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,

DIRECT TESTIMONY OF STEPHEN LEE

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

Answer: My name is Stephen Lee. My business address is 2626 Cole Avenue, Dallas, Texas 75204.

2. Please state your position with Navigator and provide a description of your responsibilities.

Answer: I am Senior Vice President of Engineering for Navigator Heartland Greenway LLC ("NHG") and its affiliated companies NES II LLC, Navigator CO_2 Ventures LLC, Navigator Carbon Services LLC, and HG Carbon Storage LLC. I am responsible for the safe, reliable, and compliant execution of the NHG capital program. I oversee the engineering, project management, construction, environmental/permitting, and right-of-way function groups that support the capital program.

3. Please describe your educational and professional background.

Answer: I have over 22 years of experience in the PHMSA regulated pipeline industry. I previously served as the Director of Special Projects at Plains All-American Pipeline. I have a

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BS in mechanical engineering from Texas A&M University and an MBA in Global Energy Management from the University of Houston. I am a registered professional engineer in the State of Texas. A copy of my curriculum vitae is attached as Exhibit A.

4. Have you previously submitted testimony in this proceeding in South Dakota?

Answer: No.

5. Please state the subject of your testimony and identify the sections of the application that Navigator has filed with the South Dakota Public Utilities Commission for which you are responsible.

Answer: I will describe Navigator's engineering and construction plans for the Pipeline. This includes describing the design requirements and oversight of the U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration (PHMSA), which has regulatory authority over the pipeline and design, construction, and safety requirements that will apply to the pipeline. I will describe the principal design and safety characteristics of the pipeline; the processes for pipe fabrication, transportation, installation, inspection, and testing; the engineering and construction resources that NHG has contracted with for engineering, design, and installation of the pipeline; the use of union labor for construction; and the process by which the pipeline will safely transmit carbon dioxide. My testimony relates to the following sections of the Application:

Section 2.1—Project Siting

Section 2.2—Route Selection

Section 2.3—Proposed Route

Section 3.0—Design and Engineering

Section 3.1-Technical Specifications and Design Capacity

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Section 4.0 - Construction

Section 5.0 - Operations and Maintenance

Section 5.1 - Decommissioning

Section 6.2 – Geology

Section 7.1 – Population

Section 7.2 - Employment

Section 7.4 - Housing

Section 7.5 - Public Health and Safety

Section 7.7 - Transportation

Section 7.11 - Local Land Values

Section 7.12 - Local Land Use Controls

Section 7.13 - Reducing Negative Impacts on the Community

6. Please describe the Project site in South Dakota.

The proposed Project in South Dakota requires the installation of approximately 111.9 miles of new pipeline in three segments: the Aurora to Hartley lateral, the POET Chancellor lateral, and the POET Hudson lateral. A summary of these laterals is provided in Table 2.1-1 and described in Section 2.1 of the Application. Detailed maps of the Project in South Dakota are provided in Exhibit A to the Application. Exhibit A1 includes maps of the project vicinity.

7. Will Navigator update its exhibits during the course of this proceeding to show any changes to the proposed route?

Answer: Yes.

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8. How did Navigator develop the proposed route?

Answer: As described in Section 2.0 of the Application, our key objective in determining the proposed route of the Pipeline is to minimize the collective impact of the Pipeline along its route. Provided all other things are equal, the most direct route between two points would offer the least impact. However, not all things are equal across a footprint of five states, or even multiple counties as in South Dakota. Positive and negative considerations and constraints such as colocation; avoidance and minimization of contact with populated areas and sensitive environmental resources; geological, topographical and other constructability factors; setbacks from inhabited structures and gathering places; and the other types of features were gathered and weighted in determining a preliminary route, along which a corridor was established (this is further described below). Then, as additional information and details were gathered from specific aerial imagery and Lidar data commissioned by Applicant and accomplished by flyovers along these routes; public informational meetings and other discussions with landowners and local officials; and on-the-ground surveys and inspections, further micro-routing was and will continue to be performed.

We used a third party GIS-based proprietary computer program known as Pivvot. This GIS program provides suitable baseline pipeline routes between two points using and weighting multiple publicly available, purchased and licensed data sets that provide information on engineering, environmental, physical, geotechnical, and land use and ownership, and other geographic and demographic features. Features that were considered in the route development process include, but are not limited to, existing linear infrastructure (i.e. railroads, pipelines, and electric power lines, roads); infrastructure and structures (e.g. buildings, wells, levees,); environmental (i.e. wetlands, waterbodies, protected habitats, floodplains), land use (e.g. land

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cover, conservation easements, land cover, state and national parks, national forests, and wildlife management areas; other federal and state lands; other recreation lands and areas; easements); geological (e.g. slope, topography, depth bedrock, karst, fault lines/areas, landslide potential, peak ground acceleration; mines and mining activity), soils (series, soils categories, prime farmlands, hydric soils, and corrosivity) cultural (cemeteries, national register of historic places); other (e.g. brownfield, superfund, and hazardous waste sites and landfills. Each of the data sets used in the GIS program is weighted, based on whether it represents characteristics desirable for a pipeline route or undesirable characteristics to be avoided. The GIS program also takes into account the objective to minimize the overall length of the route, consistent with consideration of the other criteria and constraints (*i.e.* features to be avoided as described above).

9. In developing the proposed route of the Project in South Dakota, did Applicant consider and evaluate any alternative routes to the route proposed in the Application?

Answer: Navigator did not use a process in which it first expressly identified a set of distinct or largely distinct potential routes for the Pipeline segments and then analyzed the competing routes based on a set of criteria to select the optimal route. The GIS program that I described earlier in this testimony essentially performs this type of analysis by identifying multiple paths from the designated starting points to designated ending points and evaluating them based on the extensive information provided by the data sets, to identify a preferred baseline route. The micro-routing process I described earlier then further evaluates the baseline route for possible alterations and deviations based on additional information such as I described earlier, including information obtained from landowners, surveys, and inspections of individual properties.

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10. Are comments and information obtained from landowners in South Dakota taken into account in developing the route?

Answer: Yes. Specific information from landowners about their property was taken, and continues to be taken, into consideration, such as plans for future development of the property or the presence of conditions within the property that could make it undesirable for pipeline installation.

11. Please describe the federal regulatory oversight of the Pipeline as outlined in Section 3.1 of the Application.

Answer: The design, construction, operation, and maintenance of the Project is regulated by the Pipeline Hazardous Materials Safety Administration (PHMSA), pursuant to federal law and regulation, primarily 49 Code of Federal Regulations (CFR) Part 195. Navigator is committed to designing, building, and operating a safe, reliable, state-of-the-art system. In doing so, Navigator will meet and often exceed federal regulations and industry standards. Exhibit D to the Application provides a summary of measures in 49 CFR Part 195 that NHG is proactively exceeding. PHMSA has the jurisdiction to enforce compliance with the requirements in 49 CFR Part 195 during the design, construction, and operation of the pipeline. Thus, PHMSA has the authority to, and does, perform inspections to ensure ongoing compliance with its regulations by pipeline owners and operators. We have already had meetings with PHMSA regarding the Heartland Greenway and expect PHMSA will perform multiple inspections to document compliance with its regulations and required specifications during the design, material procurement, and installation of the pipeline.

Design requirements are included in Subpart C of Part 195 and address, among other items, requirements related to design temperature, internal and external pressure, external and

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geohazard loads, design and composition of the pipe, and design and location of the isolation valves. Leak detection and internal inspection devices are also covered in Subpart C and are applicable in the design phase of the Project. Construction requirements are included in Subpart D, including requirements governing the transportation of pipe, welding requirements, weld integrity inspection, and installation requirements such as specifications for the location and depth of pipe and the location of valves.

12. Are there other design requirements or recommended practices being used to design a safe and reliable pipeline system?

Answer: NHG will also use several recommended practices identified in DNV-RP-F104 Design and Operations of CO_2 Pipelines (Sep 2021) and portions of 49 CFR Part 192 to enhance the design and public safety of the system. See https: //www.dnv.com/oilgas/download/dnv-rp-f104-design-and-operation-of-carbon-dioxide-pipelines.html

13. Will there be other third-party oversight over installation of the pipeline in South Dakota?

Answer: Yes. NHG will implement a robust third-party inspection program for the pipeline, employing third-party inspectors including utility, welding, coating, safety, agricultural, and environmental inspectors to ensure compliance with applicable specifications, standards, regulatory requirements, and commitments. None of these third-party inspectors will be affiliated with NHG, its affiliates, or the contractors hired to assist with designing and installing the pipeline. In addition, NHG will comply with the inspection protocols the Commission may include in permit conditions.

14. Please describe the principal design characteristics of the pipeline in South Dakota as discussed in Section 3.1 of the Application.

