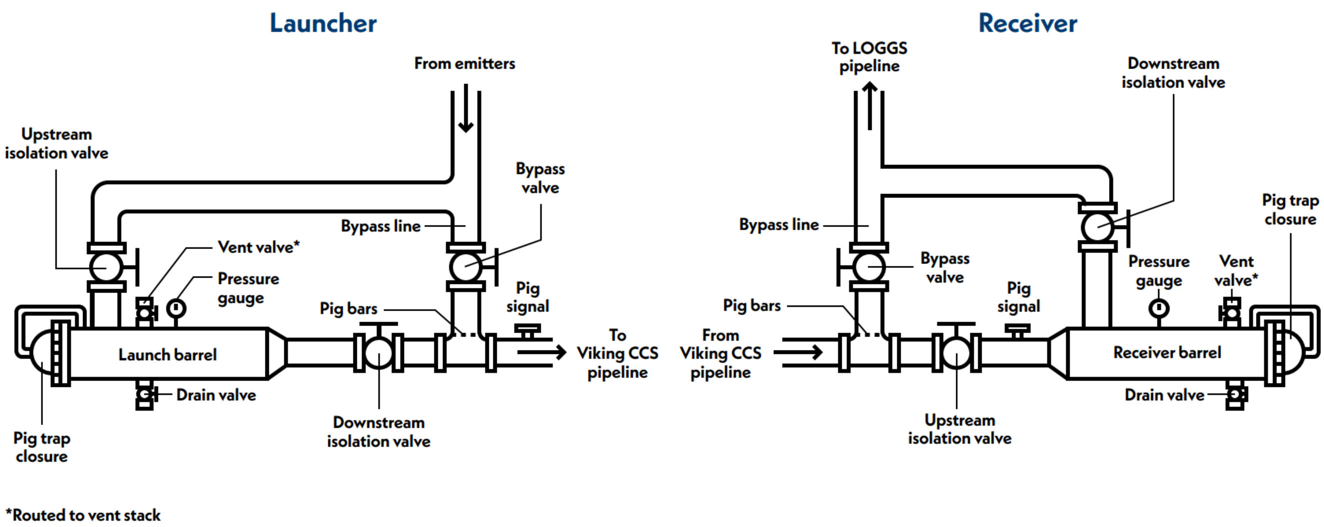

Figure 1. Typical pig launcher and receiver arrangement

2.1.3 Final planned maintenance schedules will be determined once equipment selection is complete, as this will depend on manufacturer recommendations, however Table 1 below gives the expected frequency. It is standard practice when starting up a new project to have an increased maintenance and inspection frequency to allow knowledge of the operating system to be gained. It is also standard practice to extend the time between inspections following that initial period once it is confirmed that the system is operating as expected.

Frequency	Equipment to be maintained
1 yearly	Pipeline inspection (in early years of operation)
2-yearly	Flow meters at Immingham and Theddlethorpe
5-yearly	Pipeline inspection (in later years of operation)

Table 1. Expected maintenance frequency by equipment type

2.2 Maintenance Venting Volumes and Durations

2.2.1 The largest volumes that will be required to be vented relate to the pig launcher / receivers at the Immingham and Theddlethorpe facilities. The volumes quoted below are provisional as the detailed design is still in progress, but they are considered a reasonable worst-case scenario.

Equipment to be vented	Approximate volume of CO_2 to be vented (Tonnes)	Estimated time to vent (Hours)	Estimated release rate (Kg/s)
Immingham pig launcher	3	8	0.1
Theddlethorpe pig receiver	3	8	0.1
Theddlethorpe pig launcher*	5	20	0.07
Flow meter body **	~0.1	~ 0.25	~0.1

Table 2. Potential venting volumes by equipment type

*Note that the Applicant will likely choose to vent the Theddlethorpe pig launcher in stages to avoid overnight venting, to minimise noise disturbance.

**Volumes to be vented from flow meter bodies are indicative but will be an order of magnitude smaller than those for the pig receiver and launchers and take a very short time to vent.

