



DESIGN VERIFICATION REPORT

DVR: 1896636
Rev.: 0

Particulars of Design

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

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

This is to verify that the design philosophy of

Navigator's Heartland Greenway System CO2 pipeline

has been reviewed against the requirements of

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

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

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

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



The verification is based on the following

A. Design codes/standards used as references:

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

B. Design Specification

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

C. Documents Reviewed

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



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

D. Comments

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

Issued at Katy, TX on 2023-04-21

for DNV

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