Written Representation on behalf of the residents of Corner Farm
Interested Party reference number: 20047155
Deadline: 26 April 2024

Summary

The Written Representation:

- CO_2 is toxic well below asphyxiant concentrations: 5% -> debilitating effects, 10% -> rapid mortality, 20% -> near-instant mortality.

- Dense-phase CO_2-pipeline ruptures can result in hazard to humans, including toxicity, blast, and thermal shock.

- A full-bore rupture would have a fatal blast limit of ~90 m.

- A 4" rupture of an 18" pipe would have a down-wind toxic footprint extending to 90 m for near-instant mortality, 200 m for rapid mortality, and 380 m for debilitating effects.

- Safe shelter could be provided by buildings over 150 m from the release.

- It is necessary both to minimise the frequency and to mitigate the severity of potential hazards. Safe distance is a recommended primary method of mitigation.

- In diverting its originally preferred route past Grimoldby it seems that, in its eagerness to give the appearance of safety, the applicant has both increased the potential frequency of hazard events, by lengthening the route, and the potential severity of hazard events, by placing residential properties within the near-instant-mortality or rapid-mortality zones, where none previously lay. If the applicant has used a minimum safe distance in its calculations, it is evidently insufficient to have an appreciable effect in mitigating fatal hazards.

- Alternative safe routes are available and have been suggested to the applicant. We hope that they may yet be adopted.

Comments on First Written Questions:

- Routine odorisation of CO_2 may assist emergency responders in the event of a rupture.

- Plume modelling for vent design should be confirmed by fresh experiment.

- Deeper pipelines result in greater hazard ranges.

Comments on Relevant Representations:

- Disruption of grass verges to create passing places could impact on barn owl hunting.

- We agree that consultation was inadequate, affected by lack of integrity, and treated more as a PR exercise than a genuine attempt to engage.

- We agree that the supposed benefits of the Viking CCS project, as proposed, are highly questionable, citing research which concludes that “governments should rapidly scale up CCS but reserve it only for essential use cases” and warns that “using CCS to facilitate ongoing fossil fuel use would be, globally, highly economically damaging”.

(1) We wish to thank the ExA for First Written Questions 1.1.22 and 1.3.11, and for the opportunity to submit a Written Representation.

(2) Twenty Relevant Representations cite safety concerns. Unfortunately some misinformation has slipped into circulation, but, while the fear expressed by four representations that a pipeline rupture would asphyxiate every breathing creature within a 15 km radius is incorrect, the concerns of those living close to the proposed route are real and justified.

(3) CO_2 is in fact toxic at concentrations well below those required for asphyxiation, so that, for instance, concentrations ≥20% result in 100% probability of death within a minute, concentrations ≥10.5% result in ≥50% mortality within 10 minutes, and concentrations as low as 6.3% cause disorientation, can lead to loss of consciousness within minutes and even 1% mortality if sustained for ≥1 hour (CO2RISKMAN – Level 3, section 5.12.2; Energy Institute (2010), Tables 3-5, Figure 5).

(4) A number of large-scale tests have been conducted to study, and help to model, the range of hazards associated with CO_2 pipeline rupture. Perhaps the most illustrative of these is the COSHER JIP test rupture of a buried, dense-phase CO_2 pipeline, conducted at the DNV-GL Spadeadam testing and research centre in Cumbria, pictured on the cover of the CO2RISKMAN reports and reported in detail by Ahmad et al. (2015). Please note that this test used an 8" diameter pipe, one third of the 24" diameter proposed. In this test, the visible plume of condensate and ice extended roughly 60 m vertically and 400 m in a downwind direction. However, please note that the visible plume does not necessarily represent the extent of the dense gas hazard and that it boils off well before the invisible blanket-cloud has dispersed. As seen in Ahmad et al. (2015), Fig. 4, the initial plume cascades under its own weight, forming a gas blanket which then drifts in the wind. The toxic gas cloud is accompanied by a rapid drop in temperature (Figures 13 and 14), sufficient to induce cold shock in humans and shatter windows and windscreens. Fine dry-ice particles (-78°C) carried in the cloud may cause freeze burns to airways, eyes, etc. As confirmed in the Satartia incident, the CO_2 cloud may be sufficient to stop combustion engines, hampering escape and the emergency response (see also CO2RISKMAN – Level 3, sections 6.3 – 8).