2.3 Vent Modelling

2.3.1 Vent stacks are used to ensure safe dispersal of CO_2, with dispersal effectiveness governed by the height of the vent stack and the rate of venting. The key design aspect of a vent stack is that it is tall enough so that CO_2 disperses and does not slump down to ground level in concentrations that could cause harm to people or the environment. Vented CO_2 is more prone to slumping downwards at lower windspeeds. When CO_2 is vented, it cools, leading to a reduction in temperature due to the Joule-Thomson effect. At higher discharge rates, there is a larger cooling effect which could lead to the formation of solids (hydrates) within the vent system, thereby restricting flow from the vent. The maximum rate of discharge is therefore principally set by these temperature considerations.

2.3.2 The CO_2 concentration in the atmosphere is typically around 400 ppm (concentration of CO_2 of 0.04% v/v in air). When assessing an appropriate concentration baseline to inform the vent modelling and eventual height of the vent stack, best practice is to take account of the Health and Safety Executive's (HSE) Workplace Exposure Limit guidance (EH40/2005 Workplace exposure limits) and HSE's Dangerous Toxic Load Assessment (Dr Peter Harper, UK HSE, Assessment of the major hazard potential of carbon dioxide (CO_2)). EH40 states the following concentrations as the relevant thresholds:

- 5,000 ppm (concentration of CO_2 of 0.5 % v/v in air): The Long-Term Exposure Limit (LTEL, based on an 8-hour time weighted average period)
- 15,000 ppm (concentration of CO_2 of 1.5 % v/v in air): The Short-Term Exposure Limit (STEL, based on a 15-minute time weighted average period)

2.3.3 It is noted that the HSE's Dangerous Toxic Load assessment (Dr Peter Harper, UK HSE, Assessment of the major hazard potential of carbon dioxide (CO_2)) for CO_2 shows a significant danger to humans if they inhale CO_2 at concentrations above the following:

- > 140,000 ppm (concentration of CO_2 of 14% v/v in air) for 1 min and;
- > 84,000 ppm (concentration of CO_2 of 8.4% v/v in air for 60 mins.

2.3.4 Preliminary modelling undertaken for the Proposed Development has been undertaken based on the LTEL, as this is the lower limit prescribed in HSE guidance for CO_2 concentration exposure.

2.3.5 Preliminary modelling for CO_2 dispersal from a vent stack has been undertaken, assuming atmospheric conditions that would represent a realistic-worst-case scenario. This scenario is considered to be Pasquill stability class 2F, which represents a wind speed of 2m/s in stable atmospheric conditions (less than 50% nighttime cloud cover). These are benign conditions under which a dispersing plume is most likely to slump, giving a realistic worst case scenario.

2.3.6 Figure 2 overleaf shows the results of this preliminary modelling with a vent stack height of 20m and three different atmospheric conditions. The chart shows the extent at which the CO_2 concentration in air would be 5000 ppm at a release rate of 5kg/s. The realistic worst-case contour is depicted in blue. The graph shows that below a height of approximately 9m, CO_2 concentration in air would be less than 5000 ppm.