Answer: The pipeline in South Dakota will consist of three segments, the Aurora to Hartley lateral, the POET Chancellor lateral, and the POET Hudson lateral. The Aurora to Hartley lateral will be constructed of 8-inch diameter pipe, and the POET Hudson lateral will be built of 6-inch diameter pipe and the POET Chancellor lateral will be built of 6-inch diameter steel pipe until the junction of the POET Hudson lateral, at which point the volumes from those lines will merge into one 8-inch diameter pipeline. Both the Aurora to Hartley and POET Chancellor lateral (after it connects with POET Hudson) extend into Iowa and connect to each other south of the South Dakota state line and Minnehaha County. Consistent with PHMSA regulations, the Pipeline will have a maximum operations pressure ("MOP") of 2,200 psig, with a normal operational range between 1,300 and 2,100 psig. NHG will determine the metallurgical and dimensional properties of the steel in accordance with PHMSA requirements and will account for all pressure ranges, temperature ranges, and risk for both ductile and brittle facture.

The specific design factors and steel properties for the pipeline in South Dakota include, but are not limited to, high-yield carbon steel with added toughness parameters, maximum operating pressures of 72% specified minimum yield strength (SMYS), isolation valves located at a maximum interval of 20 miles in non-HCAs and 7.5 miles in HCAs, external coating and cathodic protection system to have redundant external corrosion prevention systems, redundant leak detection system, crack arrestors to mitigate future propagation, increased depth of cover to mitigate risk of third-party damage, CO_2 plume dispersion modeling and buffer concentration for initial route alignment and high consequence area determinations, and inlet monitoring devices for CO_2 quality assurance.

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A process flow diagram for the South Dakota segment of the Project is included in Exhibit B to the Application.

15. Will the Pipeline's design characteristics meet or exceed the design requirements in the PHMSA regulations?

Answer: Yes. The pipeline will always meet and often exceed PHMSA design requirements. Some examples of exceedances we are implementing include using increased wall thickness, enhanced API 5L-PSL2 line pipe specifications, redundant leak detection systems, constant materials inspections during the manufacturing process, increased clearance between existing utilities, more frequent isolation and control valves, 100% non-destructive testing of all welds, increased depth of cover from 36" to a minimum of 60", and continuous eight-hour hydrotest at 125% of the MOP.

16. How will the pipeline be tested before operation to verify that it can safely operate at or above its MOP as determined by PHMSA regulations?

Answer: NHG will use eight continuous hours of hydrotest at a pressure of 125% of the maximum operating pressure for each pipeline segment. After a successful hydrotest, a high-resolution internal inspection tool will be used to inspect all mainline and lateral pipe segments.

17. How will NHG ensure that the pipeline is not operated in excess of its MOP?

Answer: NHG will use redundant systems and equipment to ensure that the MOP is not exceeded during operations, including a Supervisory Control and Data Acquisition (SCADA) system with control set points for all compression and pump equipment (located at the capture facilities and booster stations) that are continuously monitored by qualified controllers 24/7/365 so that if any parameter at a set point (i.e., monitored location) detects conditions outside the set tolerance, the system can control the compression and pump equipment to prevent an incident.

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The SCADA system is discussed in Section 5.0 of the Application. There are also local equipment shut-down parameters and set points at the pump and compression stations that are set below the established MOP. Each pipeline segment and facility piping will have independent over-pressure devices that are calibrated to open at a set pressure that is at or below MOP for a controlled release of carbon dioxide to the atmosphere.

18. Are there other ways in which the integrity of the pipeline will be tested before the pipeline is placed in service?

Answer: Yes. The pipeline coating will be examined during handling and installation of the pipe. Non-destructive testing will be performed on all field welds, which greatly exceeds PHMSA's requirement of ten percent. The pipeline will be inspected after installation using a caliper pig to validate that damage did not occur during installation. In-line smart tools will be used to conduct an internal inspection of the pipeline before carbon dioxide is introduced to establish a baseline to monitor for corrosion throughout the operational life of the pipeline. Finally, the pipeline system will be placed into service after a detailed inspection and review, referred to as the Pre-Start Up Safety Review, to verify compliance with applicable regulations, design and construction standards, and operational checklists and management of changes (MOCs). This review is conducted by a team of engineering, operations, environmental health and safety, and regulatory personnel to inspect all field installations, equipment set points, safety and communication devices, operating procedures, compliance records/documents, and local notifications before commissioning.

19. In what form will the pipeline transport carbon dioxide?

Carbon dioxide will be received from customers via carbon-capture equipment installed at each customer's emitting facility. The carbon capture equipment will include dehydration

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equipment to remove water, and cooling and compression equipment that effectively compresses the carbon dioxide gas to convert it to a dense phase to allow for increased transportation efficiency and volume. While these carbon capture systems are not part of the pipeline for which NHG is seeking a permit under SDCL Ch. 49-41B, there will be continuous monitoring of the carbon dioxide stream before it enters the pipeline to ensure that the quality of carbon dioxide meets or exceeds the necessary composition quality to ensure safe and efficient transportation of the carbon dioxide.

20. What may be experienced in the event of a pipeline leak?

Answer: An unintended release of carbon dioxide from the pipeline will not cause long-term environmental consequences and carbon dioxide does not ignite. In the unlikely event of a release, there would be an initial release of energy at the point of failure and a plume of carbon dioxide would enter the atmosphere, undergoing immediate phase change to its gaseous state as it dissipates into the air. Carbon dioxide is non-flammable, colorless, odorless, and heavier than air. The symptoms from exposure depend on a combination of concentrated CO_2 coupled with exposure time and range from no effects, mild to moderate respiratory stimulation to asphyxiation. The natural environment (air, soil, plants) would experience a large drop in temperature in the immediate vicinity of the release and a white plume would be visible as a result of the water vapor in the air cooling rapidly. The carbon dioxide would passively release from the isolated pipeline segment until equalization and would continue to dissipate into the atmosphere. NHG has used several established air dispersion and plume models to evaluate the various concentration levels of CO_2 as a function of both time and distance. These plume models were used to assist in initial routing of the pipeline to further mitigate the risk and impacts to stakeholders.

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21. What steps will be taken to minimize the potential for leaks?

Answer: The pipeline includes many features to prevent or minimize leaks that meet or exceed PHMSA requirements and industry standards; (1) installation of mainline isolation and control valves (MLVs); (2) internal and external corrosion protection equipment and programs; (3) initial and ongoing integrity validation of the pipeline; (4) the installation and use of a state-of-the-art leak detection system; and (5) the use of a SCADA telecommunications network. Third-party damage is a notable threat to pipeline integrity, so the pipeline will be installed at least five feet below ground surface with a 24-inch separation from existing utilities, in excess of PHMSA requirements. Warning tape will be installed 24 inches above the pipeline where conventionally installed to avoid and minimize the potential for unintentional damage. NHG will participate in the 811 Call Before You Dig program and public-awareness programs. Corrosion is also a contributing factor to leaks on pipeline systems, which NHG is mitigating with the quality control monitoring and automatic shut-off capability of the CO_2 stream entering the Pipeline, and the cathodic protection system and routine inspection of the system further discussed in Vidal Rosa's testimony.

22. Please explain how the pipeline is inspected internally after construction.

Answer: As explained in Section 3.1 of the Application, all pipeline segments will allow the passage of internal inspection devices, which are capable of detecting internal and external anomalies in the pipe such as corrosion, dents, deformations, and scratches. Internal inspection of pipelines has been largely responsible for reducing pipeline incident frequencies over the past decade; these inspections are conducted using in-line inspection (ILI) tools often referred to as pigs. Launcher/receiver facilities are designed to launch and receive these internal inspection devices and are located at the capture facilities and generally at interconnection points of pipeline

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segments. Approximately 2-4 acres will be necessary for launcher/receiver facilities at interconnection points for the pipelines, which will be located on and extend adjacent to the pipeline right-of-way (ROW),and will be fenced on permanent easements or land purchased or leased from landowners. Only one of these facilities is proposed on the pipeline system in South Dakota at the interconnection of the POET Chancellor and Hudson laterals in Lincoln County. Inline inspection will occur once at installation after the successful hydrostatic test to establish a baseline and will then be conducted periodically at three- to five-year intervals throughout operation.

23. Please describe the pipeline's leak detection system.

Answer: As discussed in Section 5.0 of the Application, the system will use both continuous and non-continuous monitoring. The non-continuous components will consist of an aerial patrol of the pipeline at a minimum of two times per month and use of an in-line inspection tool to validate pipeline integrity. The continuous components will consist of a variety of compensated mass balance, real time transient model, negative pressure wave, fiber optic sensing cables, and strategically placed carbon dioxide monitoring devices. The compensated mass balance monitors the mass that enters the pipeline to ensure that it is equal to the mass at the delivery facility. The quantitative fiber optic systems will be placed externally to the pipeline and use acoustics to identify third-party activity or the acoustic signature of a CO_2 release. The negative pressure wave technology sends a signal through the product on the inside of the pipeline and measures the return waves in the event of a leak or abnormal operation. The fiber will also detect a drop in temperature, which is indicative of a CO_2 phase change. NHG will use CO_2 and air quality monitors at mainline valve locations and strategic locations along the pipeline system.

