BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF SOUTH DAKOTA

o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o

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,

DIRECT TESTIMONY OF JOHN GODFREY

o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o

1. Please state your name and business address for the record.

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

2. Have you previously provided testimony in this matter?

Answer: No.

3. Please describe your present employment.

Answer: I currently serve as a Senior Principal Consultant with the Integrity Solutions and Compliance Department within the Energy Services Group of DNV GL USA, Inc. ("DNV").

4. Please describe your educational background, employment history, and professional affiliations.

Answer: I have a Bachelor of Science in General Engineering with an emphasis in Hydraulics and Strength of Materials from the University of Illinois, which I received in 1987. I have over 35 years of experience related to pipeline design, construction, operation, maintenance, regulatory compliance, and safety issues, including 22 years with hazardous liquid

EXHIBIT
N10

pipeline operators. Over the years I have held various positions in pipeline engineering, operations, manufacturing, consulting, and asset integrity services. I have developed and managed Integrity Management Programs for pipeline companies. My experience also includes regulatory compliance, standards development, pipeline operations, pipeline design and construction, line pipe manufacturing, and non-destructive examination. I am a past Chairman of the American Petroleum Institute ("API") Pipeline Integrity Committee, a past Vice Chair of the Pipeline Research Council International Materials Committee, and a previous member of the API Operations Technical Committee. A copy of my C.V. is attached as Exhibit A.

5. Are you being compensated for your testimony?

Answer: DNV invoices my services at the rate of $525 per hour for my expert witness testimony in this matter. I am a salaried employee and not personally compensated specific to this testimony.

6. What is the purpose of your testimony?

Answer: The purpose of my testimony is to describe:

(1) DNV's development of the international Recommended Practice ("RP") for CO2 pipelines design, construction and operation, "DNV-RP-F104, Design and Operation of Carbon Dioxide Pipeline.". This RP was in response to the emergence of carbon capture and storage as a key abatement technology for achieving a significant reduction of CO2 emissions to the atmosphere;

(2) Navigator's retention of DNV to assess Navigator Heartland Greenway System ("NHG") pipeline's safety philosophy, concept development and premise, material selection and design against the requirements of DNV-RP-F104; and

(3) The results of DNV's verification of Navigator's proposed NHG pipeline.

EXHIBIT
N10

7. Please describe the business of DNV.

Answer: DNV is the leading technical advisor to the global energy industry. We provide consistent, integrated services within technical and marine assurance and advisory, risk management and offshore classification, to enable safe, reliable, and enhanced performance in projects and operations. Operating in more than 100 countries, our over 12,000 professionals serve our customers in the maritime, oil and gas, energy, and other industries. DNV services span the entire value chain of carbon dioxide ("CO_2") from capture and conditioning to compression, transport, utilization, and storage. DNV is a recognized global authority in onshore and offshore pipeline integrity asset management. Our subject matter experts ("SME") are backed by industry-leading laboratories and research scientists for material testing, modeling and simulations, corrosion research, failure analysis, technology, and equipment. We build trust for industries, investors, and governing bodies globally from strategic planning through technology demonstration to operational excellence.

8. Has DNV done work for Navigator in connection with the proposed Navigator Heartland Greenway Pipeline?

Answer: Navigator retained DNV to perform PHAST air dispersion modeling, facilitate a safety risk analysis, and assess NHG pipeline's safety philosophy, concept development and premise, material selection and design against the requirements of DNV-RP-F104.

9. Please describe the development and purpose of DNV-RP-F104.

Answer: The objective of this RP is to provide an internationally acceptable framework for the design, construction and operation of offshore and onshore CO2 pipelines, with a focus on structural assessment and with the aim of obtaining an appropriate and consistent level of safety. Safety of the pipeline is emphasized though all phases, as described in section 3 of DNV-

EXHIBIT
N10

RP-F104 on safety philosophy. The RP states that the overall safety philosophy for the pipeline shall be established, planned and implemented in the concept development, design, construction, and operation of CO2 pipelines. A copy of the RP has been filed confidentially as Exhibit B.