(5) Larger-bore rupture tests have been conducted at the same site, reported by Xiong Liu et al. (2019), who found that hazard levels of CO_2 extended over several hundred metres, depending on windspeed, and that consequence distance varied almost linearly with pipe diameter. In the modelling exercise reported in Energy Institute (2010), fatality ranges are estimated for both toxicity and blast, for a range of pipe diameters at 117 barg (Figures 19-21); higher pressures would render these underestimates. Interpolating for a 24" pipe, the limit of fatal blast would be approximately 90 m. However, this is exceeded by the limit of fatal toxicity. Again by interpolation, the limit of 1% toxic fatality (conservatively equivalent to the HSE’s Specified Level Of Toxicity (SLOT)) for a full-bore rupture of a 24" pipe would be approximately 345 m directly downwind. This will be an underestimate, because versions of the PHAST model prior to 8.9 do not include the ‘gas blanket’ model based on plume behaviour in the above COSHER JIP experiment. For a 4" jet, considered to be an order of magnitude more common, SLOT would similarly be exceeded at approximately 185 m for an unimpeded jet and at approximately 320 m for an impeded jet (e.g. from under a roadway); higher pressures would render these underestimates.

(6) In Witkowski et al.(2013), the downwind limits of 5% (debilitating), 10% (rapidly fatal), and 20% (near-instantly fatal) CO_2 concentrations are estimated for a 20% (4") rupture of an 18" pipe at 153 barg, placing these at roughly 380 m, 200 m, and 90 m respectively; the duration being dependent on the volume of CO_2 expelled. They recommend that “A leak from high pressure pipelines can result in hazard to humans. Therefore, safety considerations require that safety zones should be established around such pipelines, and that the pipelines should be fitted with safety valves that, in the case of rupture, shut off the damaged section of the pipeline, limiting in this way the amount of gas released into the surroundings.”

(7) CO2RISKMAN (2013) also echoes HSE advice in emphasising the need both to minimise the frequency and to mitigate the severity of hazard events. Among mitigation measures, it highlights the need for safe distance, or “segregation by distance between inventories and potential receptors of harm”.

(8) At short range, escape from a pipeline rupture may be impractical; however, buildings may provide refuge (if not ruptured by blast or temperature differential). Lyons et al. (2015), used the DNV-GL COOLTRANS model with a simplified infiltration scenario, assuming valve closure within 15 minutes, to conclude that “safe shelter will be provided in any building located more than 150m from the release for this case study”. Leakier buildings such as the average old Lincolnshire farmhouse, will reach a SLOT DTL at greater distances (see Lyons’ published thesis), but in the absence of better data, this is an appropriate working figure.

(9) Following the first round of consultation (EN070008/APP/3.2, 5.3.2), an alteration was made to the preferred route as it passes Grimoldby (EN070008/APP/4.3, sheets 27-29). This new, longer section of the preferred route is the one that concerns us personally, as the DCO limit runs ~33 m from our property (see above for implications in the event of rupture). However, the concern applies generally. The original route, which we assume met other QRA requirements, placed 8 homes, on Pickhill Lane and around the junction of Northgate Lane with Middlesykes Lane, within outdoor SLOT range for a full-bore rupture. None of these were within indoor SLOT range and none within fatal blast or near-instant-mortality range. The diverted route placed 7 different homes, on Red Leas Lane, Marsh Lane, and Pickhill Lane, within outdoor SLOT range. One of these (ours) was placed within indoor SLOT range, fatal blast range, and outdoor near-instant-mortality range. Following further consultation a small adjustment was made to the preferred route (sheet 29), too small however to take Corner Farm out of any of these ranges. (The applicant told us that the route would run “equidistant between Corner Farm and the nearest property” and comments in our Relevant Representation were based on that assumption, but examination of sheet 29 shows that it does not.) Taking measurements from Sheet 29, from the midpoint of the DCO limits, Corner Farm lies within the near-instant-mortality zone, Pickhill Farm lies within the rapid-mortality zone, and both lie within indoor SLOT range and could not be relied upon for safe refuge in the event of a rupture (depending, of course, on wind direction, etc.).

