VikingCCS

Viking CCS Pipeline

9.55 Applicants Response to Representations made at the Open Floor Hearing 25 June 2024

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Applicant: Chrysaor Production (U.K.) Limited,
a Harbour Energy Company
PINS Reference: EN070008
Planning Act 2008 (as amended)
The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 - Regulation 5(2)(q)
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1 Introduction

1.1 Purpose of this Document

1.1.1 This document has been prepared for the Viking CCS Pipeline (the 'Proposed Development') on behalf of Chrysaor Production (UK) Limited ('the Applicant'), in relation to an application ('the Application') for a Development Consent Order (DCO) that has been submitted under Section 37 of the Planning Act 2008 (PA 2008) to the Secretary of State (SoS) for Energy Security and Net Zero.

1.1.2 This document provides the Applicant's responses to comments and questions raised during the Open Floor Hearing that took place on 25 June 2024.

1.2 The DCO Proposed Development

1.2.1 The Proposed Development comprises a new onshore pipeline which will transport CO_2 from the Immingham industrial area to the Theddlethorpe area on the Lincolnshire coast, supporting industrial and energy decarbonisation, and contributing to the UK target of Net-Zero by 2050. The details of the Proposed Development can be found within the submitted DCO documentation. In addition to the pipeline, the Proposed Development includes a number of above ground infrastructure, including the Immingham Facility, Theddlethorpe Facility and three Block Valve Stations.

1.2.2 A full, detailed description of the Proposed Development is outlined in Environmental Statement (ES) Volume II Chapter 3: Description of the Proposed Development **[APP-045]**.

2 The Applicant's responses to representations made during the Open Floor Hearing on 25 June 2024

2.1.1 This section provides the Applicant's comments responses to representations made during the Open Floor Hearing on 25 June 2024.

Table 2-1: Response to representation made by Michael Crookes

Ref	Matter raised	Applicant's response
1.1	**Extract from hearing transcript:** The project will capture from emitters using electricity. It will compress CO_2 by using electricity. It is put in the pipeline using electricity, pumped through using electricity. Put into the sea using electricity and the platform powered by diesel producing CO_2. Polluters can keep polluting and this product has CO_2 emissions on the planet.	The Proposed Development relates specifically to the transportation of CO_2 through the new Viking CCS pipeline for onward transportation into the existing LOGGS Pipeline. The electricity requirements for the operation of the Proposed Development are very limited. ES Chapter 15: Climate Change **[REP2-008]** includes an assessment of the greenhouse gas emissions across the lifetime of the Proposed Development. The annual emissions calculations have been undertaken in accordance with the most up to date guidance. Annual emissions are expected to be approximately 332 tCO2e (tonnes of CO_2 equivalent per year) in the first year of operation and will decrease to approximately 15 tCO2e from 2049 onwards due to projected electricity grid decarbonisation. This leads to projected overall emissions from operations activities across the predicted operational life of the Proposed Development of 3,871 tCO2e. These figures need to be assessed within the wider context of the project which aims to facilitate the safe transportation and storage of 10 million tonnes of CO_2 per year by 2030 and up to 15 million tonnes of CO_2 per year by 2035. In summary, the CO_2 generated in order to power the Proposed Development over its entire predicted life is less than 0.04% of the emissions which are predicted to be prevented from being released in a single year of operation.