10. When did Navigator retain DNV to perform verification against the requirements in the RP?

Answer: March-May 2023

11. Please describe the scope of the design verification that DNV has completed for Navigator with respect to the Heartland Greenway Pipeline.

Answer: For technical assurance of assets, DNV offers a suite of services, including certification and verification of pipeline systems. The Scope of Work was defined between Navigator and DNV and includes verification in different stages via a Design Verification Report ("DVR") which addresses unique elements associated with the transportation of CO2 addressed within DNV-RP-F104. The purpose of the DVR is to provide documentation that objective evidence has been presented, to confirm compliance with these requirements, and to document the work performed by DNV. To date, Navigator has retained us for the following sections of the RP:

- Section 3 (Safety Philosophy)
- Section 4 (Concept Development and Design Premises)
- Section 5 (Materials and Pipeline Design)

Each section is verified separately.

12. What work did DNV do to complete the verification process?

Answer: DNV's scope of work included the following tasks and activities:

EXHIBIT
N10

(1) Document Mapping. Mapping all Navigator supplied documents (engineering & construction specifications, other key / engineering documents) against the relevant sections of DNV-RP-F104.

(2) Document Verification. Review of key documents identified during the document mapping activity in stages (documents verified against DNV-RP-F104 Section 3, Section 4, and Section 5 requirements) starting from Section 3. The review is based on following categories of documents:

- NCO2V specifications
- Project design basis/design premise
- Engineering documents (i.e., calculations, if available at the time of review)

This process included verification of all mapped documents against each section's requirements for identification of potential gaps. DNV documented the requirements from DNV-RP-F104 in a spreadsheet. DNV's assessment and Navigator's responses are also included in this spreadsheet. Review of project design basis/design premise against DNV-RP-F104 requirements from relevant sections.

- Engineering document review

The engineering document review process includes the verification of calculations, if available at the time of the review.

(3) Deliverable: DVRs issued for each Section documents the verification against the relevant section of DNV-RP-F104 and includes the major findings and identifies ongoing design activities that need to be completed to meet the requirements of the relevant sections of DNV-RP-F104, if any.

EXHIBIT
N10

13. Are the verifications completed?

Answer:

- Section 3 was completed on April 26, 2023, a copy of which is provided as Exhibit C.
- Section 4 was completed on May 15, 2023, a copy of which is provided as Exhibit D.
- Section 5 will be completed before June 1, 2023.

14. Please explain the results of the verifications that have been completed.

Answer: DNV finds that Navigator's proposed design concept and premise would result in the NHG pipeline system complying with the requirements of Sections 3 and 4 of DNV-RP-F104, subject to adherence to the applicable codes, standards, specifications, and project specific plans/documents planned to be developed or finalized.

15. Are you familiar with PHMSA's regulation of carbon dioxide pipelines?

Answer: Yes. PHMSA has regulated the transmission of CO2 in dense or supercritical phase as a hazardous liquid in accordance with 49 CFR Part 195 for over 40 years. These are the same rigorous requirements that apply to other hazardous liquids, such as crude oil, anhydrous ammonia, and propane pipelines. The safety performance of CO2 pipelines during this time has been excellent. No CO_2 pipeline leaks or releases have resulted in a fatality, injury to the public, impact to wildlife, or water contamination and only one injury, to a pipeline contractor, has been reported in the past 22 years.[1,2]

[1] PHMSA Pipeline Incident Flagged Files, https://www.phmsa.dot.gov/data-and-statistics/pipeline/pipeline-incident-flagged-files, accessed 5-17-2023

[2] Prior to 2002 injuries were reported as "Bodily harm to any person resulting in one or more of the following: (1) Loss of consciousness, (2) Necessity to carry the person from the scene, (3) Necessity for medical treatment, (4) Disability which prevents the discharge of normal duties or the pursuit of normal activities beyond the day of the

EXHIBIT
N10

16. How does DNV-RP-F104 compare to PHMSA's regulation of pipeline design?

Answer: DNV-RP-F104 was produced specifically for CO2 pipelines. It should be recognized that CO2 pipelines at the scale that are associated with Carbon Capture and Sequestration ("CCS") projects are novel to many countries. The RP provides detailed guidance for locations where the regulatory framework is not as established as in the U.S. DNV-RP-F104 can be considered complimentary to PHMSA regulations, offering detailed guidance for operators during all phases of pipeline design, construction, and operation.