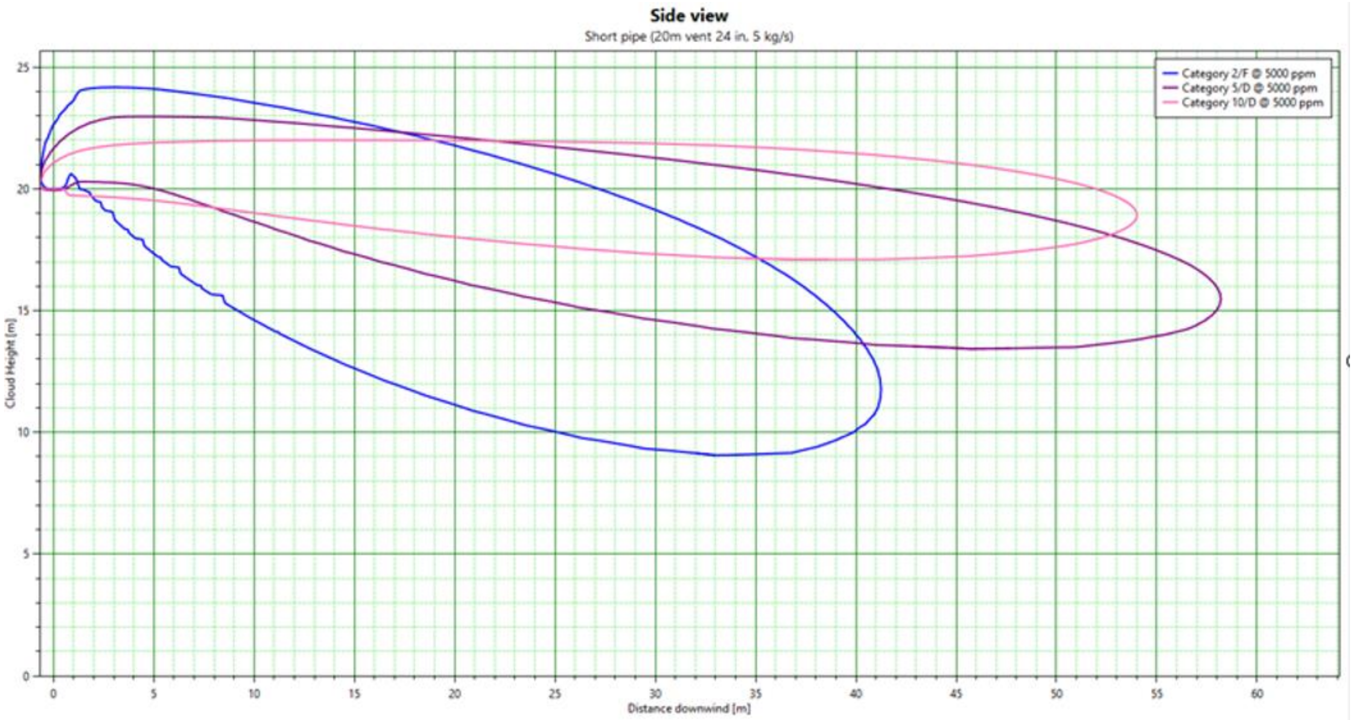

Figure 2. Preliminary modelling with vent stack height of 20m

2.3.7 This preliminary modelling has concluded that for a 20m vent stack at Immingham and Theddlethorpe, under a discharge rate of 5kg/s, concentrations of CO_2 in air at ground level were less than the LTEL concentration of 5000 ppm. This aligns with preliminary engineering work during FEED, which has suggested the Viking CCS vent stack will be 20m to 25m in height with a vent rate determined by temperature considerations. Ongoing engineering studies suggest the stack height is likely to be closer to 25m. This will be confirmed by repeated dispersion modelling.

2.3.8 The preliminary modelling therefore demonstrates that a 25m vent stack is high enough to provide dispersal of any vented CO_2 below the lower thresholds within HSE guidance.

2.3.9 As venting will be a planned maintenance activity it will be possible to stipulate a minimum windspeed for this activity if required, which will ensure the requirements of safety, environment and noise are met.

2.3.10 It is anticipated that actual rates vented will be lower than the 5kg/s modelled here due to the thermal effects discussed above.

2.4 Composition of Vented Gas

2.4.1 Pipeline systems have strict entry requirements and the composition of CO_2 entering the Viking CCS pipeline will be continually monitored to ensure it meets the agreed specification. All potential connectors into the Proposed Development are designing their equipment to comply with the prescribed Viking CCS entry specification.

2.4.2 Viking CCS will control the entry specification of CO_2 from emitters by way of approval of the emitter project metering and verification equipment and plans. Viking CCS will be able to shut in any emitters that cannot meet the specification for entry to the Viking CCS system and have appropriate monitoring in place to assure that CO_2 entering the network meets the defined specification.

2.4.3 There may be components, such as hydrogen sulphide, sulphur oxides and nitrogen oxides, however, these will be limited to low parts per million concentrations. There is no expectation of nitramines and nitrosamines in the CO_2 stream as these will be removed in the emitters' processes.

2.4.4 The currently proposed specification for the pipeline would allow a maximum concentration of water of 50 ppm. Figure 3 below shows a hydrate formation curve for a CO_2 system. Highlighted in the orange segment is the operating region in which hydrates could form with a water content of 50 ppm or below (the maximum entry specification for the Viking CCS pipeline).

2.4.5 In simple terms, hydrate formation is only possible at this concentration of water if the system is operating between a temperature range of -50°C to -20°C and a pressure range of between 0 to 20 bar.

2.4.6 The pipeline will operate at temperatures and pressures significantly above the hydrate formation zone and therefore there is no risk of hydrate formation.

