BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF SOUTH DAKOTA

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HP 22-002

IN THE MATTER OF THE APPLICATION OF NAVIGATOR HEARTLAND GREENWAY LLC FOR A PERMIT UNDER THE SOUTH DAKOTA ENERGY CONVERSION AND TRANSMISSION FACILITIES ACT TO CONSTRUCT THE HEARTLAND GREENWAY PIPELINE IN SOUTH DAKOTA,

REBUTTAL TESTIMONY OF JOHN GODFREY

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1. Please state your name and business address.

Answer: My name is John F. Godfrey. My business address is 5777 Frantz Road, Dublin, Ohio, 43017.

2. Have you previously submitted testimony in this proceeding?

Answer: Yes. I submitted direct testimony dated May 25, 2023.

3. To whose testimony are you responding in rebuttal?

Answer: I am responding to the testimony of Mr. Bill Caram and Dr. John Abraham.

4. Do you agree with Mr. Caram's testimony that there are regulatory and knowledge gaps related to carbon dioxide pipelines?

Answer: I do not. The second attachment to his testimony includes an undated summary written for the Pipeline Safety Trust; the summary is titled "Regulatory and Knowledge Gaps in the Safe Transportation of Carbon Dioxide by Pipeline." With respect to this proceeding, the summary is potentially misleading and in several instances inaccurate.

First, the report states that "[f]racture propagation protection, or fracture arresters, and steel thickness requirements should be carefully examined and incorporated into federal CO2 pipeline design regulations." (Attachment 2 at p. 5 of 13, ¶ 4(b).) Current federal pipeline safety regulations require a CO2 pipeline operator to have a fracture control plan. 49 CFR § 195.111. The absence of specific regulatory requirements is not relevant to Navigator's actual design with respect to fracture control. The properties of CO2 that lead to the risk of ductile fracture are already well known as are the mitigation strategies.

Second, the report states that "[c]ontaminants within CO2 products being transported can jeopardize the integrity of the pipeline . . . . Standards for maximum contaminant levels within different CO2 producing industries should be reviewed and set by PHMSA in the federal pipeline safety regulations." (*Id.* ¶ 5(c).) While research at government and industry levels is already underway to better understand the effects of various contaminants, Navigator's proposed pipeline will transport CO2 at least 98% pure. Concern about impurities is therefore not an issue in this proceeding.

Third, the report states: "Given the unique properties of CO2 mentioned previously, pipeline conversions have the potential to be at higher risk of failure from CO2 service than conventional hydrocarbon or even new construction CO2 pipelines." (*Id.* at p. 6 of 13.) Navigator's proposed pipeline is all new construction, so risks associated with conversion are not an issue in this proceeding.

5. Do you agree with Mr. Caram's conclusion that "regulatory and knowledge gaps and shortfall related to CO2 pipelines . . . underlies the need to not rush consideration of these projects without due diligence on missing regulatory framework?" (Caram Testimony at p.1.)

Answer: No. Supercritical phase CO2 pipelines like Navigator's project have been in regulated operation in the United States for over 40 years. Pipeline safety considerations are well known, including DNV's Recommended Practice F104, which Navigator has voluntarily used to benchmark its safety and design philosophy. Two of the three verifications that DNV has done for Navigator were attached to my direct testimony, and the third is attached to Steve Lee's rebuttal testimony. The general concerns stated in the report summary do not address the specifics of Navigator's pipeline design and are inconsistent with the safety record of CO2 pipelines in the United States.

6. Are you familiar with the principles of Computational Fluid Dynamics, or CFD, which are discussed in Dr. John Abraham's testimony?

Answer: Yes. CFD is a comprehensive scientific and engineering approach to modeling a variety of fluid flow scenarios, which for CO2 would include transport and dispersion. While CFD is terminology used globally to refer to an aspect of the science of fluid mechanics, there are multiple methods, models, and computer programs available for its application. Each has its own strengths and weaknesses. It is problematic to refer to CFD as a catch-all term, especially with respect to its application to a proposed carbon capture pipeline.

7. Dr. Abraham addresses differences between PHAST modeling and CFD and states that CFD is an alternative to PHAST modeling. Is this a fair comparison?