17. Does Navigator's request for the design verifications exceed what PHMSA regulations require with respect to pipeline design?

Answer: Yes. Conformance with DNV-RP-F104 and third party design verification as provided by DNV exceeds PHMSA requirements. In PHMSA's regulatory scheme, PHMSA inspects new pipeline construction, commissioning, and subsequent operations to verify for themselves that regulatory requirements are met. By engaging DNV in design verification, Navigator has taken a proactive approach to compliance by adopting in a verifiable manner the recommended practices contained in DNV-RP-F104 in advance of PHMSA engagement.

18. Does this conclude your testimony?

Answer: Yes.

Dated this 25th day of May, 2023.

/s/John Godfrey
John Godfrey

accident". This definition was replaced by Amdt. 195-75, 67 FR 831 in January 2002 with "Personal injury necessitating hospitalization".

EXHIBIT
N10

EXHIBIT
A

John F. Godfrey
Senior Principal Consultant

Curriculum Vitae:

Personal Statistics:
Citizenship: United States

Language Capabilities:

Language	Level
English	Native

Academic Attainment:
- Bachelor of Science in Engineering with emphasis in Hydraulics and Strength of Materials, University of Illinois, 1987

Present Position:
DNV GL **Sept. 2014 – Present**
Mr. Godfrey is a Senior Principal Consultant with the Integrity Solutions and Compliance department within the Energy Services Group of DNV GL USA, Inc. (DNV) in Columbus, Ohio.

Prior to joining DNV, Mr. Godfrey held various positions in pipeline operations, manufacturing, consulting, and Asset Integrity services. His experience includes Integrity Management Program development and management, regulatory compliance, standards development, pipeline operations, pipeline design and construction, line pipe manufacturing and non-destructive examination. Mr. Godfrey is the past Chairman of the API Pipeline Integrity Committee, past Vice Chair of the PRCI Materials Committee, and previous member of the API Operations Technical Committee.

Mr. Godfrey represents various clients in regulatory proceedings including formal and informal consultations, special permit applications, and hearings before state and federal regulatory agencies.

Mr. Godfrey has provided written and verbal testimony regarding pipeline safety and construction practices before state regulatory agencies, state and federal courts.

Detailed Professional Experience:

SGS Industrial Services, Asset Integrity Management, Bartlesville, OK **April 2012 – Sept. 2014**
Vice President - Operations
Full responsibility for the Asset Integrity Solutions (AIS) division which provides Mechanical Integrity (MI) services in support of Process Safety Management (PSM) implementation for the oil and gas industry in the upstream, mid-stream, downstream, and petrochemical industry. Services provided by AIS include;
- Engineering Fitness for Service, failure analysis and Risk Based Inspection (RBI) services.
- API Certified Inspection of pressure vessels and piping.
- Non-Destructive Examination and Integrity Testing Planning.
- Data Management and Hosting for compliance with PSM requirements.
- Customer and staff training for PSM compliance.

RCP, Inc., Houston, TX **2011 – April 2012**
Executive Consultant
Regulatory and engineering consulting services for the oil and gas pipeline industry. Areas of focus include;
- Process management and procedure development.

EXHIBIT
N10

- Internal and regulatory audit support.
- Integrity Management Program development and review.
- Litigation support and expert witness.
- Merger and acquisition due diligence.