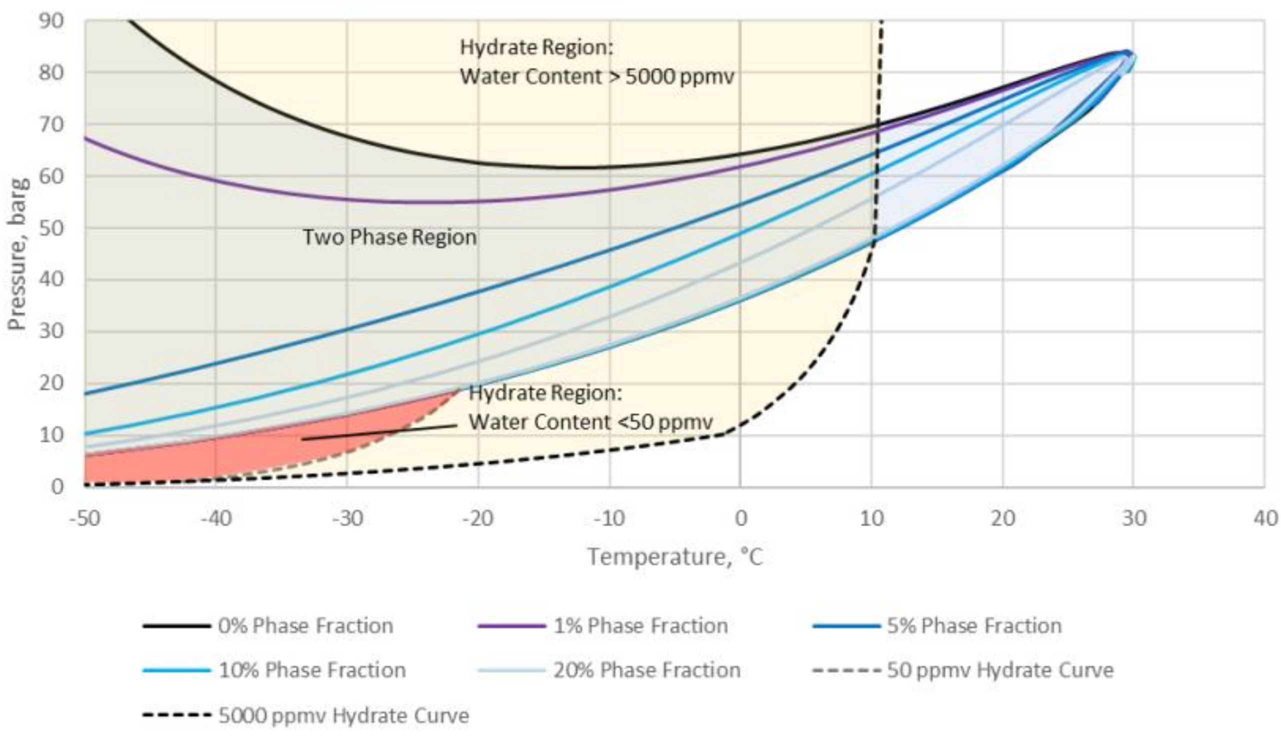

Figure 3. Hydrate formation curve for a CO_2 system

2.5 Noise from Venting

2.5.1 The venting of CO_2 will be undertaken at a rate whereby the noise at the nearest Noise Sensitive Receptor will be no greater than 10 dB above daytime background levels, which are 51 dB at Immingham and 38 dB at Theddlethorpe. These levels will be back calculated to the perimeter of the facility and monitored as such. The Applicant has committed to this in Environmental Statement (ES) Volume IV – Appendix 3-6: Operational Phase Mitigation [REP2-014] with commitment Op17. Compliance with this commitment is secured through requirement 15 of the Draft DCO [REP1-002].

2.5.2 At these noise levels there will be no significant effects associated with venting. This is the conclusion of ES Volume II – Chapter 13: Noise and Vibration [APP-055].

2.6 Shutdown scenarios

2.6.1 In the unlikely event of a shutdown to the Viking CCS Pipeline system there is an expectation that the emitters feeding into the system would be able to continue operating by releasing CO_2 at source. Under these conditions, venting would not take place from the Viking CCS pipeline facilities, but may take place from emitter facilities (as is the current situation).