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24. Will there be pumping stations on the pipeline?

Answer: Yes. Mainline booster stations are needed in places to ensure that the carbon dioxide is continually transported in the target range of 1,300 – 2,100 psi to remain in a dense phase. There are currently four booster stations anticipated for the pipeline, however none are proposed to be located in South Dakota.

25. Please describe the purpose, operation, and location of mainline valves (MLVs).

Answer: As explained in Sections 3.1 and 5.0 of the Application, NHG will install numerous remote-controlled and automatic MLVs along the pipeline as a safety measure. The MLVs will allow for prompt response and isolation of line segments in the unlikely event of an emergency or other abnormal operating condition. These MLV locations will be approximately 30 feet wide by 70 feet long and located within the permanent easement area. The MLVs will be installed in locations that are accessible to authorized employees, protected from tampering, and consistent with 49 CFR § 195.260. The spacing intervals between the MLVs will be determined in accordance with 49 CFR Part 195 as well as CO_2 dispersion modeling, and will account for HCAs, populated areas, environmentally sensitive areas, and unusually sensitive areas. Spacing will not exceed 20 miles in non-HCA areas and 7.5 miles in HCA areas. The final MLV locations cannot be determined until the final route of the pipeline is determined.

26. Please describe the remote monitoring and control capabilities of the pipeline.

Answer: The SDACA system will be monitored and controlled from an Operations Control Center (OCC) 24/7/365. MLVs, pumps, and compressors will be remote controlled to allow for prompt response and isolation in the event of an abnormal operating condition or emergency. The advanced SCADA system will be used to continuously monitor pressure, temperature, and flow of carbon dioxide in the pipeline. The SCADA system is designed and

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will be installed with back-up power and communication capabilities. The SCADA system will include a subsystem called the Computational Pipeline Monitoring System, which will analyze deviations of flow through the pipeline, improving the ability to identify leaks and other abnormal operating conditions. In addition to remote control, local automated controls and manual overrides will be installed to enable field operators to control and operate the pipeline if remote communication fails.

27. What is multiphase flow and what will Navigator do to prevent it?

Answer: Multiphase flow occurs when both gas and liquid are present in a pipe segment. This could occur if pipe pressure were to drop below its specified MOP. Multiphase flow is not a hazardous condition and does not create a risk of leak or rupture, but it could create operational difficulties in the respective pipe segment. The NHG system will have pressure monitoring devices and pressure control devices that will maintain the minimum pressure to ensure single-phase flow. These devices will actuate or close to ensure the minimum pressure is maintained throughout the system.

28. What other safety features will the pipeline have?

Answer: Navigator will use an AC mitigation system when the pipeline is in the proximity of high-voltage transmission power lines to mitigate any induced AC current on the system. NHG is also in the process of research and development of a unique odorant to further enhance public awareness and leak detection. The NAV911 system we are developing will be an automatic call alert system to a local region in the event of an emergency.

29. Please describe the fabrication process for the pipe.

Answer: Pipe fabrication will occur in accordance with NHG's line pipe and material specifications, applicable PHMSA regulations, and industry standards. Third-party inspection

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will be used at all phases of manufacturing and logistics for quality control and quality assurance to the respective specifications and requirements. Each line pipe joint will undergo a hydrotest at the production facility before coating. The pipe will be externally coated with 14-16 mils fusion-bonded epoxy to protect against corrosion. Coating in a controlled environment, such as a factory, will enhance the efficacy of the coating process. Pipe segments that will be installed via trenchless methods will have an additional 30-50 mils of abrasive resistant outer coating. All field welded pipe joints will utilize non-shielding field-applied two-part epoxy at girth welds. The pipe will be inspected, and integrity tested at the mill where it is fabricated for quality assurance. After delivery, the coating of the pipe will be re-inspected in the field during each phase of installation. Cathodic-protection systems will be installed to prevent external corrosion and preserve the integrity of the system.

30. What measures will you take to prevent damage to pipe segments while in transit and during installation?

Answer: The pipe segments will be transported in accordance with PHMSA regulations and industry standards to their installation locations. There will be several intermodal systems (truck/rail/ship) utilized between the mill and the final installation location of the line pipe and inspection for quality control and quality assurance will occur throughout the process. As noted above, the coating and the pipe will be re-inspected multiple times in the field during installation, including for damage occurring during in transit, for quality assurance purposes.

31. Please describe how the pipeline will be installed.

Answer: As explained in Section 4.0 of the Application, different techniques will be used to install the pipe depending upon site-specific conditions and factors along the route. These techniques include conventional trenching, bore, and horizontal directional drilling ("HDD").

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The primary method used for installation will be conventional installation via open trench at a depth of at least five feet in soil. The line pipe joints (typically 40 to 80-foot lengths) will be welded together by qualified welders into a single pipeline. Non-destructive inspection of every weld will be performed to validate integrity. Upon successful inspection, the pipeline will be lowered into the excavated trench. A separation of approximately two feet will be kept between the pipe and existing infrastructure like district drainage and existing utilities. A separation of at least one foot will be kept between the pipe and existing or planned private drain tile.

Bore and Horizontal Directional Drill (HDD) methods will be utilized when surface disturbance from trenching is not desired or feasible. For example, bore or HDD may be utilized at road crossings, railroad crossings, large waterbodies, or in other sensitive areas or areas with sensitive resources. When the bore method is used the pipe will typically be installed at a depth of at least 10 feet and when HDD is used it will typically be installed at a depth of 25-50 feet or deeper. When these methods are used for installation, additional measures will be taken to protect the pipe, including the application of an abrasion resistant overcoat on top of the fusion-bonded epoxy coat of the pipe. This further protects the integrity of the Pipeline by adding a reinforced coating layer to protect against physical encounters that may occur for pipe installed using these methods.

32. Has NHG retained outside engineering firms to perform or assist in the engineering and design of the pipeline?

Answer: Yes. DNV GL USA ("DNV") and Integrity Solutions Ltd. ("IS") have been retained to assist with the Pipeline design process and to assist with ensuring the safety of the Pipeline. DNV will validate the metallurgical analysis for the line pipe. It will also facilitate hazard identification and risk analysis and conduct a study, using proprietary software, of the

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potential vapor cloud air dispersion for controlled and accidental releases of carbon dioxide from the Pipeline. IS will conduct air dispersion modeling using Areal Locations of Hazardous Atmospheres software for analysis and identification of HCAs crossed by or near the proposed Pipeline route.

Terracon Consultants, Inc. ("Terracon") has been retained to complete a Geological and Geohazard Assessment. Terracon is a leading provider of geotechnical engineering services and will provide professional review of expected geotechnical conditions and geohazard threats crossed by or near the proposed Pipeline route.

LJA Engineering Inc. ("LJA") has been retained to perform detailed engineering design for the Pipeline, including design of the pipe, MLV settings, launcher and receiver assemblies, booster pump facilities, and carbon capture facilities that will feed into the Pipeline. Trimeric Corporation has been retained to work with LJA to finalize the overall engineering related to carbon dioxide capture facilities and to provide additional quality and technical review of LJA-produced engineering packages. Together DNV, IS, LJA and Trimeric Corporation are referred to in the remainder of my testimony as the "Engineering Firms"

33. Please describe the experience and qualifications of each Engineering Firm.

Answer: DNV is an independent expert in assurance and risk management in the pipeline industry. IS is a company with expertise and experience supporting pipeline operators in making more informed integrity management decisions about their pipelines and related assets, based on integrated data analysis. LJA was founded in 1972 and is an experienced and comprehensive full service, multi-disciplinary engineering firm specializing in pipeline and facility design. Trimeric Corporation was founded in 2003 and provides process engineering, chemical engineering,

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research and development, and other specialized technical services to industry and governmental entities.

34. Please describe how Navigator will oversee and manage the work of the Engineering Firms.

Answer: Navigator directly hired fulltime engineers who will manage and accept the engineering design scopes and deliverables associated with each of the Engineering Firms. Current personnel who will be overseeing and managing the Engineering Firms' work include but are not limited to: myself; our Director of Engineering; and our VP of Capital Projects.

35. Please describe Navigator's process for retaining a construction firm to construct and install the pipeline in South Dakota.

Answer: Navigator will retain multiple construction firms to construct the pipeline, which will be done in spreads. Navigator continues to be in discussions with several constructions firms and will select firms for the project when the final design of the system is complete and all material permits necessary for construction are received. Navigator uses a comprehensive pre-evaluation program for contractor selection that considers experience, previous projects in the region, labor and equipment resources, financial strength, safety record, and outstanding litigation, to name a few. An official pre-qualification package will be finalized when all permits and agricultural considerations are identified to ensure that qualified and competent contracts are selected.