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1.2	**Extract from hearing transcript:** The pipeline angles on the agricultural land, do farmers really know what temperature it gets to? If they're in a situation where they need to stop the pipeline, it will get very cold. It is buried at minimum depth of 1.2m and backfilled. 37cm soil on top of pipe. Farmers in Lincolnshire area do mole drill to 27cm so that leaves a safety margin of potentially 10cm.	The figures quoted in the open floor hearing regarding the amount of cover above the pipeline at a burial depth of 1.2m are incorrect. The target burial depth for the pipeline is at a minimum depth of 1.2m to the top of the pipe. The burial depth will be greater at crossing points of railways, roads and watercourses. It would only be in exceptional circumstances where the minimum depth cannot be achieved. The Applicant does not anticipate such conditions in the location of the Proposed Development, as other pipelines in the wider area have achieved target depths. The main constraints that could require a deviation from the intended depth of at least 1.2m are geological features and existing services. Until the Applicant has undertaken pre-commencement surveys, it cannot be certain of the depth of potential geological features that could prevent burial at this depth. Additionally, older services are often not mapped accurately meaning the Applicant cannot be certain of their location or depth at this time. The Applicant will endeavour to achieve the minimum depth in all agricultural locations in order that normal farming use can be resumed over the pipeline, however until the final pre-commencement surveys are complete, and the final alignment is known, the potential need for minor deviations from that cannot be ruled out. The Applicant has discussed this possibility with all landowners / occupiers along the route that it is currently engaging with. The potential for deviation is reflected in the commercial heads of terms that have been offered to those clients which include, amongst other things: • An obligation on the Applicant to engage with the landowner where the target depth cannot be achieved, with a view to reaching a mutually agreeable solution. • An obligation on the Applicant to pay additional compensation where previous agricultural activities cannot be resumed as a result of the Proposed Development. With regards to temperature, when transporting CO_2 in dense phase, the operating temperature of the pipeline will be up to a maximum of 35ºC and there

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		will be little reduction in this temperature over the length of the pipeline. Research has indicated that in UK soils, soil temperature responses are restricted to within 450mm of the heat source. Given that the depth of the pipeline is 1200mm from the top of the pipe to ground level, this means that there will be no temperature responses in the top 750mm of topsoil. The main rooting zone for crops is down to 600mm and any changes in soil temperature will therefore not occur in the crop rooting zone.

Table 2-2: Response representation made by Vince Loy on behalf of Guardians of the East Coast

Ref	Matter raised	Applicant's response
2.1	**Extract from hearing transcript:** Previous questions which had previously not adequately been responded to. First is on pipeline inventory, nearly 10,000 tonnes of CO_2. Applicant's response was they didn't see a situation where full inventory would need to evacuated, but can be found there is. Not exactly sure what the construction of the block valves and isolation valves is but it is important, assume they would be standard oil and gas with elastomers. Very large risk the elastomers could suffer impregnation or permeation. In circumstances where they had to close a block valve, this would cause explosive decompression. If Block Valve Station 1 was to suffer then the whole inventory would have to be vented to be able to work on Block Valve 1, looking at 10,000 tonnes of CO_2. Looking at 11 and a half days of venting. If Teflon is used it's less likely to suffer impregnation or permeation of CO_2, but does still suffer. Standard Oil and Gas block valves rely on wetting, down to the hydrocarbons to provide the	To address the issues related to block valve construction, the Applicant can provide the following information. The block valves will have a Carbon Steel body that is rated for Low Temperatures and will be fully qualified for CO_2 service, adhering to fugitive emission leakage criteria in accordance with ISO 15848-1. These valves will be welded into the main onshore pipeline and buried, with the valve actuator extending approximately 1.5m above ground. The actuator will be designed with a safety margin to ensure it can provide enough torque to close the valve when needed. The Applicant's selected Front End Engineering Design (FEED) Contractor is currently engaging with several valve manufacturers. Although there is currently no specific standard for CO_2 service valves, there are globally operational CO_2 pipelines where valve manufacturers and their supply chains are demonstrating relevant experience.