3. Emissions from Decommissioning

3.1.1 Requirement 16 of the Draft DCO [REP1-002] requires the undertaker to submit to the planning authority for approval a decommissioning environmental management plan. The approved plan must thereafter be implemented. As set out in paragraph 2.1.4 of the ES Volume IV – Appendix 3-5: Draft Decommissioning Strategy [APP-072], the plan will include provision for the final venting of the Proposed Development to ensure safe dispersion of material. The Applicant considers that this provides an adequate control on future methodology, which will be based on best practice at the time of decommissioning. As with venting during maintenance, the venting rate during decommissioning would be based upon dispersion modelling of the CO_2 inventory present at the time of decommissioning. The rate of venting would be managed to ensure there would be no possibility of risks to human or ecological receptors and no risk of generating significant noise or other environmental effects.

3.1.2 At the end of field life, the pipeline will require depressurisation before it is decommissioned. It is likely that this will be carried out at the offshore facility.

3.2 Notifications

3.2.1 Currently the transportation of CO_2 is not a permitted activity that would fall under the Environmental Permitting (England and Wales) Regulations 2016 and as such there would be no need to notify the Environment Agency before undertaking a venting activity.

4. Conclusion

4.1.1 Venting will only be required for planned maintenance operations. The equipment will be designed to minimise the amount of maintenance required and therefore minimise volumes of CO_2 vented.

4.1.2 Maintenance will be a planned activity that the Applicant will be in control of and will ensure that any venting that does take place will comply with any prevailing legislation and associated guidance in place at that time (e.g. the Control of Substances Hazardous to Health Regulations 2002 relating to exposure of employees to hazardous substances, such as CO_2).

4.1.3 The Applicant has also committed to operational mitigation through the ES Volume IV – Appendix 3-6: Operational Phase Mitigation [REP2-014] with commitment Op17 stating: "The venting of CO_2 will be undertaken at a rate whereby the noise at the nearest Noise Sensitive Receptor will be no greater than 10 dB above daytime background levels, which are 51 dB at Immingham and 38 dB at Theddlethorpe. These levels will be back calculated to the perimeter of the facility and monitored as such." Compliance with that commitment is secured through requirement 15 of the Draft DCO [REP1-002].

4.1.4 Through compliance with relevant legislation, associated guidance and operational mitigation measures, any potential adverse effects on human and ecological receptors from venting would be avoided.

Appendix 1 – Responses to REP1-144

The Applicant has been asked by the Examining Authority in its Rule 17 letter to respond to the Deadline 1 submission by Vince Loy [REP1-144]. The Applicant provided a response to Mr Loy's written submission within the Applicant's Comments on Written Representations [REP2-029]. The Applicant has provided a further, more technical, response below to a number of comments raised by Mr Loy that were specific to venting.

Interested Party comment	Applicant's further response
1) The Pipe line inventory at 53km and 84bar (1200psi) is circa 9858tons of CO_2. 1 ton of CO_2 is 556.2m3. The Block valves as per the latest map are spaced at 10.5km, 10.5km, 15.5km and final leg to Theddlethorpe is 16.5km - this means 1,953 tons CO_2 between Immingham and block 1, also 1,953 tons between block 1 and block 2, between block 2 and block 3 = 2,883 tons CO_2 and the final leg between block 3 and Theddlethorpe will have 3069 tons CO_2. When converted into cubic meters at atmospheric pressure to make it easier to visualise these figures become as below 1953 tons becomes 1,086,258m3 2883 tons becomes 1,603,524m3 3069 tons becomes 1,706,977m3 - if broken down further each and every meter of pipeline contains 103m3 of CO_2 and given the fatal concentration is accepted as 10% that becomes 1030m3 affected, CO_2 is heavier than air so will not reach any great altitude so will spread further than it rises - I acknowledge that the above figures are based on no external influence by environmental or geological factors and assume a uniform expansion rate. If a breach/failure were to occur does VIKING CCS consider this volume of CO_2 being released into the local population / environment to be acceptable and complies with reducing the risk to ALARP.	The pipeline has been designed in compliance with Engineering Standard BSI PD 8010- 1:2016, which makes specific provision for CO_2 pipelines and the approach to routeing, including minimum distances to buildings. In addition, the pipeline has been designed in accordance with the established principle of ALARP ("As Low As Reasonably Practicable"), as described in the Health and Safety Executive's (HSE's) longstanding framework document "Reducing Risks, Protecting People." The purpose of ALARP is to ensure risks are reduced as far as is reasonably practicable. The Applicant has referenced the HSE's Tolerability of Risk framework (which is defined in the 'Reducing Risks, Protecting People' framework document mentioned above) to assess the pipeline risks. This assessment shows that the risk to members of the public living near to the Viking CCS pipeline route is well within the framework's lowest classification of risk. Under the framework, the HSE considers that "risks falling into this region are generally regarded as insignificant and adequately controlled." HSE does not usually require further action to reduce risks in this lowest classification unless reasonably practicable measures are available, such as developing comprehensive emergency response plans. The Applicant will work with all relevant local authorities to develop such plans. The Applicant has engaged with the HSE, including their science division, to seek their expert opinion on the pipeline design and associated risk assessments. The Applicant has also engaged with other industry experts and will continue to engage both regulator and industry experts throughout the pipeline design and subsequent operation. The Applicant has adopted a robust design