36. How will Navigator oversee and supervise the contractors?

Answer: Navigator directly hired fulltime personnel to oversee and manage the construction firms to ensure compliance with all permits and regulations, as well as to ensure implementation of a proactive safety program that is part of the culture of Navigator. Our

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Director of Construction and will be responsible for the performance and compliance of the construction firms. Hundreds of qualified and competent third party inspectors will perform QA/QC of the selected contractor to ensure compliance with all Company specifications, standards, and permit conditions.

37. Will Navigator use union labor for construction and installation of the pipeline in South Dakota?

Answer: Yes. Letters of Intent ("LOI") were executed in February 2022 with the following labor unions for construction and installation of the Pipeline in South Dakota: Laborers' International Union of North America ("LiUNA"); International Union of Operating Engineers ("IUOE"); the International Brotherhood of Teamsters ("IBT"); and United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry ("UA"). The labor unions have established training and competency verifications as well as proven track records for their members to promote the safe and quality installation of the pipeline. NHG is committed to using highly qualified and experienced resources to construct the pipeline. Employing a skilled workforce, including internal resources, consultants, and these labor unions, ensures that the pipeline will be constructed and designed to meet or exceed all applicable standards.

38. How many union workers do you estimate will be involved in construction and installation of the pipeline?

Answer: As discussed in Section 7.2 of the Application, Navigator currently estimates approximately 600 to 1,000 workers on the two construction spreads anticipated for pipeline segments that originate in South Dakota and terminate in Iowa The number present in South Dakota at any given point in time is dependent on the construction schedule, such that fewer

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personnel would be present over a longer period if the spreads are constructed sequentially versus more personnel present for a shorter period if constructed concurrently.

39. Please describe any economic deposits within or affected by the proposed ROW.

Answer: As explained in Section 6.2.3, according to the South Dakota Department of Agriculture and Natural Resources, there are four construction aggregate sites within 0.25 miles of the Project area, one of which will be crossed by the Project. All four, however, are identified as reclaimed, so the Project is not expected to preclude access to mineral resources at these sites. There are no oil and gas wells within 0.25 miles of the Project. Thus, the Project is not expected to impact mineral resources in South Dakota.

40. How are geological hazards identified and addressed in design, construction, and operation of the pipeline?

Answer: A Geohazard Analysis is performed. First, a desktop analysis is performed along the route to understand the geological setting and identify potential hazards including topography (including lidar where available), geology (i.e. mines, slopes, landslides, slough, karst, etc.); earthquake/seismic hazards, mass wasting (movement of rock and soil down slope under the influence of gravity), flooding and high groundwater areas, stream channel migration and avulsion hazards, surface erosion, subsurface erosion and sinkhole development, karstic formations and proximity to subsurface mines, soil types (soil bearing pressure) and liquefaction risk, and frost lines and water table depths. The results of the study will lead to recommendation of hazard avoidance and mitigation along the route.

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41. Is seismicity or soil liquefaction expected to be a concern along the route in South Dakota?

Answer: No. According to the USGS Seismic Hazards maps, the Project is located in an area of low seismic probability, and there are no faults within 100 miles of the Project area. Therefore, seismicity is not anticipated to be a concern but will be further evaluated by the third party geohazard evaluation. Because of the low probability of seismic activity, soil liquefaction, which is a condition that typically occurs when loose, saturated soil is subject to a seismic event, is therefore also unlikely. More detail is contained in Section 6.2.2 of the Application.

42. Is Karst geology or landslides expected to be a concern along the route in South Dakota?

Answer: Karst terrain occurs in approximately 15.58 miles of the Project ROW in South Dakota; this terrain is more susceptible to subsidence. Only one geologic formation within the Project ROW, Pierre Shale, which is crossed by approximately 8.32 miles of the Project ROW in South Dakota, is susceptible to landslides. Areas most susceptible to landslides are those with steep slopes that are cleared of vegetation during construction. To minimize the risk of landslides during construction, Navigator will use the erosion and sediment control devices in these areas. Upon receipt of the formal Geohazard Analysis and recommendations from Terracon, Navigator will implement additional mitigation measures in regard to Karst and landslides to protect the system throughout its existence.

43. What impacts do you expect to local housing during construction?

Answer: As explained in Section 7.4 of the Application, NHG expects that most non-local Project workers will use temporary housing, like rental units, hotels, motels, campgrounds, and recreational-vehicle parks. In the counties crossed by the Project route, there are

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approximately 2,500 available rental units, 4,700 motel rooms, and 54 recreational vehicle parks within approximately 10-40 miles of the pipeline ROW. During construction which is anticipated between Q2 2024 and Q1 2025, NHG estimates that there will be approximately 1,000 pipeline construction personnel located in South Dakota at peak times. NHG expects that most of these temporary workers will seek housing in the more populated, service-oriented towns located within a reasonable commuting distance to the Project worksite. Navigator does not anticipate any man camps or temporary housing exclusively for construction of the pipeline to be in South Dakota.

44. What impacts do you expect to public health and safety during construction?

Answer: As discussed in Section 7.4 of the Application, with respect to health facilities, Navigator is committed to protecting the health and safety of construction workers and anticipates that any health-care needs during construction can be met by local healthcare facilities. The construction contractors will have health and safety plans in place prior to mobilizing, these plans include communication and coordination with local healthcare facilities. Because there are only a few permanent employees required for operations in South Dakota, there should be no effect on health services and facilities during operation of the Pipeline. With respect to energy use, construction needs can be provided through existing facilities. Navigator is working with local electric providers to provide power for the capture facilities and will enter in appropriate agreements to ensure that safe and reliable power is provided without any negative consequences for the grid. With respect to sewage and water, existing and portable facilities should be adequate during construction, and no effects during operation are anticipated. With respect to solid waste management, during construction there will be non-hazardous pipeline construction wastes including human waste, general refuse, pipe banding and spacers,

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waste from coating products, welding roads and blast media, timber skids, cleared vegetation, and other miscellaneous construction debris. Trash will be removed from the construction ROW daily. Vegetation, rock, and other natural debris will be removed by the completion of clean up. All waste materials are expected be disposed of at local licensed waste disposal facilities. All HDD cuttings and drilling mud will be disposed of as required by applicable regulations. Human waste will be handled and disposed of through portable self-contained facilities. All petroleum products, oil, grease, and other solvents will be disposed of as required by state and federal regulations. There should be no significant impacts to solid waste management during construction or operation.

With respect to fire protection and law enforcement, local law enforcement agencies should have adequate officers to accommodate the construction workers. Throughout operations, Navigator will work with local law enforcement, fire departments, and emergency medical services to plan, coordinate, and implement effective emergency response. Navigator will maintain emergency response equipment and personnel at strategic points along the Project ROW and train and coordinate with local emergency responders to respond to any pipeline-related problems. After construction and throughout operation of the Pipeline, Navigator will conduct and host emergency response drills with its employees and local emergency responders.

45. What impacts do you expect to transportation?

Answer: A discussed in Section 7.4 of the Application, Navigator will work with state and local agencies, including county highway superintendents, county and local road managers, to establish transportation routes and to enter into road use agreements. Navigator will obtain any necessary permits to use state and local roads and has already initiated contacts with permitting authorities to establish timelines for road permit approvals. As required by SDCL §

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49-41B-38, Navigator will post a road bond with the Commission to ensure that roads are returned to their preconstruction condition. During construction, traffic on highways and secondary roads will increase. Hauling pipe and most construction equipment will fall within existing state road and bridge weight limits, but Navigator will obtain any necessary temporary permits for heavier loads if needed. Navigator will repair any damage to roads and reach agreements with state and local authorities to establish a process to restore roads to their preconstruction condition.

46. Please describe the impact of the Project on local land values.

Answer: As discussed in Section 7.11, we are seeking non-exclusive easements for the project are based on a 50-foot permanent right of way and are limited to one pipeline for transporting CO_2. They prohibit a landowner from impounding water, establishing mature trees, and building a structure on the easement area, but they do not prevent growing crops, pasturing cattle, or other normal farming practices. Because the pipe will be under five feet of cover and normal farming practices are not restricted after construction, Navigator anticipates no decrease in property values as a result of the easement. Navigator commissioned a detailed HGPS-specific market study that analyzed local property values based on a multitude of factors to guide the base offers for easements and other land rights. The market study reflected that property values in predominantly agricultural areas are not usually affected by the installation or presence of a pipeline. Navigator is contractually obligated to repair any damage to land or property resulting from construction, and will pay damages for crop loss and the inability to use or limitations imposed on pasture during construction. Navigator will restore or compensate landowners for damage or disturbance to land and will repair or replace drain tile, irrigation systems, fences, and other damages resulting from construction and installation of the Pipeline.

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47. Please describe the ways in which Navigator works with landowners during all phases of the Project.