BERG STEEL PIPE CORPORATION, **Panama City, FL** **2009 – 2011**
Vice President of Quality Assurance
Major responsibilities include technical services, material testing, production quality control, and customer service for pipe and coating mills in Panama City, FL and Mobile, AL. Lead a team of professionals responsible for;

- Management of Quality Assurance and API/ ISO certification programs.
- Ensure inventory control, traceability and the investigation and disposition of non-conforming materials in accordance with Company, API, and ISO certified processes.
- Internal audit in support of API, ISO, and Company requirements.
- Technical support, specification review and document preparation in support of raw material procurement and sales.
- Preparation of Manufacturing Procedure Specifications, Integrity Testing Plans and mill instructions in accordance with customer specifications and technical agreements.
- Test laboratory services, material test reports, and product traceability in support of production.

Explorer Pipeline Company, Tulsa, OK **2005 – 2009**
Manager, Asset Integrity
Accountable for the overall management of Explorer Pipeline Company's (EPL) integrity management program including pipeline inspection and remediation efforts. Responsibilities included training of staff and contractors, risk management, pipeline inspection and testing, defect assessment, welding procedures and qualification, root cause failure analysis, corrosion control and fitness-for-service. Work functions included strategic planning, budget development, project management and field implementation. Represented the company during regulatory audits and failure investigations working closely with state and federal agencies to ensure safe pipeline operations.

Colonial Pipeline Company, Alpharetta, GA **2004 – 2005**
Engineering Manager–ULSD Project
Management oversight of all Colonial Pipeline Company's (CPC) engineering functions related to facility upgrades and modifications related to the shipment of Ultra Low Sulfur Diesel fuel. Coordinated with operations to ensure engineering modifications meet or exceed safety goals, regulatory standards, and product quality requirements. Lead a team of internal and contract engineering resources responsible for all standards, designs and specifications for the project.

Colonial Pipeline Company, Alpharetta, GA **1999 - 2004**
Operational Excellence and Asset Integrity Team Leader
Responsible for the development and implementation of the company's Integrity Management Program (IMP) inclusive of line pipe, facilities and tankage. Reporting departments included regulatory compliance, risk management, corrosion control, tank inspection, and line pipe inspection and remediation. Operational excellence responsibilities included the development of safety related processes, failure investigations and management of corrective action order and consent agreement activities resulting from spills and regulatory findings. Lead a team of engineers and professionals with responsibility for procedure development, process mapping, and training of operations and engineering personnel. Represented the company during regulatory audits, failure investigations, and subsequent corrective actions to ensure safe pipeline operations.

EXHIBIT
N10

Colonial Pipeline Company, Linden, NJ **1999**
Operations Manager
Management of petroleum products delivery facility and tank farm operations for Colonial's terminus at Linden, NJ. Duties included performance management of 24 technicians and operators, local customer relations, product quality control, public education, and emergency response. Implemented conduct of operations training and local procedure development in support of company Operational Excellence initiatives.

Colonial Pipeline Company, Various Locations **1987 – 1999**
Project Management and Engineering
Lead a team of project managers and inspectors with responsibility for implementation and management of all construction projects, pipeline maintenance, tank inspection and maintenance, damage prevention, and cathodic protection within Colonial's Southeast District. Field implementation and project management of construction and maintenance projects in North Carolina and Southern Virginia. Mechanical engineering corporate design functions including line pipe, facility piping, hydraulic design, equipment and tank foundations, and storage tank modifications and repairs. Responsible for field engineering support for pipelines, tanks, and facilities located in Delaware, Pennsylvania, New Jersey and New York.

Accomplishments
- Course instructor, Pipeline Safety Management Systems, PPIM – 2015, 2016
- Lead Bergs quality assurance organization in support of start-up and qualification of Berg's new spiral pipe mill in Mobile, AL.
- Integration of EPL's Integrity Management Program into corporate strategic planning and formal work processes.
- Lead all major aspects of Colonial Pipeline's (CPC) integrity program resulting in an unprecedented 4 years as API Distinguished Pipeline of the Year.
- Frequent presenter on MI and regulatory issues at the API Pipeline Conference and PHMSA regulatory workshops. Additional presentations to AGA, NACE and Senior Government Officials.
- Administered the development and implementation of the AOPL Performance Excellence in System Integrity effort resulting in unprecedented industry cooperation.