Interested Party comment	Applicant's further response
	and route selection process for the Proposed Development, with safety of local communities being a key consideration. The routeing and design accords with adopted guidance, including on managing risk, and has been informed by advice from experienced technical consultants.
2) in the event an emergency depressurisation had to be conducted as per the above figures a significant volume of CO_2 would have to be vented. A 25m stack will route to CO_2 to an assumed "safe" height but you must agree is very much dependant upon metrological condition at the time of release i.e. if nil wind there will minimal to no dispersion and CO_2 will sink to the ground level very quickly - CO_2 when changing to gas phase cools to between -54 Celsius and -78 celsius - this will be significantly colder than the ambient temperature even on the coldest of winter days and is extremely likely to result in the formation of micro weather system at the vent/breach site whereby a convective downdraft will be formed and fed by the continued release /venting of CO_2. As long as the downdraft air is denser (colder) than the environmental air at the same level, it will continue to accelerate. It will not decelerate until it becomes less dense (warmer) than the environment or until it begins to spread out in response to the surface. Couple with this the relative humidity at the breach site or venting site and it will rapidly cool the water droplets in the surrounding air causing potential carbonic acid hail/rain to form which will further exacerbate the downdraft potential not to mention the environmental and health related issues that will arise from acid hail/rain and the groundwater acidification due to increased CO_2 at ground level, What has VIKING CCS done to mitigate this potential event specifically with regard to harm to human health and environmental impacts.	When operating at full capacity the Viking CCS pipeline will contain approximately 10,000 Tonnes of CO_2. There are no credible circumstances where the Applicant would vent this quantity of CO_2 in a single instance. Venting at the Immingham and Theddlethorpe facilities will only be undertaken when planned maintenance is required on the installed equipment. This will allow control of timing according to weather conditions should this be required. It has been demonstrated in section 2.3 of this technical note that a 20-25m high vent will be sufficient to ensure the safe dispersal of vented CO_2 during planned maintenance activities.
3) The process used in carbon capture utilises amines to scrub the CO_2 from	Pipeline systems have strict entry requirements and the composition of CO_2

