Response from Guardians of the East Coast (GOTEC) to Meeting with Inspectorate Tuesday 25th June 2024

1. The Applicant responded that they could see no instance whereby the full inventory of the pipeline would need to be vented – If there is a problem with block valve #1 it would need to be vented Upstream back to the compression facility at Immingham and all downstream inventory to Theddlethorpe thereby requiring the full pipe line to be vented – it would appear not a great amount of thought has gone into the responses if a simple situation like this has been overlooked, any leaks in flanges, flowmeters etc upstream of valve #1 would also require full shutdown and venting – If venting is carried out at the stated maximum rate of 5kg/s this process utilising 1 vent stack would take 23.3 days utilising both Theddlethorpe and Immingham vent stacks it would take 11 ½ + days. A significant shut down period with loss of revenue and emitters having to revert to normal discharge of flue gases, I have grave concerns that small leaks will be ignored due to financial and logistical considerations, small leaks very quickly become big leaks and big leaks even quicker become catastrophic failures exponentially increasing the risk to the local population.
2. The applicant states that the HSE Tolerability of Risk framework has been adopted to assess the pipeline risk and they have classified it as lowest risk and the HSE does not usually require further action to reduce risk if the lowest classification – I would like to see the assessment evidenced to confirm due diligence was followed throughout the process and the correct outcome was reached. The Incident at Satartia Mississippi on 22nd Feb 2020 was also deemed to be of the lowest risk factor and the company involved (Denbury – accepted as a leader in the field of CO2 transport and sequestration) also felt that additional safety measures were not required, Over 300 people had to be evacuated and at least 45 people were hospitalised with ongoing medical requirements and legal cases. A suggestion from USA regulatory bodies is that CO2 should the same as natural gas have an odour added to help with identification of leaks. A US report from September 2023 states "*Caram of the Pipeline Safety Trust says if there's a disaster while the CO2 is a gas or other unregulated state, "I worry about a good lawyer getting an operator out of any kind of liability." There are other potential regulatory gaps. CO2 itself is odorless. So is natural gas, but companies add an odorant to alert people to its presence. There is currently no such requirement for CO2. There's also a limited understanding of how CO2 can move through the air, says Caram. "As we're building these pipelines, we don't have a good sense of who's going to be in that potential impact area in the case of a failure," Caram says*".

3. In the event there was a leak and release of significant volume of CO2 then emergency response would be severely hampered due to the internal combustion engine being rendered inoperable with the displacement of oxygen and people would be unable to utilise vehicles to escape, emergency response unable to attend and assist – all responders would have to be under air and this also severely limits their ability (+/- 30mins max without cascade system) to provide assistance and evacuation help. Oxygen starvation causes brain cells to die in 2 -3 mins and motor

and cognitive functions are irreparably damaged when this occurs, Too late to try and mitigate or formulate adequate response plan after the event, HSE Tolerability of Risk framework said it was ok won't satisfy burdened or grieving relatives.

4. The free water values stated by the applicant (50ppm) that they will adhere to and ensure that are not exceeded are very ambitious in any theatre of operation. I am unsure how they will achieve these values possibly through a combination of dessicant, MEG, TEG or DEG, there are additional issues related to the use of MEG, TEG and DEG - See the following extracts from NACE INTERNATIONAL: VOL. 53, NO. 5 May 2014 regarding corrosion due to impurities – full article is attached for reference

- Introduction of the pig will allow ambient humidity into the pipe line at both the loading station and receiving station allowing formation of free water.

- *"If glycol (i.e., MEG, DEG, TEG) and amine carryover form a separate phase, it will extract water and form a corrosive environment. If the CO_2 is contaminated with glycols, the solubility and possibility of forming separate aqueous phases should be investigated.*

- *Amine and ammonia carried over from the CO_2 capture process will dissolve in a free water phase. This will increase the pH while the potential corrosion rate (the corrosion rate without protective layers on the steel surface) might be reduced. The effect of pH adjustment or pH stabilization is not well documented and should be investigated in more detail*

- *Solids in the pipeline can be hygroscopic and become wetted at water concentrations below the solubility limit for bulk phase precipitation. For instance, solid phases might be present in old pipeline systems that are converted to CO_2 transportation lines.*

- *Corrosion prediction and solids formation models that cover CO_2 pressures up to several hundred bar and take the true corrosion and reaction mechanisms into account will be needed in order to predict the corrosion rates in CCTS pipelines. And even more important, the models have to include the effect of impurities like SO_x, NO_x, and O_2. None of the existing models can presently be used and an extensive amount of experimental corrosion and solubility data will be needed in order to develop a model.*