Investigations and Incident Response
- Variable and low strength pipeline materials root cause analysis and remedial action.
- Major pipeline ruptures and failure root cause analysis and response.
- Tank fires and loss of containment root cause analysis.
- Process equipment failure and subsequent fire investigation.
- Company liaison to DOT PHMSA, EPA, NTSB, DOJ, USCG, OSHA.

Professional Affiliations
- American Petroleum Institute, Pipeline Integrity Committee 2005 – 2009. Past Chairman, 2005 to 2007.
- API/AOPL Performance Excellence Team, 1999 to 2009
- Pipeline Research Council International (PRCI), Vice Chairman of the Materials Committee, 2005
- American Petroleum Institute, Operations Technical Committee balloting representative, 1999 to 2005
- API 1160, Managing System Integrity for Hazardous Liquid Pipelines work group

EXHIBIT
N10

DESIGN VERIFICATION REPORT

DVR: 1896636
Rev.: 0

Particulars of Design

Customer:	Navigator CO2 Ventures LLC (NCO2V)
Location:	Illinois, Iowa, Minnesota, Nebraska, and South Dakota
Asset:	Heartland Greenway System (HGS) CO2 Pipeline

The purpose of the Design Verification Report (DVR) is to provide documentation that objective evidence has been presented to confirm compliance with the requirements and to document the work performed by DNV.

This is to verify that the design philosophy of

Navigator's Heartland Greenway System CO2 pipeline

has been reviewed against the requirements of

Design and Operation of Carbon Dioxide Pipelines (DNV-RP-F104), Section 3 (Safety Philosophy)

The design of the NCO2V Heartland Greenway CO2 pipeline system at the time of this assessment is in the P2 phase, which is the second of four progressive design cycles as defined by NCO2V, namely P1 (30%), P2 (60%), P3 (90%/IFB) and IFC (100%).

DNV-RP-F104 provides a framework for the design, construction and operation of offshore and onshore CO2 pipelines, with a focus on structural assessment and with the aim of obtaining an appropriate and consistent level of safety. Section 3 of the DNV-RP-F104 requires the overall safety philosophy be established, planned and implemented in the concept development, design, construction, operation and for re-qualification of existing pipelines to CO2 pipelines.

DNV finds that NCO2V's proposed safety approach would result in the HGS pipeline system complying with the requirements of Section 3 (Safety Philosophy) of DNV-RP-F104, subject to adherence to the applicable codes, standards, specifications, and project specific plans/documents planned to be developed.

The verification is based on the following

A. Design codes/standards used as references:

1. Design and operation of carbon dioxide pipelines, DNV-RP-F104, 2021

B. Design Specification

Design Codes and Standards	49 CFR 195, ASME B31.4
Pipe Material	API 5L PSL-2
Pipe Grade	X60 M/X65 M
Maximum Operating Pressure (psig)	2,200
Design Temperature (°F)	120
Nominal Pipe Sizes (inch)	6, 8, 12, 16, 20
Proposed D/t for Nominal Pipe Sizes	6-inch: 26.50 8-inch: 31.14 12-inch: 37.06 16-inch: 37.30 20-inch: 37.38
Pipeline System Length (mile)	1350