Interested Party comment	Applicant's further response
exhaust gases - it is then processed and the CO_2 is captured dewatered and compressed/heated ready for transport, as part of the process Nitramines and Nitrosamines are produced - Permissible total concentrations of nitrosamines and nitramines proposed by Norwegian Institute of Public Health are 0.3 ng/ m3 in air and 4 ng/l in drinking water. According to WHO, Health Canada and U.S. EPA, the NDMA limit in drinking water are 100 ng/l and 0.7 ng/l respectively. In contrast to nitrosamines, data on chronic toxicity of aliphatic nitramines are very limited and there is not sufficient toxicological information for a proper evaluation of their health hazard. Although nitramines are less mutagenic and carcinogenic than their corresponding nitrosamines, they should also be considered as highly toxic. DMNA, N-diethylnitramine (DENA) and MNA should still be regarded as carcinogen of high potency. Many research on nitramines have shown their carcinogenic potential in animals The studies confirm the toxicity of some nitramines. Their results exhibited that amongst MEA-NO2, 2-nitramine-2-methylpropanol and nitropiperazine, only MEA-NO2 showed positive mutagenic effect. The other two nitramines were found not to be mutagenic. In turn, mutagenic potential of DMNA was not confirmed. To put into context 1ng is 1 billionth of a gram the recommended exposure is 0.3ng 1 grain of salt is approx 65,000ng therefore 1 grain of salt in an olympic sized swimming pool (25,000,000litres) is approximately 6 times the maximum recommended concentration of 0.3ng When asked how it would be monitored there was not a suitable answer given - it would be down to the contractor that was operating the site to manage. Not the answer I would have liked to hear from the Duty holder. What controls and mitigations are in place to prevent exposure and in the case of accidental release what Emergency response protocols will be implemented by VIKING CCS	entering the Viking CCS pipeline will be continually monitored to ensure it meets the agreed specification. All potential connectors into the Proposed Development are designing their equipment to comply with the prescribed Viking CCS entry specification. Viking CCS will control the entry specification of CO_2 from emitters by way of approval of the emitter project metering and verification equipment and plans. There is no expectation that Nitramines and Nitrosamines will enter the pipeline as these will be removed in the emitter's processes and are not part of the entry specification for the project. The Applicant will be able to shut in any emitters that cannot meet the specification for entry to the Viking CCS system and have appropriate monitoring in place to assure that CO_2 entering the network meets the defined specification.

Interested Party comment	Applicant's further response
4) Water within the Dense phase CO_2 is likely to be in the range of 500ppm to1500ppm and most probably towards the higher end of the range, if the water droplets are allowed to pool into free water then strong acids (specifically carbonic, sulphuric and nitric) can be formed which will react adversely with carbon steel and are likely to cause niche environment corrosion hotspots leading to rapid degradation of the internal surface of the pipeline and may result in localised failure at the corrosion site, H2S is also a byproduct of the combustion process (as well as sulphur dioxide, nitrogen dioxide, carbon monoxide and more) which is well known to cause embrittlement within carbon steel. A further concern regarding free water within the dense phase CO_2 is clathrate hydrate formation which could cause further embrittlement and failure mechanisms. I note there are 12 area's within the current schematic of the pipeline where there are bends in the 70 - 90 degree range - will these be "cushioned" to prevent erosion and accelerated degradation of the pipeline. How will these concerns be addressed by VIKING CCS and integrity of the pipeline monitored.	The figures stated in Question 4 are incorrect. Please refer to section 2.4 of this technical note for an explanation on maximum water content and the potential for hydrate formation.

Appendix 2 – Responses to Issue 1 in ExA's Rule 17 Letter

The Applicant has been asked by the Examining Authority in its Rule 17 Letter to respond to the following questions:

Question 1 - If the quantities of carbon dioxide passing through the pipeline were to be vented at any one time, why this is not accounted for in the Environmental Statement in terms of air quality or climate change?

The Applicant's experience of CO_2 vent modelling to date is that it has been a requirement related to the Environmental Permit application process for capture plants, at the request of the Environment Agency, and not as part of the Planning process. Air quality relevant national and local planning policy, against which planning applications are determined, are focused on the current air quality standards and air quality strategy, which do not include standards for carbon dioxide nor reference to that pollutant being harmful to human health or the wider environment.

When operating at full capacity the Viking CCS Pipeline will contain approximately 10,000 Tonnes of CO_2. There are no credible circumstances where the Applicant would vent this quantity of CO_2 in a single instance.

Question 2 - What options, if any, were considered for capturing the venting gases at each block valve station to minimise the losses?

As stated in section 1.2 of this technical note, under the ongoing work on detailed design, it is considered very likely that the need for a permanent vent at each of the block valve stations can be removed.

The primary aim of venting gas from equipment at the above ground facilities is to remove stored energy from the systems, rendering them safe to be worked on for maintenance purposes.

Systems to capture vented gases would add complexity and necessitate a much larger footprint for each facility. Increased complexity comes with an increased safety risk, with the inherent increase in hazards that such additional process plant would bring and a risk that the primary aim of proving the system safe could be compromised.

Storage for vented gas is considered inappropriate as it adds complexity and would increase the required footprint of the Proposed Development. Additionally, the volumes of vented CO_2 are very small in the overall context of the Proposed Development. Therefore, storage of vented gas has not been taken forward for consideration at the design stage.