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	seal. CO_2 has a very, very low surface tension, compressed into a liquid form but kept in a very critical dense phase. It has a very low surface tension which allows it to be pumped extremely easily with very low friction. Would affect the block valve operation where the block valves aren't 100% efficient and there is some leakage. If there is leakage then that can cause scouring and erosion etc. From technical standpoint on venting, inventory within the pipeline don't feel like this has been addressed.	
2.2	**Extract from hearing transcript:** The Applicant goes on to say HSE doesn't require reduction in risk beyond ALARP. Only statement in response to that is Satartia and Mississippi February 2020. They also felt they did not need it but legal cases and medical response still ongoing. No adequate response to that. Texas release hadn't happened before the application, but several instances where CO_2 released and people adversely affected.	As is stated in HSE "Guidance on Conveying Carbon Dioxide in Pipelines in connection with carbon capture and storage projects": operators of CO_2 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. The priority is to eliminate hazards where possible to create an inherently safer design. ALARP is demonstrated by referring to the following aspects, listed in order of priority: 1. Codes and Standards 2. Good Practice 3. Engineering Risk Assessment The pipeline has been designed in compliance with the applicable Engineering Standard BSI PD 8010- 1:2016, which makes specific provision for CO_2 pipelines. There is not at present a universal standard CO_2 specification (eg British Standard, or European standard), for carbon capture projects in the UK with which the Applicant (or the emitters) must comply. Therefore, the Applicant will set a CO_2 specification for the emitters to export CO_2 into the Proposed Development taking cognisance of:

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		• all other regulatory compliance, • maintaining integrity of the infrastructure including the risks and uncertainties associated with impurities in CO_2, and • monitoring emitter compliance with the specification. The Proposed Development specification may be further revised in the future if other CO_2 emitters from other industry segments are routed by UK Government to the Proposed Development. The emitters will monitor the composition of their own individual CO_2 stream and transmit real-time compositional data to the Proposed Development. The Applicant will monitor the composition of the commingled CO_2 stream entering the onshore pipeline. Key impurities, for example water, will be monitored continuously. The Proposed Development will not contain any process or equipment that will change or modify or control the composition of the CO_2 stream; individual emitters will be responsible for ensuring that their individual CO_2 stream is within the agreed CO_2 specification. The Immingham Facility will include the facilities (shutdown valves) to isolate individual emitter CO_2 streams, which could be activated if an individual emitter CO_2 stream were found to be outside specification. It should be further noted that the emitters' operations will be the subject of permits issued by the Environment Agency which would also limit their emissions.
2.3	**Extract from hearing transcript:** CO_2 is super solvent as predominantly CO_2 will be flue gases, which have been captured. Will be in trend within that sulphur oxides, sulphur dioxide is nitrate, nitrogen dioxides, etc various contaminants ammonia etc. The chemicals that are used in the process are called amines. During the process they form nitromines and nitrosamines which are recognised as being extremely carcinogenic and	The CO_2 specification set by the Applicant for the emitters to export CO_2 into the Proposed Development takes cognisance of the risks and uncertainties associated with impurities in CO_2, based upon both historical and ongoing testing and studies as the carbon capture and storage industry develops. Ongoing FEED by the chosen Contractor includes a Literature Search to capture recent insights into cross-reactions between impurities already at low parts per million concentrations, and development of corrosive fluids. The current CO_2 specification set by the Applicant for the two anchor emitters will

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	mutagenic. At very small concentrations, four nanograms per litre in drinking water in three nanograms per cubic metre in air as the Norwegian health institute's recommended annual exposure limit. One nanogram is a one billionth of a gram, infinitesimally small quantities of this chemical that are hazardous to health. Without getting too technical lots of dangerous compounds made during the capture process. Response from applicant was they won't be in the stream. To me an oil and gas professional that has been involved in various projects over the years, the only way to say that with any authority is to not use it. We're talking about amounts that are so small, don't know how they could monitor that level. Don't know of any technology that measures 3 or 4 nanograms specification. They say it is the emitters problem, but it is their problem as duty holders. The other aspect of the nitrosamines is they raise the pH level, within the CO_2 stream which encourages formation of free water, even at the 50 ppm which they state they will achieve it being extremely dry. Think it is difficult to achieve dryness of .005% quantities. The other chemicals that they would have to use to achieve that present their own issues, because they are basically hydrocarbon based which can change the compressive qualities of the gas, and they can form their own compounds. Issues in the drying process as there will be certain amounts of meg, teg or deg? Introduced into the stream, which can also help with the formation of free water. Free water in conjunction with x 2 S, can form sulphuric	remain under review and may be revised as further information becomes available. The Proposed Development does not contain any amine-based process equipment. The two anchor emitters' CO_2 drying technology to achieve the Applicant's specified fifty parts per million water concentration in CO_2 streams will both be a solid bed absorption technology. Liquid glycol-based systems (DEG, TEG) will not be used. At Deadline 3 the Applicant submitted a Venting Technical Note **[REP3-029]**. Section 2.4.4 of this document covers the water specification for the fluid entering the pipeline and goes on to explain how this prevents hydrates.