C. Documents Reviewed

Doc. Type	Doc. Title	Doc. No.	Doc. Rev.	Date
Engineering Specifications	Pipeline Systems Design	NCO2V-ENG-200	A	05/19/2022
	Pipeline Survey	NCO2V-ENG-202	A	12/15/2021
Construction Standards	Facility Construction	NCO2V-CONST-1002	A	08/24/2022
	Pipeline Construction Near High Voltage Power Lines	NCO2V-CONST-2012	A	08/19/2022
	ROW Fencing Installation & Modification	NCO2V-CONST-2013	A	08/26/2022
	Right-of-Way Clean-Up	NCO2V-CONST-2014	A	08/24/2022
	Site Preparation, Excavation, and Backfill	NCO2V-CONST-2015	A	08/26/2022
	Drainage Tile	NCO2V-CONST-2017	A	08/29/2022
Supporting Documents	Bow Tie Analysis Report	10364050-0	0	09/26/2022
	HAZID Report	10364050	1	10/10/2022
	Environmental Construction Guidance	-	-	09/2022
	HGS - PHMSA Meets and Exceeds Summary - Part 195	-	-	-
	HEARTLAND GREENWAY Risk Assessment - Project Execution - P2	-	-	-
	HGS DESIGN BASIS – P2	HGS Design Basis – P2	B	08/24/2022
	Emergency Management System (EMS) Guidance and Framework	HGS-EMS-001	A	09/26/2022
	Heartland Greenway System Guidance Document NCO2V-ENG-HCA High Consequence Areas (HCAs)	NCO2V-ENG-HCA GUIDANCE	A	09/29/2022
	Heartland Greenway System Plume Modeling and Buffer Overview	-	-	-
	Heartland Greenway System Routing Philosophy	HGS Routing Philosophy	B	09/09/2022
	Heartland Greenway System Safety Systems and Considerations (DRAFT)	-	-	-
	HGS Blowdown & Venting Background – P2	HGS Blowdown and Venting	A	11/02/2022
	NCO2V - Plume Modeling	-	-	-
	PHMSA CO2 Incident Data	-	-	10/24/2022

EXHIBIT N10

Doc. Type	Doc. Title	Doc. No.	Doc. Rev.	Date
	Vent Discussion – Process Schematic	-	A	07/22/2022
Documents Taken for Information	Form D1000 - Project Records Mgt Process & Checklist_HGS SP1	-	-	-
	2022 Hazardous Liquids / CO2 HCA Analysis	-	-	08/29/2022
	HCA Impact Summary	-	-	-
	HGS Execution Resources	-	-	11/2022
	SP1 - Bentley - 4 (Topography Heat Map)	-	-	-

D. Comments

- Scope and Limits of Verification:
  - DNV verification is limited to the pipeline components and the booster pumping stations.
  - Scope of the current DVR is verification of Safety Philosophy for CO2 transport pipeline against requirements in Section 3 of DNV RP F104.
- Based on DNV verification, the NCO2V pipeline safety philosophy is in compliance with DNV-RP-F104 safety philosophy. Subsequent phases of the project activities, such as design, construction, operation etc. should conform against the established safety requirements. These activities are considered ongoing.

Issued at Katy, TX on 2023-04-21

for DNV

Mohsen Shavandi
Head of Section
Technical Advisory and Verification

Prepared by:
Vivek Jaiswal
Principal Engineer

EXHIBIT
N10

EXHIBIT
D

DESIGN VERIFICATION REPORT

DVR: 1919587
Rev.: 0

Particulars of Design

Customer:	Navigator CO2 Ventures LLC (NCO2V)
Location:	Illinois, Iowa, Minnesota, Nebraska, and South Dakota
Asset:	Heartland Greenway System (HGS) CO2 Pipeline Phase 1

Navigator CO2 Ventures LLC (NCO2V) has requested DNV GL USA Inc. (DNV) to perform a design verification for NCO2V's proposed Heartland Greenway System (HGS), a 1350-mile CO2 pipeline system spanning five states (Illinois, Iowa, Minnesota, Nebraska, and South Dakota). DNV's overall involvement in the verification of NCO2V's HGS pipeline is detailed in the enclosed document (Doc. No. 1907045).

DNV has developed an industry recommended practice document, DNV-RP-F104 (for CO2 pipelines) and unique elements associated with the transportation of CO2 are addressed within this document. For technical assurance of assets, DNV offers a suite of services, including certification and verification of pipeline systems. The Scope of Work was defined between NCO2V and DNV and includes verification in different stages via a Design Verification Report (DVR). The purpose of the Design Verification Report (DVR) is to provide documentation that objective evidence has been presented, to confirm compliance with the requirements, and to document the work performed by DNV.