(10) In diverting its originally preferred route past Grimoldby it seems that, in its eagerness to give the appearance of safety, the applicant has both increased the potential frequency of hazard events, by lengthening the route, and the potential severity of hazard events, by placing residential properties within the near-instant-mortality or rapid-mortality zones, where none previously lay. If the applicant has used a minimum safe distance in its calculations, it is evidently insufficient to have an appreciable effect in mitigating fatal hazards.

(11) We assume that the applicant has used a QRA approach similar to that outlined by Cooper & Barnett (2014), and that the requirements of this model were satisfied by both the original preferred route and the diverted route. The difficulty of this approach is that, while it controls overall societal

risk, it can leave residents of smaller clusters and isolated dwellings exposed to elevated individual risk and without safe refuge in the event of a rupture. These residents can effectively be left living under the sword of Damocles.

(12) “Until the assessment of CCS CO_2 stream pipeline hazards becomes a mature subject with accepted industry guidance on determining hazardous distances there will be uncertainty. Factors such as the influence of topographical features (e.g. valleys), crater shape and impurities, need to be adequately understood and models and modelling approaches developed and validated. Increasing separation distances will help manage the current uncertainty” (CO2RISKMAN – Level 4, p 39). Research has advanced slightly since 2013, but significant technical uncertainties and regulatory deficiencies remain (Lu et al. (2020); Kuprewicz (2022); El-Kady et al. (2024)). Given that experience with CCS is somewhat limited (CO2RISKMAN – Level 3, section 4.4.1) and that, as the HSE acknowledges, safety codes remain a work in progress (ISO/TC 265, Carbon dioxide capture, transportation, and geological storage), hazard mitigation should take priority over other technical considerations in design and planning and we would urge a cautious, layered approach, making use of safe distance wherever practicable. QRA calibrated to control societal risk should at minimum be supplemented by a safe-refuge requirement in residential settings to control individual risk. That is, at minimum, to control indoor exposure in the event of a rupture below the SLOT DTL, and, on the ALARP principle, wherever practicable, to control outdoor exposure below the SLOT DTL.

(13) On the face of it, the diversion should be reversed in the interests of safety, but, in consultation with the applicant, we suggested alternative routes that would take all residential properties along the diversion out of the most serious hazard zones. First, examining the original route options (see Alternative_Routes.pdf, attached), the applicant decided against route E-1B, as it was constrained by ribbon development on the B1200. This, however, is a false choice; if E-1B is linked to E-2 between the Greyfleet and the B1200 (marked in pink), across open farmland with access routes, the resulting E-1B+link and E-2 form two sides of a lens-shape, incurring no significant increase in pipeline length and crossing the B1200 on the current preferred route. We do not consider the small additional incursion into flood zones 2 and 3 to be significant when weighed against safety. To consider a substantial reroute at this stage of application would incur costs, but, to quote Trevor Kletz, “if you think safety is expensive, try an accident”.

(14) Alternatively, we suggested shorter reroutes that would have a similar result (see Alternative_Routes.pdf, attached). Anticipating the stagger in the red route by following the green route would take three residences out of the most serious hazard zones and following the blue route would take a further four residences out of outdoor SLOT range. The applicant’s only response was “noted”.

(15) Safe alternative routes are available and we hope that they may yet be adopted in the interests of safety and of reducing the burden of risk imposed by this project more meaningfully ALARP.

Comments on First Written Questions:

(16) In First Written Questions 1.2.3, the ExA enquires about odour during operation. We would comment that odorisation, similar to natural gas, has been suggested, not so much as a way to help detect leaks (Kilgallon et al. (2015)), but as a way to assist emergency responders in the event of a rupture.

(17) In relation to First Written Questions 1.2.1 and 1.2.10, we would suggest that modelling exercises be confirmed by fresh experiment.