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	acid, can form nitric acid, can form hydrochloric acid with the ammonia. So various nasties and only needs a very small amount of concentrated acid to create a nice environment for corrosion, which can then cause low pressure zones, turbulence, mineralisation and hydrate formation or increased erosion. In the event there was a failure in the pipeline and it was to burst, then the Thompson dual process indicates there would be a rapid cooling down to minus fifty-four celcius to minus seventy-eight Celsius. DNV testing shows this would massively enhance crack propagation and there's a couple of studies which say it is almost impossible to mitigate the cracking to be able to project where the crack is going to propagate to and to drill it to prevent further cracking is almost impossible and its such an explosive decompression that its not practicable or feasible.	
2.4	**Extract from hearing transcript:** Original information given was that it would be trenched to 1.2m and then a 24 inch pipeline would have a 28 to 30 inch flange which further exacerbates risk to farmers contacting the flange, with the flange being the weak point, rather than the actual pipe body. It wouldn't take much deflection on the flange for it to impinge on the security of the seals. So, you know, that's another aspect that should be addressed by the applicant as well.	There will not be any flanged connections along the buried sections of the pipeline. The onshore pipeline would comprise an all-welded steel pipeline construction, with flanged connections used only at the Above Ground Installations (AGIs) located at Immingham, Theddlethorpe and the three Block Valve Stations. Each AGI site would be secured by a 3.2-metre-high single mesh security fence (e.g. weldmesh fencing), with all flanged connections located within the respective fenced areas. More detail on the pipeline construction is described within ES Chapter 3: Description of the Proposed Development **[APP-045]**, starting from paragraph 3.12.110.

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2.5	**Extract from hearing transcript:** CO_2 is well known and classified as a super solvent, which means that the various nasties spoken about, the sulphur oxides, sulphur dioxides, NOx, various other compounds which form acids etc. go into solution very easily. In the event there was a breakdown in the second stage compression or if a block valve was too close, or there was a problem at the receiving end, and the pipeline was to slow down and not be able to maintain the 1200 psi and 30 degree heat, then it doesn't take CO_2 long to revert back to a gaseous liquid state then back to a gaseous state which is a 535:1 expansion rate and massive cooling rate. How is that addressed? A 24 inch pipeline should be good for a working pressure around 3000 psi. It's based on oil and gas but don't think it comes under the oil and gas regulations as it's a supercritical fluid. There isn't a specific regulation as far as aware at the moment regarding CO_2 transport. It's a mish mash of other hydrocarbon rules that have been implemented and utilised and modified to suit the process. Not here to throw a spanner in the works, but to keep people on earth.	The scenario of a rapid expansion and cooling of the fluid on loss of compression as described is not possible. In the extremely unlikely event that there was no action to stop forward flow to the storage wells on loss of compression or if a block valve closed, the pipeline would gradually depressurise until the pressure in the pipeline equalised with the reservoir pressure. The Proposed Development is designed to operate in the dense phase regime and the materials proposed to build it will be specifically rated for the temperatures and pressures of CO_2 in this phase. Deviations in pressure would be detected by the proposed monitoring equipment and would be corrected by adjusting valves within the system, as such the pipeline will operate in a single phase.
2.6	**Extract from hearing transcript:** *[David Wallis – The Applicant said the pipeline will be made with a thick wall design. Does that give any reassurance to erosion or cracks?]* It gives a longer pipeline. Carbon Steel is extremely prone to carbonic acid, uric acid, nitric acid. But various studies show issues with dense	Bends within the pipeline design are necessary to allow changes in direction due to routing, terrain or infrastructure/features. Where fabricated bends are installed, these will be designed in accordance with either the pipe specification or ASME/ASTM requirements dependent upon the manufacturing process. Scouring of a pipeline on a bend typically only occurs when there are solids present within the pipeline. The Proposed Development will not have any solids within it so scouring will not be an issue.