This is to verify that the design philosophy of

Navigator's Heartland Greenway System CO2 pipeline

has been reviewed against the requirements of

Design and Operation of Carbon Dioxide Pipelines (DNV-RP-F104), Section 4 (Concept Development and Design Premises)

DNV-RP-F104 provides a framework for the design, construction and operation of offshore and onshore CO2 pipelines, with a focus on structural assessment and with the aim of obtaining an appropriate and consistent level of safety. Section 4 of the DNV-RP-F104 provides a basis for definition of relevant field development characteristics for CO2 pipelines. Further, key issues required for design, construction, operation, and abandonment of CO2 pipeline systems are identified.

The design of the NCO2V Heartland Greenway CO2 pipeline system at the time of this assessment is in the P2 phase, which is the second of four progressive design cycles as defined by NCO2V, namely P1 (30%), P2 (60%), P3 (90%/IFB) and IFC (100%).

DNV finds that NCO2V's proposed design concept and premise would result in the HGS pipeline system complying with the requirements of Section 4 (Concept Development and Design Premises) of DNV-RP-F104, subject to adherence to the applicable codes, standards, specifications, and project specific plans/documents planned to be developed or finalized as noted in Section E of the DVR. Defining the acceptable risk profile is the responsibility of the pipeline operator and DNV did not participate in evaluating the risk profile for the HGS pipeline.

EXHIBIT
N10

The verification is based on the following

A. DNV Scope of Work and Key Activities

The scope of work covered in this DVR is limited to verification of DNV-RP-F104 Section 4 requirements for NCO2V's HGS pipeline. DNV's overall involvement in the verification of NCO2V's HGS pipeline is detailed in the enclosed document (Doc. No. 1907045).

B. Design codes/standards used as references:

1. Design and operation of carbon dioxide pipelines, DNV-RP-F104, 2021

C. Design Specification

Design Codes and Standards	49 CFR 195, ASME B31.4
Pipe Material	API 5L PSL-2
Pipe Grade	X60 M/X65 M
Maximum Operating Pressure (psig)	2,200
Design Temperature (°F)	120
Nominal Pipe Sizes (inch)	6, 8, 12, 16, 20
Proposed D/t for Nominal Pipe Sizes	6-inch: 26.50 8-inch: 31.14 12-inch: 37.06 16-inch: 37.30 20-inch: 37.38
Pipeline System Length (mile)	1350

D. Documents Reviewed

Doc. Type	Doc. Title	Doc. No.	Doc. Rev.	Date
Engineering Specifications	Facility Design - General	NCO2V-ENG-100	A	08/01/2022
	Piping Class Sheet	NCO2V-ENG-101	D	01/20/2023
	Orifice Meters	NCO2V-ENG-103	A	06/07/2022
	Pipeline Systems Design	NCO2V-ENG-200	A	05/19/2022
	Shop Fabricated Pipe Bends	NCO2V-ENG-201	A	08/01/2022
	Pipeline Survey	NCO2V-ENG-202	A	12/15/2021
	I&E General	NCO2V-ENG-300	A	08/01/2022
	Medium Voltage Motors	NCO2V-ENG-301	A	05/02/2022
	PCR Building	NCO2V-ENG-302	A	05/02/2022
	MCC Building	NCO2V-ENG-303	A	05/02/2022
	Medium Voltage Switchgear & Motor Control Center	NCO2V-ENG-304	A	05/02/2022
	Medium Voltage Variable Frequency Drive	NCO2V-ENG-305	A	05/02/2022
	Distribution Transformers	NCO2V-ENG-306	A	05/02/2022
	Valve Specification and Application Guidelines for Dense Phase CO2 Service	NCO2V-ENG-401	A	08/29/2022
	API 610 Centrifugal Pumps	NCO2V-ENG-800	A	08/15/2022
	Packaged Reciprocating Compressors	NCO2V-ENG-801	A	06/07/2022
	Packaged Centrifugal Blowers	NCO2V-ENG-802	A	08/11/2022
	Glycol Dehydration Packages	NCO2V-ENG-803	A	08/11/2022
	Geotechnical Engineering Investigation (For Station)	NCO2V-ENG-910	A	06/07/2022
	Geotechnical Engineering Investigation (For HDD)	NCO2V-ENG-920	A	05/02/2022
Construction Standards	Pipeline Construction	NCO2V-CONST-1001	A	08/26/2022
	Facility Construction	NCO2V-CONST-1002	A	08/24/2022