Answer: Navigator engaged landowners along the Aurora corridor directly through mailings describing the project and public meetings held in Flandreau, Garretson, and Brookings, and a virtual meeting in January 2022. Starting in January 2022, our agents also attempted to directly contact each landowner along the proposed Aurora route to discuss our need for access to lands for surveys and to gather specific information from each landowner and their property, and to answer landowners questions about the Project. Agents began reaching out to landowners along the POET routes in June 2022 after those facilities and laterals were added to the Project. Additional virtual meetings were held in September 2022 to include the added POET laterals, but also to provide a project update to all potentially affected landowners in South Dakota. Invitations to these meetings were sent to all landowners within the one-mile corridor prescribed by SDCL § 49-41B-5.2. At the informational meetings, Navigator provided technical and general information about the company and the project and had subject matter experts available to answer questions from the participants. Land agents began contacting all potentially affected landowners in South Dakota in July 2022 to further discuss easements, construction, reclamation, crop yields, pasture or range concerns, and other information specific to each landowner and the property, and they continue to answer questions landowners may have. Navigator will maintain contact with landowners throughout construction, will provide each landowner and local jurisdiction with access to company representatives to address issues or questions that arise during operation of the Pipeline, and will cooperate with a public liaison officer that may be appointed by the Commission as a condition of permitting the Pipeline.

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48. How will the Pipeline be decommissioned?

Answer: If and when decommissioning is necessary, it will be done pursuant to applicable federal and state laws at the time of decommissioning.

49. Does this conclude your direct testimony?

Answer: Yes.

Dated this 26th day of September, 2022.

/s/Stephen Lee
Stephen Lee

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STEPHEN LEE, P.E.

Executive Vice President, Engineering and Construction

Navigator CO_2

PROFILE

As EVP of Engineering, Stephen is responsible for the safe, reliable, compliant execution of the NCO2V Capital Program. Responsibilities include engineering, project management, construction, environmental and permitting, and right-of-way acquisition.

CONTACT

WEBSITE:
navigatorco2.com

EMAIL:
SLee@navco2.com

WORK EXPERIENCE

Navigator, **SVP/EVP, Engineering and Construction**
[2019-current]
Serves as the head of the Engineering and Construction department for two of the Navigator companies, Glass Mountain Pipeline companies (Oklahoma and Texas crude pipelines) 2019-currrent, and Navigator CO2, 2020-current

Plains All-American Pipeline, **Director of Special Projects**
[2012-2017]
Oversaw and managed a large capital project portfolio associated with intermodal transportation and storage of crude in the Gulf Coast and Midcontinent regions. Project Leader for the $923MM Diamond Project, approximately 450 miles of 20" pipeline and four facilities, with oversight and direction of entire project

Southern Union - FGT, **Project Manager**
[2009-2012]
Directly managed capital and pipeline operations projects for the Southeast Division. Includes integrity validations, greenfield and brownfield installations, and compliance auditing

EDUCATION

University of Houston
M.B.A., Global Energy Management – May 2013

Texas A&M University
Bachelor of Science, Mechanical Engineering – May 2001

CAREER HIGHLIGHTS & CERTIFICATIONS

- NBE Borger Express ($224MM) – 193 mi of 16" [2019 – Present]
- Diamond Pipeline ($923MM) – 450 mi of 20" and Facilities [2012-2017]
- FGT AMAOP Uprate – 742 mi of 36" integrity validation and uprate for 80% SMYS [2009-2012]
- Registered Professional Engineer, State of Texas

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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,

SUPPLEMENTAL DIRECT TESTIMONY OF STEPHEN LEE

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

Answer: My name is Stephen Lee. My business address is 2626 Cole Avenue, Dallas, Texas.

2. Have you previously provided testimony in this proceeding?

Answer: Yes, I submitted prefiled testimony dated September 26, 2022. This supplemental testimony provides updated information on some of the subjects covered in my previous testimony, addresses some issues raised during discovery, and adopts portions of David Giles's prefiled testimony as explained below.

3. Have the route maps been updated since they were submitted with the Application?

Answer: Yes. The process of refining the route is ongoing based on survey results and consultation with landowners. To date, route changes have been minor, without affecting any new landowners. They have been based on landowner preferences and/or constructability factors. Updated route maps are attached as Exhibit B to Brandi Naughton's Supplemental

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Testimony. Route maps that are current as of the deadline for filing hearing exhibits will also be filed as a hearing exhibit.

4. Has Navigator determined the number and location of access roads needed during construction of the pipeline?

Answer: The process is ongoing based on survey work, but Navigator has identified approximately 14 temporary access roads planned for use during construction. Navigator expects to obtain necessary access roads by voluntary agreement and is not aware of any locations where that may be problematic. Navigator will provide further evidence on the number and location of access roads before the hearing.

5. Has Navigator completed the formal Geohazard Analysis discussed in paragraph 42 of your direct testimony?

Answer: Navigator retained Terracon to provide an overview of the expected geotechnical conditions along and in proximity to the route using publicly available data and in-house database information. Terracon completed a Phase I Geological and Geohazard Desktop Study Report that was previously provided to Staff in discovery. Terracon will also complete a Phase II study using field verification and additional due diligence, which may include site-specific assessments documented by geotechnical observations, field notes, photographs, measures, and GPS location of features at areas of interest identified in the Phase I report. Based on the information gathered during the Phase II study, Navigator will identify areas of potential risk for geohazards and develop appropriate risk-mitigation measures. This work should be completed by the end of Q1 2024. Where there may be a risk of landslides during construction, Navigator will use the erosion and sediment control devices in these areas. If landslide prone areas

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are identified during the Phase II study, mitigation measures could include, but are not limited to, a change in construction methodology to an HDD or avoidance of the area.

6. Has Navigator identified the location of mainline valves?

Answer: Determining the number and location of mainline valves is an iterative process. Navigator has determined the preliminary placement of mainline valves and shared their location with Commission Staff through discovery. There are currently 18 mainline valves in South Dakota, all of which will be remotely operated. Additional valve placement may occur as a result of Emergency Flow Restrict Device analysis, and additional review of HCA and ESA analysis as a result of additional survey work. The spacing of mainline valves is determined based on 49 CFR Par 195, CO2 dispersion modeling, and will account for HCAs, populated areas, ESAs, and unusually sensitive areas. Landowner negotiations may also affect the placement of mainline valves. If a landowner has concerns about placement of a mainline valve, Navigator will work that landowner and adjacent landowners to find an appropriate location.

7. Will the pipeline have pressure release valves?

Answer: Yes. They will be located at booster stations and launcher/receiver sites. They act as a secondary measure of protection. The primary safety for pressure is automated controls for the compression equipment that will shut down the equipment in case of abnormal operations. A pressure release valve would only release CO2 if pressure exceeded the defined maximum operating limit, and a release would be limited to the volume necessary to return pressure to below the defined maximum limit, which would be limited to several seconds and a temporary release of negligible volume.

8. Please describe the carbon dioxide monitoring devices mentioned in Paragraph 23 of your direct testimony.

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Answer: These devices would be redundant systems to offer increased reliability in leak detection. They would be located on the pipeline system at above-ground facilities, which in South Dakota includes mainline valve sites. They would be connected to the pipeline SCADA system and alert the OCC in the event CO2 is detected in the atmosphere above ambient/present threshold in the vicinity of the device's location. This sensor technology is similar to a 5-gas monitor for personal protection, which Navigator will also employ for mobile use.

9. Are you adopting part of the previously submitted prefiled testimony of David Giles?

Answer: Yes. David Giles's wife recently passed away and he is unable to travel due to family obligations, so he is unable to attend the evidentiary hearing scheduled in this docket.

10. Which portions are you adopting?

Answer: I have sufficient knowledge of and sufficient education, training, and experience to testify to the following subjects from Giles's prefiled testimony:

- Paragraph 10—the purpose and need for the Project;
- Paragraph 11—an overview of the Pipeline in South Dakota;
- Paragraph 12—demand for the Project;
- Paragraph 13—permits being sought from other state siting authorities;
- Paragraph 19—the Project schedule;
- Paragraph 20—expansion opportunities.

I adopt these questions and answers from Giles's prefiled testimony as my own and will be able to answer questions about these subjects at the evidentiary hearing.

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11. Does this conclude your supplemental testimony?

Answer: Yes.

Dated this 25th day of May, 2023.

/s/Stephen Lee
Stephen Lee

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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 STEPHEN LEE

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1. Please state your name, business address, and present position.

Answer: My name is Stephen Lee. My business address is 2626 Cole Avenue, Dallas, Texas. I am Senior Vice President of Engineering for Navigator Heartland Greenway LLC.

2. Have you previously submitted testimony in this proceeding?

Answer: Yes. I submitted testimony with the Application on September 26, 2022, and Supplemental Testimony on May 25, 2023.