Answer: No. PHAST is a specific form of computer modeling for predicting discharge and dispersion of a wide range of loss-of-containment scenarios. CFD refers to a much broader scientific approach to such modeling. The comparison of a specific computer model to a general engineering approach, PHAST to CFD, has the potential to be misleading.

8. Dr. Abraham describes CFD in his testimony as the "gold standard" that should be used for CO2 pipeline dispersion analysis (Abraham Testimony at p. 8.) Do you agree?

Answer: No. Dr. Abraham is correct to state that CFD models will produce more comprehensive results than PHAST or similar programs, but this is an academic argument. Dr. Abraham fails to address the time and effort to produce just one CFD model related to a large linear project like Navigator's proposed pipeline. In fact, a single scenario will take days to model using CFD. Evaluating multiple geographic sites under different seasons and weather scenarios for a single pipeline will exponentially increase this time and effort. It is simply impractical and unrealistic to use CFD to model plume dispersion for linear assets like Navigator's proposed pipeline. Instead, PHAST modeling is a more practical approach that provides a sound means to assess multiple locations under a variety of scenarios in a reasonable and feasible manner.

9. Dr. Abraham states on page 11 of his testimony: "I encourage the Commission to consider Navigator's Application in light of the most accurate scientific information available including CFD modeling, and to evaluate the proposed project based on consideration of whether or not all buffer zones and setbacks are supported by CFD modeling." Do you agree that the Commission should reject dispersion modeling other than CFD in considering Navigator's permit application?

Answer: No. Dispersion analysis is not new or limited to CO2 pipelines. Other pipelines regulated under 49 CFR Part 195 such as propane, natural gas liquids, and ammonia pipelines utilize dispersion models including PHAST to help assess risk. The limitations of implementing CFD are recognized for these assets as well. The testimony of William Byrd, one

of Staff's experts, helps put this issue in context. With respect to routing, the use of CFD for site-specific modeling is not practical:

> Site specific modeling is expensive and time consuming and can't be performed until a site is selected. Applicant has used generalized assumptions concerning a significant CO2 release as part of its routing process. This is essentially a screening process and is normal and appropriate when determining a pipeline route. Once the route is determined, based on a variety of considerations, site-specific modeling can be performed for pipeline segments in proximity to important or vulnerable areas. The purpose of this modeling is to inform risk management decisions such as higher integrity pipe or enhanced emergency response. It is not normally used to determine a pipeline's route.

(William Byrd testimony at p. 8.) Moreover, such site-specific modeling is one part of integrity management:

> Site-specific dispersion and overland flow modeling is part of a pipeline's integrity management program, to determine pipeline segments requiring a higher level of integrity management / accident prevention / accident mitigation. The net effect is to minimize or avoid any exceptional risk to the potentially affected areas from these pipeline segments. Thus, the Commission does not need to delay its approval pending site-specific dispersion and overland flow modeling, because "the health, safety or welfare of the inhabitants" should be adequately addressed by the PHMSA-mandated pipeline integrity management program.

(William Byrd testimony at p. 8.) I agree with Mr. Byrd's understanding of how CFD might best be used with respect to Navigator's proposed pipeline. CFD modeling in this context serves a different purpose than the PHAST modeling that DNV did for Navigator. This is also consistent with Steve Lee's rebuttal testimony that Navigator intends to use CFD modeling in the manner described by Mr. Byrd.

10. Dr. Abraham testifies that PHAST modeling is not appropriate for CO2 dispersion analysis or buffer zones and the results of any such PHAST modeling should be dismissed (Abraham testimony at pp. 9-11). Do you agree?

Answer: No. PHAST and similar programs when properly applied and understood can be useful tools to evaluate a wide range of scenarios that are important to routing a CO2 pipeline and that could not practically be done using CFD.

11. Dr. Abraham states that he relied on information from the Satartia incident and that PHAST modeling done by Denbury was inaccurate (Abraham testimony at pp. 5, 7-8). Do you agree that this information means that the PHAST modeling done by DNV for Navigator is unreliable or not useful?