(18) In First Written Questions 1.5.10, the ExA queries the variation in pipeline depth. We would comment that there is a slightly counterintuitive balance to be struck. Rupture of a pipeline that is buried deeper will result in a release with a larger proportion of its momentum removed, leading to lower dispersion rates and correspondingly greater hazard distances.

Comments on Relevant Representations:

(19) In its Relevant Representation, Lincolnshire County Council notes that "at ATC 66 and 67 – Red Leas Lane and Pick Hill Lane – both these are narrow (3m) lanes and vehicles have to pass at house/field accesses or on the verges. Given that the increases on these links are over 30% and the roads are not really suitable for significant 2-way traffic flows it is therefore recommended that some passing places are provided, unless it can be demonstrated that they would not be required". We would comment that these verges, together with the banks of the Greyfleet, provide the main hunting areas for local barn owls. Loss and disruption of these habitats would have a negative impact in addition to those listed by Natural England.

(20) 52 Relevant Representations cite failures in consultation and even "lack of integrity/disingenuous conversations", mainly in connection with property and commercial interests, but also failure to provide information in a reasonably understandable form. Our own experience of the consultation was that our written responses tended to be misquoted or quoted selectively so as to misrepresent their substance. If this represents the general treatment of responses then we feel the ExA can place little faith in the applicant's summaries. The applicant was consistently reluctant or unwilling to engage at a technical level. From our experience and that of others, we conclude that the consultation was inadequate and treated more as a PR exercise than a genuine attempt to engage.

(21) Two Relevant Representations questioned the benefits of the Viking Project as a whole. There is a broad consensus that CCS will be vital in achieving 'Net Zero'. However, there is also broad acknowledgement that not all CSS projects are equally beneficial. Reputable climate think tanks E3G and the Bellona Foundation have created what they call a CCS Ladder of priorities for CCS (E3G & Bellona Foundation (2023)), emphasising the need to avoid "fossil fuel lock-in", and concluding that "The climate value of CCS is lowest in the power sector and is expected to diminish considerably over time. CCS's climate value is greatest for industrial applications with significant process emissions, particularly in non-metallic mineral sectors such as cement and lime."

(22) Similarly, a recent report from The Smith School of Enterprise and the Environment, University of Oxford (Bacilieri et al. (2023)), has assessed "the relative costs of low-CCS [10% of today's emissions] and high-CCS [50% of today's emissions] pathways to 1.5°C using scenarios developed for the IPCC's Sixth Assessment Report (AR6)". They conclude that "From 2021 to 2050, taking a low-CCS pathway to net zero emissions will [globally] cost at least US$30 trillion less than taking a high-CCS route – saving approximately a trillion dollars per year". They advise that "governments should rapidly scale up CCS but reserve it only for essential use cases" and warn that "Using CCS to facilitate ongoing fossil fuel use would be, globally, highly economically damaging". Judging by its known emitter partners, the Viking project appears to be designed primarily to serve CSS which would promote fossil fuel lock-in and be economically damaging.

(23) Journalists and campaigners doubt whether the fossil-fuels industry can be trusted not to use CCS for enhanced recovery of oil and gas from otherwise spent fields, given its recent enthusiasm for doing precisely that. Enhanced recovery could be profitable, but would undermine any carbon-capture gains from CCS and should be specifically prohibited in any relevant consent.

(24) Any decarbonisation scenario consistent with the 1.5°C target in the Paris Agreement will require a large and increasing component of nuclear power generation. This in turn will require Geological Disposal Facilities. The NWS proposals for GDF at the Theddlethorpe site rely on mature technology and safety protocols and should be regarded as a national priority. However, combining GDF operations with any technology with the potential to fail explosively in close proximity would be ‘crazy dangerous’. We do not believe that GDF and CCS are compatible in proximity. We suggest that NWS be given exclusive priority to pursue its investigations and local engagement, in the national interest.

(25) In First Written Question 1.3.10, the ExA has identified that CO_2 emitters south of the Humber could opt instead to connect to the Endurance Pipeline, rendering the long Theddlethorpe pipeline redundant.

(26) Is the Viking CCS project, as envisaged, really in the national interest? Is the national benefit from it really so great as to outweigh all the local detriments? We are not convinced.

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