3. To whose testimony are you responding in rebuttal?

Answer: I am responding to the testimony of Richard Kuprewicz, Bill Caram, Dr. John Abraham, William Byrd, Sara Throndson, Matthew Frazell, and Jon Thurber.

4. Do you have any general comment on Mr. Kuprewicz's experience with respect to carbon dioxide transportation pipelines?

Answer: Yes. Based on his experience summarized in his resume, Mr. Kuprewicz apparently has been involved in a number of pipeline-related cases, matters, and investigations, but very few if any relating specifically to carbon dioxide transportation pipelines. His most

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directly relevant experience with respect to carbon dioxide handling and transportation may have been as a Hydrocracker Complex Supervisor at Arco Products refineries from 1973 to 1977.

5. In the paper he wrote for the Pipeline Safety Trust, which is attached to his testimony as Attachment 2, Mr. Kuprewicz says that because of the construction of CO2 pipelines, PHMSA "would be faced with the greatest and fastest pipeline expansion in the history of the U.S. pipeline industry, and many of these pipelines could threaten the safety of countless individuals and communities." Do you agree?

Answer: No. First, the development of shale oil recovery and "fracking" techniques in the last decade resulted in the expansion and development of crude oil, natural gas, and natural gas liquids production areas in the U.S., with corresponding development of many new pipelines to serve the production areas. Second, the article provides no data or other specifics to support the conclusion that many carbon dioxide pipelines could threaten the safety of countless individuals and communities. This broad generalization is not only unsupported, but at odds with available public data from PHMSA establishing that pipelines remain a safe way to transport hazardous materials. Vidal Rosa (who has submitted prefiled testimony for Navigator) and I have explained in our testimonies how the Navigator Heartland Greenway Pipeline will be engineered, designed, fabricated, constructed, inspected, tested, operated, and maintained in a safe manner while meeting or exceeding federal pipeline safety requirements. Mr. Kuprewicz's testimony does not address any specific facts about the design, construction, or operation of the Navigator Heartland Greenway Pipeline or the many ways that Navigator will exceed PHMSA's regulatory requirements with respect to this project.

6. Mr. Kuprewicz says in the paper that PHMSA currently has no regulations applicable to pipelines transporting CO2 as a gas, liquid, or in a supercritical state at

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concentrations of CO2 less than 90%, which creates a regulatory gap. Do you agree that this is a concern with respect to the proposed Navigator Heartland Greenway pipeline?

Answer: No. The carbon dioxide in the pipeline will be compressed to a supercritical state, but will not be maintained in a supercritical state for the entire transport to the sequestration cite. Because the CO2 will be transported, at least part of the time, in a supercritical state, the pipeline falls within PHMSA's jurisdiction. PHMSA has publicly confirmed this, as stated in paragraph 15 of Mark Hereth's prefiled testimony. I attended PHMSA public meetings held on December 13, 14, and 15, 2022, and on May 31-June 1, 2023 at which PHMSA representatives discussed PHMSA' regulatory authority over pipelines transporting carbon dioxide in liquid, supercritical, and dual phase flow. PHMSA has also confirmed regulatory jurisdiction in their clarification to the Illinois Commerce Commission staff member Mark Maple on May 1, 2023 from Tewabe Asebe (attached as Exhibit A).

As Mr. Kuprewicz states on page 1 of his paper, the United States currently has over 5,000 miles of carbon dioxide transmission pipelines, which is the most carbon dioxide transmission pipeline mileage of any country. PHMSA and its predecessor agency the Office of Pipeline Safety in the USDOT have had safety regulation authority over carbon dioxide transportation by pipeline for more than 30 years.

PHMSA's regulations provide specific safe harbor requirements for the design, installation, and operation and other aspects of a pipeline transporting carbon dioxide. This is especially important for the operator of an interstate, multi-state pipeline such as Navigator, which would want to be subject to and comply with a single set of federal regulations rather than multiple sets of potentially inconsistent and conflicting state regulations.

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As a practical matter, and in the real world, PHMSA is already actively engaged with Navigator and other industry organizations (like the American Petroleum Institute, Pipeline Research Council International, and Pipeline Safety Trust) with respect to the safety requirements for the proposed pipeline, including design and engineering plans and specifications, fabrication and installation requirements, geological hazard evaluations, maximum pressure specifications, public education and awareness programs, emergency response, High Consequence Areas on the pipeline route, and other topics. Navigator has been meeting with PHMSA at least quarterly since January 2022 to inform PHMSA of its project development progress and discuss compliance with PHMSA's regulations, including those pertaining to safety. PHMSA will be further involved in detailed reviews of the project's design specifications, plans, procedures, and other material that may be requested; as Navigator's pipeline design and construction cost exceeds $2.5billion, Navigator will enter into a Master Agreement with PHMSA for payment of a design review fee under 49 C.F.R. Part 190 Subpart E, Cost Recovery for Design Reviews.

Moreover, as stated in the Application, Navigator has committed to meeting or exceeding PHMSA's pipeline safety requirements.

7. On page 5 of his paper discussing transporting CO2 in a supercritical state, Mr. Kuprewicz states that "a clever pipeline operator could employ loopholes to avoid pipeline safety oversight by PHMSA." Is this Navigator's intention?

Answer: No. I am not aware of any case in which a carbon dioxide transportation pipeline operator attempted to avoid PHMSA regulation, or in which PHMSA disclaimed safety jurisdiction or authority over an interstate carbon dioxide transportation pipeline transporting carbon dioxide in a fluid or dense phase. As indicated, Navigator knows that PHMSA has

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regulatory oversight of the Navigator Heartland Greenway Pipeline, is working with PHMSA, and will in many cases exceed PHMSA's requirements.

8. Mr. Kuprewicz states on page 6 of his paper that a carbon dioxide pipeline operating in a supercritical state can be more prone to pipe running ductile fractures than hazardous liquids or natural gas pipelines. Attachment 2 to Bill Caram's testimony raises the same issue. Do you agree?

Answer: No. Mr. Kuprewicz cites no data on how frequently or how many times carbon dioxide pipelines have experienced ductile fractures in 30 years under federal safety regulation, nor any specific instances of such occurrences. Navigator's pipe specification is being developed with the assistance of third-party subject matter experts (specifically, DNV GL USA) to mitigate ductile fracture propagation. As verified by DNV in its third Design Verification Report dated June 2, 2023, and attached as Exhibit B, addressing materials and pipeline design, the engineering specifications for the pipeline include steps to mitigate ductile fracture propagation, including sections or areas of pipeline of more conservative design factors including locations of bores, horizontal directional drills, valves and crack arrestors as warranted to further design and implement redundant fracture control mitigation systems. The redundant utilization of crack arrestors located through the pipeline systems will serve to further mitigate ductile fracture propagation in natural gas, hazardous liquids, and CO2 pipeline systems. These design specifications address the concern in Attachment 2 to Bill Caram's testimony about fracture toughness and steel pipe quality.

9. On page 10 of his paper, Mr. Kuprewicz states that a CO2 pipeline's impact area, if there is a release, may be measured in miles and not feet. What is your response?

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Answer: Mr. Kuprewicz does not explain what volume or concentration percentage of carbon dioxide or amount of time following a release would be required to produce an impact miles from the location of the release. He also states that carbon dioxide may not disperse quickly and gives several reasons why this may be the case, but he fails to identify other factors that could result in rapid dispersal, such as wind speed and atmospheric instability. Further, in asserting that federal pipeline regulations do not require that pipeline operators adequately address this risk, he ignores 49 C.F.R. § 195.452 as well as the use of plume modeling as a tool to assess the risk he refers to.

While plume modeling is not required by federal regulation, it is part of Navigator's design and routing analyses and assessments to achieve compliance with 49 C.F.R. § 195.210, which specifies that "Pipeline right-of-way must be selected to avoid, as far as practicable, areas containing private dwellings, industrial buildings, and places of assembly," and that "No pipeline may be located within 50 feet (15 meters) of any private dwelling, or any industrial building or place of public assembly in which persons work, congregate, or assemble, unless it is provided with at least 12 inches (305 millimeters) of cover in addition to that prescribed in § 195.248." The cover requirements specified in § 195.248, and the depths at which navigator will bury the pipeline, are stated in the Application and exceed these requirements. Navigator is using plume modeling to identify buffer zones where applicable that exceed the Part 195 requirements as well as maintain at least 60 inches (5 feet) of cover over the pipeline. While Mr. Kuprewicz states on page 8 of his paper that a release from a carbon dioxide pipeline may potentially increase the "affected" or "potential impact" area and recommends that PHMSA should identify in regulations the potential impact areas of carbon dioxide pipeline ruptures (page 12), he does not

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recognize the use of plume modeling to identify the area that may be impacted by a postulated release.