Answer: No. Not every scenario can be reasonably foreseen or predicted. Even with CFD, there will be situations that the engineers implementing the model could not foresee or predict. It is important to remember that pipeline risk management and integrity management regulations focus on preventing and mitigating releases. An overly detailed analysis of the specific effects of a pipeline failure has the effect of dismissing preventive efforts and leaving the impression that a given pipeline could fail everywhere at any time. By hyper-focusing on a gold-standard approach, Dr. Abraham's testimony suggests that Navigator's pipeline cannot be constructed and operated without substantially impairing the health, safety, or welfare of the inhabitants of the siting area. SDCL § 49-41B-22(3). That is not true because the modeling that Navigator did must be considered in context with the pipeline's design and Navigator's risk management and integrity management, which are designed to prevent and mitigate releases.

12. Dr. Abraham testifies "Denbury – and unfortunately, every community where this particular pipeline was located – inappropriately relied upon a calculation approach that should have been known by Denbury, and its consultants, to be unable to incorporate critical factors necessary to determine the risks that its pipeline posed to Satartia and to vastly under-predict downstream gas concentrations." (Abraham Testimony at p.8) Would a different plume dispersion model have significantly changed the Satartia response?

Answer: In my opinion, the Satartia response was hampered by factors more consequential than Denbury's dispersion modeling. Based on PHMSA's incident investigation and testimony I have reviewed, local first responders were unaware a CO2 pipeline was even in the county, let alone near Satartia.[1] Second, initial reports of a green, rotten egg smelling cloud led to the initial conclusion that a pipeline chemical release had occurred. Third, air monitoring to determine the composition and extent of the release did not occur until four hours after the release. Finally, training and equipment to deal with a CO2 release were not provided to first responders in advance. It is highly unlikely that any different dispersion model would have cured the underlying lack of coordination and communication between Denbury and local emergency responders. These factors are obviously not applicable here. Navigator's Heartland Greenway Pipeline is already well known within local communities even before construction and operation.

13. Mr. Caram talks about the need for regulation to define a safe distance or plume dispersion model for development of a potential impact area along CO2 pipelines. Specifically: "Without a PIR [Potential Impact Radius], it is impossible to establish accurate emergency response safe distances."[2] Is it practical to establish a standard PIR for CO2 pipelines?

Answer: No. In the highly unlikely event of a CO2 pipeline failure the potential impact is dependent on many pipeline and site specific variables. The pipeline diameter, operating pressure, temperature and purity of the CO2 stream all have a bearing on a potential release. Local climatological data, land use, and geography will also affect CO2 dispersion and spread. It

[1] Direct Testimony of Jerry Briggs, Illinois Commerce Commission, ICC Docket No. 23-0161, CCI Exhibit 4.0
[2] BILL CARAM INITIAL PRE-FILED TESTIMONY IN SUPPORT OF LANDOWNER INTERVENORS, Attachment 2, Pipeline Safety Trust, "Regulatory and Knowledge Gaps in the Safe Transportation of Carbon Dioxide by Pipeline"

is unrealistic to apply a PIR that would equate the potential impact of a release in South Dakota to a potential release in Mississippi. For these reasons, the establishment in regulation of a PIR is not advisable.

14. What role did DNV play in performing the PHAST modeling done for Navigator?

Answer: Navigator engaged DNV to perform PHAST modeling for the Navigator Heartland Greenway Pipeline. DNV developed PHAST and regularly updates and validates the program based on results of CO2 experiments that are published and publicly available. DNV's PHAST air-dispersion modeling requires information about the pipeline, the CO2 to be shipped through the pipeline, atmospheric conditions, and terrain conditions, all of which generally comprise the inputs on which the outputs are based. More specifically, the inputs are the product chemical properties, pipe dimension / diameter, pipeline inside diameter, pipe segment length, release orientation, whether the pipe is above ground or buried, the pipeline isolation segments, isolation valve closure times, product flow rate, pipeline operating pressure and temperature, or a defined release rate, and atmospheric data (wind speed, atmospheric stability class, air & surface temperature, relative humidity) and terrain roughness. DNV worked with Navigator to perform the modeling, including determining the information used for these inputs. For many of these inputs, the information used is obtained from publicly available and well established data sets. As part of the modeling process, DNV uses its engineering judgement and considers the reasonableness of the inputs.

15. Does this conclude your rebuttal testimony?

Answer: Yes.

Dated this 23rd day of June, 2023.

/s/John Godfrey
John Godfrey