EXHIBIT N10

Doc. Type	Doc. Title	Doc. No.	Doc. Rev.	Date
	Commissioning of Steel Line Pipe	NCO2V-CONST-1003	A	08/19/2022
	Pressure Testing	NCO2V-CONST-1004	A	08/22/2022
	Pipeline Bending	NCO2V-CONST-2001	A	08/11/2022
	Piping Construction	NCO2V-CONST-2002	A	08/25/2022
	Excavating for Pipelines	NCO2V-CONST-2005	A	08/26/2022
	Mechanical Construction	NCO2V-CONST-2009	A	08/24/2022
	Concrete Construction	NCO2V-CONST-2016	A	08/26/2022
	Drainage Tile	NCO2V-CONST-2017	A	08/29/2022
	Electrical Construction	NCO2V-CONST-3001	A	08/26/2022
Supporting Documents	Environmental Construction Guidance	-	0	09/2022
	HGS DESIGN BASIS – P2	HGS Design Basis – P2	B	08/24/2022
	Heartland Greenway System Routing Philosophy	HGS Routing Philosophy	B	09/09/2022
	Heartland Greenway System Safety Systems and Considerations (DRAFT)	-	0	10/17/2022
	Vent Discussion – Process Schematic	-	A	07/22/2022
Documents Taken for Information	HGS Design Report (without Appendices)	1147-1009	2	01/12/2023
	HGS – CO2 Composition Quality	-	C	02/01/2023
	HCA Impact Summary	-	0	10/17/2022
	HGS Execution Resources	-	-	11/2022
	SP1 - Bentley - 4 (Topography Heat Map)	-	N/A	N/A

E. Comments

- Scope and Limits of Verification:
    - DNV verification is limited to the pipeline components and the booster pumping stations.
    - Scope of the current DVR is verification of Design Concept and Premise for HGS CO2 transport pipeline against requirements in Section 4 of DNV RP F104.
- The design activities related to thermohydraulic analysis, structural analysis, water monitoring, and venting/blowdown procedures are ongoing. Completion of these activities is required to satisfy the requirements of Section 4 DNV-RP-F104. Details related to these activities are listed below:

  Thermohydraulic Analysis

    - Developing the line packing strategy and commissioning plan to smooth out transient/dynamic flow conditions.
    - Finalizing the thermohydraulic analysis to determine the water drop out potential for the following operational modes:
        - Normal operation pressure and temperature envelope.
        - Pipeline shut-in pressure combined with minimum ambient temperature.
        - Pipeline depressurization scenario.
    - Determining the safety factor between the specified maximum allowable water content and the calculated minimum water content that may cause water drop within the operational envelope. A minimum safety factor of 2 is recommended by DNV-RP-F104.
    - Determining the safety factor for pressure during shut-in to minimize the risk of water drop out. NCO2V has committed to a minimum safety factor of 2.

EXHIBIT N10

- Finalizing the dynamic flow and surge analysis for full parameter safety envelope.

Structural Analysis

- Performing the detailed structural analysis for installation, operating, and accidental load conditions.

Monitoring

- Defining the safety integrity level (SIL) for the water monitoring system to ensure sufficient level of reliability

Venting

- Finalizing the venting and blowdown procedures and the associated monitoring instrumentation to prevent solid CO2 formation during venting, operate within set parameter safety envelope, and minimize occupational health and third-party risks

Issued at Katy, TX on 2023-05-15

for DNV

Prepared by:
Vivek Jaiswal
Principal Engineer

Mohsen Shavandi
Head of Section
Technical Advisory and Verification

EXHIBIT
N10

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF SOUTH DAKOTA

o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o

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

o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o

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.

EXHIBIT
N10

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.)

EXHIBIT
N10

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.

EXHIBIT
N10

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

EXHIBIT
N10

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.

EXHIBIT
N10

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?

EXHIBIT
N10

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"

EXHIBIT
N10

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

EXHIBIT
N10