"PIR" is defined in the PHMSA regulations pertaining to integrity management for gas transmission pipelines as "the radius of a circle within which the potential failure of a pipeline could have significant impact on people or property." 49 C.F.R. § 192.903. This regulation also provides the formula for calculating PIR, which NHG used the concept and basis of PIR in its analyses to evaluate the potential impact buffer. Although "PIR" appears specifically in the PHMSA integrity management regulations pertaining to gas transmission pipelines, I believe the PIR concept is also useful for a risk assessment of a carbon dioxide transportation pipeline.

10. Dr. John Abraham states in his testimony that PHAST modeling is not the gold standard, is unreliable, and should not be relied upon for risk assessments. Do you agree?

Answer: No. There are a number of different models that Navigator considered as part of its risk assessment, and it used ALOHA modeling and retained DNV to conduct PHAST modeling. As explained by John Godfrey of DNV, the use of PHAST modeling is reasonable and appropriate for the scale and design of the Navigator Heartland Greenway Pipeline. The PHAST model utilized for Heartland Greenway was post DNV's Spadaem planned release utilized to update the model software from real world research data collected and outlined in the *COSHER JIP: Large scale pipeline rupture tests to study CO2 release and dispersion.*

11. Mr. Kuprewicz addresses impurities in carbon dioxide on pages 10-12 of his paper, and specifically discusses water and hydrogen sulfide, or H_2S. Will these impurities be found in the carbon dioxide being shipped from ethanol plants in South Dakota?

Answer: As addressed in the Application, the carbon dioxide shipped on the Navigator Heartland Greenway Pipeline will come from high purity sources. The carbon dioxide stream

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entering the system at the ethanol and fertilizer facilities who will be Navigator's customers will meet the CO2 quality specifications required in the shipper agreements and be of a very high purity level, above 98% carbon dioxide, which is one of the reasons the carbon dioxide produced by ethanol and fertilizer facilities is an excellent candidate for capture, transportation, and sequestration. As discussed in the application, we have measures in place to ensure specifications are met or the product will not be allowed to enter the system. Further, there is no source from which H_2S could be introduced into the pipeline. In his paper, Mr. Kuprewicz states that "[t]here are some very pure sources of CO2 emitters, such as ethanol plants and some hydrogen reformers, that emit very high concentrations of CO2 to the atmosphere that require very little, if any, impurity treatment to prepare for pipeline transportation for CCS." I agree with that.

12. Attachment 2 to the testimony of Bill Caram discussed the Denbury carbon dioxide pipeline rupture and carbon dioxide release occurring near Satartia, Mississippi in February 2020 and PHMSA's subsequent investigation report. Are you familiar with the incident and PHMSA's report?

Answer: Yes. I and my colleagues in the design, construction, and operations functions at Navigator, and our engineering and design consultants, are familiar with this report and the underlying incident.

13. What do you understand to have been the principal cause of this incident?

Answer: Per PHMSA's incident report 20-176125 dated May 26, 2022, a landslide or mudslide of soil that had become saturated due to substantial precipitation over an extended period of time, resulting in the collapse of ground supporting the pipeline, placed excessive stress on the pipeline and resulted in an unplanned release of carbon dioxide into the atmosphere. The

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risk of this geohazard and sufficient emergency response training and awareness per 49 CFR 195.403 may not have been adequately considered and addressed in the operator's integrity management plan and procedures. In addition, it appears that although the pipeline operator learned of the leak soon after it occurred, the pipeline operator did not promptly notify local emergency medical services ("EMS"), emergency response units and authority, other first responders, and local authorities in the area, of the carbon dioxide release; as a result, there was confusion and lack of information for first responders as to what had been discharged and its source.

14. What lessons has Navigator taken from the Denbury Pipeline incident in designing and constructing the Navigator Heartland Greenway Pipeline?

Answer: Navigator has proactively addressed the failures related to the Denbury incident in its design and operation of the Navigator Heartland Greenway Pipeline. Recognizing the physical cause of the Denbury Pipeline rupture, and as a matter of sound engineering practices, Navigator has retained Terracon Consultants, Inc., a leading provider of geotechnical engineering services, to complete a Geohazard Assessment Study for the pipeline route, as described in discovery responses and my supplemental testimony, that will identify areas of risk due to geologic conditions that we will account for. DNV, which is one of the engineering firms that was retained to perform forensic analysis of the weld failure on the Denbury pipeline, has been retained by Navigator to assist with pipeline design and to verify Navigator's compliance with its standard for Design and Operation of Carbon Dioxide Pipelines (DNV-RP-F104), also as described in my supplemental testimony. DNV has validated the metallurgical analysis for the line pipe and has facilitated hazard identification and risk analysis, including studying the

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potential vapor cloud air dispersion for controlled and accidental releases of carbon dioxide from the pipeline.

In addition, Navigator has focused on the need for systems and procedures to recognize a release and notify appropriate EMS, emergency management, other first responders, and other local government personnel as early as possible. In addition to development of a NAV-911 system and researching a unique odorant for the carbon dioxide being transported in the pipeline, which have been previously described in testimony, Navigator may install fiber optic sensing cables along the pipeline that can detect the acoustical signal of a leak and also detect temperature drops which may indicate a leak, and that will thereby enable the fiber optic sensing cables to identify the location of the leak so that the pipeline segment can be isolated. The fiber optic sensing cables will enable quicker and more precise identification of any leak, so that first responders, other local authorities, and the public can be notified more quickly. This is one technology that could be utilized in a comprehensive and redundant leak detection system with other proven leak detection technologies (computational pipeline monitoring, negative pressure wave, control room management, etc.) working together in order to identify an unplanned release.

15. In his testimony for PUC Staff, William Byrd, P.E., recommends that the Commission require Navigator to use inspectors during construction with API 1169 certification (p. 5 lines 41-42). Do you agree with this recommendation?

Answer: We are evaluating the requirement for inspectors to be API 1169 certified. API1169 is one of several methods for validating competency associated with the quality assurance of construction methods being adhered to in pipeline installation. There are new construction operator qualifications through ISNeworld and Veriforce, experience and standards

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verification through company exams, etc. Navigator utilizes a combination of several parameters to ensure there are competent inspectors performing quality assurance of the installation.

16. Mr. Byrd also suggests that Navigator's pipeline design may include too many valves, and that other forms of risk management are more cost-effective than extra automated valves, so that valve spacing should comply with 49 CFR § 195.260(c) rather than (g) (p. 9 lines 9-25). Mr. Byrd nevertheless concludes that Navigator's proposed valve spacing "seems to be more than adequate" (p. 9 lines 22-23). Please comment on Navigator's valve placement with respect to 49 CFR Part 195 and Mr. Byrd's comments.

Answer: The valve maps filed were baseline maps subject to change as we complete additional analyses. Throughout the application we discuss the various factors we use for risk mitigation and are not relying on any one factor; valves are one of those factors.

17. Mr. Byrd discusses the potential for a CO2 release from the pipeline to affect a High Consequence Area in South Dakota and states that to his knowledge, site-specific dispersion and overland flow modeling has not been done to determine which segments of the pipeline could affect an HCA (p. 8 lines 2-9). Please comment on this.

Answer: The updated HCA map provided in response to Staff's DR 2-10a depicts the current status of our HCA analysis, which is still in development as we are performing an EFRD analysis per Appendix C to Part 195. This is a continual process from input from stakeholders and ongoing integrity assessments of the pipeline. This is a component of the overall Integrity Management Plan. Mr. Byrd acknowledges the limitations and purpose of site-specific and overland flow modeling, otherwise known as computational fluid dynamic (CFD) modeling, as does Navigator witness Mr. Godfrey in his rebuttal testimony. Navigator does plan to use CFD modeling in the manner described on page 8 of Mr. Byrd's testimony, at discrete locations as

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warranted from our hazard analysis. This will further inform Navigator of risk mitigation measures that may be warranted in proximity to population centers.

18. Mr. Byrd discusses PHMSA's authority to grant special permits that waive compliance with one or more of the safety requirements under Part 195, and states that to his knowledge Navigator has not requested a special permit from PHMSA (pp. 6-7, lines 42-46, 2-4). Is that accurate?

Answer: Yes. Navigator intends to exceed PHMSA's safety requirements and has no intention of seeking an exemption from any portion of 49 CFR Part 195.

19. Sara Throndson recommends that the PUC review the results of Navigator's geohazard analysis (Throndson Testimony at pp. 3-4). Please comment on the status of Navigator's geohazard study.