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	phase impurities and increased erosion. Quite technical and stretches my knowledge a lot to understand it. Thick wall - absolutely. One other thing is that there are 90 degree, 70 degree bends and I asked about cushioning or double thick wall preventing erosion. That has never been answered.	By choosing to construct in thick wall along the entire length of the pipeline the Applicant exceeds the requirements of PD8010. The Applicant will also undertake a comprehensive maintenance programme throughout the operational life of the pipeline. This will include internal inspection of the pipeline to verify its condition.
2.7	**Extract from hearing transcript:** *[David Wallis - I recall Applicant saying of events in America, one was due to unstable land, the land slip caused damage, and such conditions don't exist in Lincolnshire. Don't know if you have seen that?]* Lincolnshire is reclaimed land. A thin mantle down by Saltfleet. That's why it is used for bombing range, as bombs go into quicksand. When large vehicles go past my whole house shakes. Quite a lot of subsidence towards Skegness. Where I live was 18 feet under water in the 1950s. Relatively verging on unconsolidated land. And had earthquake not too long ago.	The existing ground conditions within Lincolnshire differ significantly to those present within the area of Mississippi, USA where the Satartia incident occurred. In general terms, the Proposed Development is located in stable, low-lying ground with only minor undulations along the route, which is different to the ground where the Satartia incident occurred. Further information relevant to this comment is provided within Table 9-9 of ES Chapter 9: Geology and Hydrogeology **[APP-051],** which provides a detailed overview of the existing ground and geology across the Order Limits within which the Proposed Development is located. This includes descriptions of the made ground, superficial geology and bedrock. Furthermore, Table 9-12 presents additional information on ground stability along the pipeline route and the assessment presented includes looking at the potential for landslips.
2.8	**Extract from hearing transcript:** *[David Wallis – you mentioned BVS and if things went wrong there. In terms of issues that might be expect. What are the potential problems?]* I don't know what design the BVS is. If it is standard O&G, then will be rubber based high temperature rubber. Rubber will take CO_2 within it and if vent on other side will get explosive decompression and render the seal broken. Makes it around 85% effective. O&G valves rely on wetting to stay sealed. When we do high pressure	The block valves will have a Carbon Steel body that is rated for Low Temperatures and will be fully qualified for CO_2 service, adhering to fugitive emission leakage criteria in accordance with ISO 15848-1. These valves will be welded into the main onshore pipeline and buried, with the valve actuator extending approximately 1.5m above ground. The actuator will be designed with a safety margin to ensure it can provide enough torque to close the valve when needed. The Applicant's selected FEED Contractor is currently engaging with several valve manufacturers. Although there is currently no specific standard for CO_2 service valves, there are