- *There is a strong need to better understand the relationship between the water content and the impurity concentration at which corrosive phases form and corrosion takes place. At present, there is a lack of data and therefore it is not possible to define the safe limits for the various impurities when they are mixed.*
- *Depressurization of the pipeline will increase the concentration of many of the impurities (including water, SO_x, and NO_x) in the remaining liquid phase. In order to quantify the increased corrosivity after depressurization, there is a need for more solubility and partitioning data for the water-dense phase CO_2 system.*

5. It is stated by the applicant that there will be no Nitramines or Nitrosamines in the pipeline – the only way that this can be said with any kind of authority is for them not to be used. As Amines are the primary method of carbon capture there will inevitably be Amine byproducts in the Dense phase CO2 stream, given the miniscule amounts that are hazardous to humans this will be very difficult to control and maintain a safe concentration. *Recommended concentrations proposed by Norwegian Institute of Public Health are 0.3 ng/ m3 in air and 4 ng/l in drinking water.*
- *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 0.3/0.4ng

6. As a final point regarding Nitramines and Nitrosamines – if entrained within the Dense Phase CO2 they will increase the Ph of any water making it more susceptible to free water formation and precipitation even at 50ppm
7. Block valve selection – I assume the block valves will be standard oil and gas valves as used in hydrocarbon pipelines. I have concerns over the selection of these valves as the elastomer in a dense phase environment will suffer impregnation of CO2. Subsequent depressurisation will most likely result in explosive decompression of elastomers thereby rendering the valve inoperable and unable to provide a competent seal. Also it should be noted that the extreme ranges of temperature as acknowledged by the applicant due to the Joule-Thomson effect are likely to cause embrittlement of any plastic components, seals, o-rings and elastomers

Traditional block valves rely on wetting of the surfaces to facilitate a competent seal, due to the properties of Supercritical/ Dense phase CO2 it has a very low surface tension and will therefore make it difficult to achieve a competent seal until sufficient differential pressure is experienced across the valve and the valve paddle moves onto the seat with sufficient force to elicit a seal but this very function is likely to exacerbate the likelihood of explosive decompression of the elastomer. A further complication of the poor wetting condition is that while achieving the required differential across the valve a degree of fluid cut, scouring and phase transition with potential for Clathrate/Hydrate formation may occur due to pressure transition from high pressure jet to the lower pressure environment immediately downstream of the valve thereby releasing energy and causing rapid cooling of the liquid phase CO2. Worst case scenario in this instance is that the assumption is made that the valve closure has been successful but in actual fact a hydrate is blocking the pipe and work commences only for the hydrate to melt and there be a sudden release of high pressure CO2 into the work area and local environment.

8. Dense Phase Co2 is a super solvent and readily absorbs the other contaminants from the capture process. In the event there is a requirement to vent or stop pumping, the CO2 will revert back to the triple point gas/liquid/solid phase in a relatively short period of time, during this phase transition CO2 stops being a super solvent and any entrained contaminants and free water will be deposited and most likely create various acids / corrosive substances.
9. In the applicants response they state “it has been demonstrated in section 2.3 of this technical note that a 20-25m high vent will be sufficient to ensure safe dispersal” – yet all the data presented is “preliminary and indicates” (section 1.3.4) not has been comprehensively tested and been proven to a high level of certainty. Sections 2.3.4 & 2.3.5 both start with “preliminary modelling” and 2.3.5 continues with “assuming atmospheric conditions that would represent a realistic worst case scenario” what atmospheric conditions do they assume – those which allow them to say a 20-25m stack is suitable?
10. The final point made was that the pipeline flanges are likely to be in the 28-30” diameter range therefore making them even closer to surface and more likely to be disturbed by agricultural operations, ploughing, drilling etc – the weakest point and most likely failure point is in all probability going to be the flanges as they will not be subjected to a bolt torque cycle after pressurisation as per most HP piping found in refinery and offshore applications – this would be carried out after a pressure cycle to ensure correct and uniform torque as per API 6D which covers pipeline valves.
11. A brief discussion was held regarding the land and suitability for laying the pipeline – it was pointed out that the land around Theddlethorpe is reclaimed land and the mantel is relatively thin and shallow, subsidence is relatively common in the area and in February 2008 we had an earthquake with the epicentre at Market Rasen measuring 5.2 on the Richter scale.