Answer: Navigator provided its geohazard assessment "Geological and Geohazard Desktop Study" report on April 14, 2023 and stated that a Phase II study including field verification and additional due diligence activities will be performed. The Phase II activities are planned for later this year and will not be available for review prior to the statutory deadline for a PUC decision on the docket. The Phase II assessment efforts to validate the results in the desktop assessment will include recommended mitigation measures that focus on reducing the probability of an incident occurring or reducing the vulnerability / impact to the pipeline in the event of a potential incident. Qualified geotechnical personnel will inspect areas identified in the desktop assessment including visual inspection, geotechnical investigations, aerial inspection, and soil testing / analysis. Mitigation measures during the construction phases of the project include site stabilization measures (e.g., trench breakers, terrace installation, slope reconstruction, drainage improvements, etc.), installation of appropriate erosion and sediment

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control systems for surface water control to reduce the probability of an event occurring during construction, and post-construction activities. In addition, implementation of trench modification activities may be warranted during the construction phase (e.g., modifying the trench profile, backfill of fissures using large particles, use of free draining / engineer materials within the trench backfill material, trench breakers to restrict subsurface flow). After construction, a robust pipeline monitoring / maintenance plan will be developed and implemented, and it will include the required key activities to support safe operation of the pipeline (e.g., areas warranting increased frequency of aerial patrols, utilization of Light Detection and Raging Surveys (LiDAR) on a period basis and conducting field assessments to monitor potential problems areas).

20. In their testimony, Jon Thurber and Matthew Frazell indicate that Navigator has not provided sufficient information for them to evaluate the plume modeling that was done for the pipeline. Please respond.

Answer: Navigator is submitting a confidential document titled "Heartland Greenway System: CO2 Air Dispersion Guidance." A copy has been provided subject to the Protective Order entered in this proceeding. The document explains the modeling that was done and provides additional detail about the process and inputs used for the modeling

21. Does this conclude your rebuttal testimony?

Answer. Yes.

Dated this 26th day of June, 2023.

/s/Stephen Lee
Stephen Lee

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EXHIBIT
A

Jakubas, Andrea

From: Asebe, Tewabe (PHMSA) <Tewabe.Asebe@dot.gov>
Sent: Monday, May 1, 2023 1:00 PM
To: Maple, Mark
Cc: Morley, Meagan; Sheehan, Bridget; Simpson, Joan; Jakubas, Andrea; Harvey, Matthew
Subject: [External] RE: Request for Clarification Regarding CO2 Pipeline Regulations

Hello friends,

Please see PHMSA's response to your question below.

Take care.

Q: If a carbon dioxide pipeline is operating in such a way that the carbon dioxide is not maintained in a supercritical state for specific segments of the pipeline, would PHMSA still regulate the entire pipeline pursuant to 49 CFR Part 195?

A: It depends. PHMSA's regulatory definition of carbon dioxide at 49 CFR § 195.2 means "a fluid consisting of more than 90 percent carbon dioxide molecules compressed to a supercritical state." PHMSA interprets that to mean and include any fluid meeting the carbon dioxide content percentage (i.e., 90% carbon dioxide molecules) that has been compressed to a supercritical state. If a pipeline transports CO2 as a fluid consisting of more than 90 percent carbon dioxide molecules compressed to a supercritical state, the pipeline is regulated pursuant to part 195, even if a segment of the pipeline temporarily experiences operating conditions in which the fluid is not maintained in a supercritical state. If, however, a pipeline has operational controls in place (e.g., pressure limiting devices) that prevent CO2 from entering a supercritical state, the pipeline would not be regulated under Part 195.

From: Maple, Mark <Mark.Maple@illinois.gov>
Sent: Thursday, April 27, 2023 1:31 PM
To: Asebe, Tewabe (PHMSA) <Tewabe.Asebe@dot.gov>
Cc: Morley, Meagan <Meagan.Morley@Illinois.gov>; Sheehan, Bridget <Bridget.Sheehan@illinois.gov>; Simpson, Joan <Joan.Simpson@Illinois.gov>; Jakubas, Andrea <Andrea.Jakubas@Illinois.gov>; Harvey, Matthew <Matthew.Harvey@illinois.gov>
Subject: Request for Clarification Regarding CO2 Pipeline Regulations

On April 13, 2023, John Gale, Director, Office of Standards and Rulemaking, responded by letter to two questions posed by Matthew Harvey, Deputy General Counsel of the Illinois Commerce Commission ("ICC"), on behalf of ICC Staff (letter attached). ICC Staff appreciates PHMSA's prompt response to this matter. To ensure ICC Staff has a clear understanding of the response, ICC Staff has one clarifying question regarding PHMSA's response to Question 1.

PHMSA's response to Question 1 states: "PHMSA regulates the transportation of carbon dioxide by pipeline under 49 CFR Part 195 if the carbon dioxide consists of more than 90 percent of the composition in a supercritical state." ICC Staff respectfully requests clarification of the following:

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If a carbon dioxide pipeline is operating in such a way that the carbon dioxide is not maintained in a supercritical state for specific segments of the pipeline, would PHMSA still regulate the entire pipeline pursuant to 49 CFR Part 195?

Thank you for your assistance in this matter.

Mark Maple
Illinois Commerce Commission
Mark.Maple@illinois.gov
(217) 558-3509

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EXHIBIT
B

DNV

DESIGN VERIFICATION REPORT

DVR: 1928040
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 5 (Materials and Pipeline Design)

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 5 of DNV-RP-F104 provides guidance on material selection, guidance on corrosion mechanisms and general requirements for CO2 pipelines.

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 material selection and design approach would result in the HGS pipeline system complying with the guidelines of Section 5 (Materials and Pipeline Design) 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. Note, the list of ongoing activities referenced in Section E is not a comprehensive list of activities required for pipeline design. 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.

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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 design approach for NCO2V's HGS pipeline per DNV-RP-F104 Section 5. 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

DNV performed a high-level review of the following documents to verify the design approach against Section 5 of DNV-RP-F104. Detailed engineering documents were under development and were not available at the time of this review.

Doc. Type	Doc. Title	Doc. No.	Doc. Rev.	Date
Engineering Specifications	Piping Class Sheet	NCO2V-ENG-101	D	01/20/2023
	Orifice Meters	NCO2V-ENG-103	A	06/07/2022
	Shop Fabricated Pipe Bends	NCO2V-ENG-201	A	08/01/2022
	High Frequency Welded Line Pipe	NCO2V-ENG-203	B	08/01/2022
	Crack Arrestors	NCO2V-ENG-204	A	08/29/2022
	I&E General	NCO2V-ENG-300	A	08/01/2022
	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
	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
	Flanged Pipe and Equipment Bolting	NCO2V-CONST-2003	A	08/26/2022
	Protective Coatings	NCO2V-CONST-2004	A	08/24/2022

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Doc. Type	Doc. Title	Doc. No.	Doc. Rev.	Date
	Field Applied Coating	NCO2V-CONST-2006	A	08/26/2022
	Weld Identification	NCO2V-CONST-2007	A	08/22/2022
	Radiographic and Non-Destructive Testing	NCO2V-CONST-2008	A	08/24/2022
	Mechanical Construction	NCO2V-CONST-2009	A	08/24/2022
	Mechanical Joining by Welding	NCO2V-CONST-2010	A	08/26/2022
	Induction Bends and Welded Fittings-End Preparation for Butt Welding	NCO2V-CONST-2010F	A	08/26/2022
	Handling Pipe	NCO2V-CONST-2011	A	08/22/2022
	Field Applied Powder Coating FBE-Flocking	NCO2V-CONST-2018	A	08/26/2022
	Electrical Construction	NCO2V-CONST-3001	A	08/26/2022
Supporting Documents	HGS Design Basis – P2	HGS Design Basis – P2	B	08/24/2022
	Heartland Greenway System Safety Systems and Considerations (DRAFT)	-	0	10/17/2022
Documents Taken for Information	HGS – CO2 Composition Quality	-	C	02/01/2023

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 material selection and design approach for the HGS CO2 pipeline against the guidelines in Section 5 of DNV-RP-F104.
- The design activities related to material qualification for the specified product, evaluating the impact of impurities including H2S on selected materials, thermohydraulic analysis, structural analysis, water monitoring, and venting/blowdown procedures are ongoing. Completion of these activities is required to satisfy Section 5 of DNV-RP-F104. Details related to these activities are listed below:

Material Selection and Qualification

- Documenting the qualification of all materials for suitability to transport the specified products.
- Finalizing and documenting the metallic and non-metallic material selection and qualification to ensure that all materials meet the requirements of ISO 15156 for any potential H2S containing environment.

Thermohydraulic Analysis

- 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.
- Finalizing the thermohydraulic analysis to determine the range of expected temperatures experienced by the pipeline materials.

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Structural Analysis

- Perform detailed structural analysis for the installation, operating, and accidental load conditions, and implement any required design enhancements (e.g., increased pipeline wall thickness).

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 include the effect of product composition on decompression speed, 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 2023-06-02

for DNV

Jaiswal, Vivek Digitally signed by Jaiswal, Vivek
Date: 2023.06.02 14:51:55 -05'00'

Prepared by:
Vivek Jaiswal
Principal Engineer

Furtado, Sonia Digitally signed by Furtado, Sonia
Date: 2023.06.02 14:57:00 -05'00'

Sonia Furtado
Principal Engineer
Technical Advisory and Verification

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