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	welds offshore have to get them warm to seal. 31 degrees with CO_2 maybe not an issue. It's a question I have.	globally operational CO_2 pipelines where valve manufacturers and their supply chains are demonstrating relevant experience.
2.9	**Extract from hearing transcript:** *[David Wallis – there are gas pipelines up and down the country that are run safely. Is the issue using that technology for new type of gas, if you like, that causes this conflict and tension?]* Potentially yes. I am overseas now so don't keep up to date with HSE legislation. Last time I looked was no regulation regarding CO_2. All amended modified O&G Pipeline Act legislation. There may now be something more specific.	The Applicant is highly experienced in health and safety management and takes very seriously its legal duty under the UK's Health and Safety at Work Act to protect workers and the public from its activities. Regarding specific legislation and guidance for CO_2 the Applicant draws attention to the following. The HSE has produced a document on its website entitled: "Guidance on conveying carbon dioxide in pipelines in connection with carbon capture and storage projects" (https://www.hse.gov.uk/pipelines/co2conveying-full.htm, accessed 29/07/2024). This document identifies relevant legislation as: • Health and Safety at Work etc. Act 1974 (HSWA) - Sections 2 and 3 require employers to ensure the health and safety of their employees and others so far as is reasonably practicable. This means that CO_2 pipeline operators are required to take a proportionate approach to managing the risks from conveying CO_2 at every stage of the pipeline's lifetime. This should be demonstrated through a comprehensive risk assessment which takes account of the range of risks that arise from the design, commissioning, operation (including maintenance and inspection) and decommissioning of the CO_2 pipeline. • Pipelines Safety Regulations 1996 (PSR) - Part II defines the legal standard for the design and operation of pipelines. In particular, Regulation 5 of PSR requires that the design of a pipeline, or any modification to it, takes account of: the operating regime of the pipeline, the conditions under which the fluid is to be conveyed, the environment to which the pipeline will be subjected. The document goes on to say: Operators of CO_2 pipelines can demonstrate compliance with PSR and HSWA by making sure that the risks from their pipelines are reduced as low as is reasonably practicable (ALARP). The document then

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		directs the reader to HSE general advice on ALARP (https://www.hse.gov.uk/enforce/expert/alarpglance.htm, accessed 29/07/2024). This page also directs the reader to the document "Reducing risks, protecting people" (https://www.hse.gov.uk/enforce/assets/docs/r2p2.pdf, accessed 29/07/2024). This sets out an overall framework for decision taking by HSE which would ensure consistency and coherence across the full range of risks falling within the scope of the HSWA. The same document states: European Standards implemented in the UK as British Normative Standards (BS EN series) and supported by published documents (such as the British Standards PD series) provide a sound basis for the design of pipelines. UK and European standards relevant to the transport of CO_2 in pipelines (at the time of writing) include: • BS PD 8010: 2004 Part 1 – Steel pipelines on land • DNV RP-J202 – Design and Operation of CO_2 Pipelines (2010) • Energy Institute – 1301 CO_2 Good Plant Design • Energy Institute – 1302 CO_2 Hazard Analysis The HSE also has a document on its website entitled "Pipeline design codes and standards for use in UK CO_2 Storage and Sequestration projects" (https://www.hse.gov.uk/pipelines/resources/designcodes.htm, accessed 29/07/2024). Again, this references PD 8010 Part 1. The Applicant notes that BS PD 8010-1 guidance was updated in 2015 to include CO_2. In summary, the overarching UK legislation is the Pipeline Safety Regulations 1996 in conjunction with the Health and Safety at Work Act 1974. Supplementary to that the UK HSE state applicable guidance is BD PD Part 1 Pipeline Systems - Steel pipelines on land, which includes CO_2 and five CO_2-specific guidance/standards: • BS ISO 27913:2016 Carbon dioxide capture, transportation and geological storage—Pipeline transportation systems

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		• DNV-RP-F104: 2021 Design and operation of carbon dioxide pipelines • CO2RISKMAN Guidance on CCS CO_2 Safety and Environment Major Accident Hazard Risk Management • Energy Institute, Hazard analysis for onshore and offshore carbon capture installations and pipelines: 2024 • Energy Institute, Good plant design and operation for onshore and offshore carbon capture installations and pipelines: 2024