

# Carbon Dioxide (CO<sub>2</sub>) Training Overview

For EMS and First Responders



HEARTLAND  
GREENWAY

Carbon Capture, Utilization, and Storage (CCUS) technology safely removes carbon dioxide before it enters the atmosphere. CCUS involves a pipeline network, which is the safest, most efficient method for transporting CO<sub>2</sub> and energy fuel required for daily life.

**Heartland Greenway** is a CCUS system that will provide biofuel and other industrial customers in five Midwest states with a long-term and cost-effective means to reduce their carbon footprint. Heartland Greenway will reach industrial customers in Illinois, Iowa, Minnesota, Nebraska and South Dakota. Operations are expected to be phased in early 2025.

Omaha-based Navigator CO<sub>2</sub>, will construct, operate, and maintain Heartland Greenway, having safely constructed and operated more than 1,300 miles of new pipeline infrastructure since 2012. The company designs and constructs its projects to meet or exceed minimum safety, design, construction and operating standards, while also minimizing the collective impact to landowners and the communities where it operates.

Train

Plan

Equip

Test

# Informing and Listening to Communities

Safe planning for a pipeline project requires advance information and training for all involved communities. As part of its commitment to fostering open and regular dialogue, in early 2023 Navigator completed an initial series of special training sessions for police, fire, and emergency teams in local communities in the counties where the new CO<sub>2</sub> pipeline is planned. Critical content from these sessions – which will continue as the project develops – is summarized in this publication.

## Content summary

### Transportation

How CO<sub>2</sub> moves within a pipeline; pipeline specifications; indications of what is heard, seen and smelled during an unplanned CO<sub>2</sub> release; NAV 911 emergency notification system

### Safety Principles

Guidelines followed prior to, during, and after construction has been completed; 24/7/365 monitoring; maintenance and response protocols

### Emergency Response Development

Engagement and planning prior to putting a pipeline in service; toxicity levels of CO<sub>2</sub>; process followed in the event of emergencies

### Comparative Plume Modeling

How CO<sub>2</sub> travels in the air and dissipates in the event of an unplanned release

### Additional Resources

Online references for emergency personnel

## An established track record

CO<sub>2</sub> pipelines have been in service since the late 1970's. Currently, there are approximately 5,500 miles of pipeline in the US carrying liquefied CO<sub>2</sub>. Since the 1990's, they have been regulated by the US Dept. of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) under 49 CFR Part 195.

Other liquid CO<sub>2</sub> pipelines in the Midwest:

- Dakota Gas, 205 mi ND to Canada, in-service 2000, 12–14" pipe, 2700 psi MOP for 14-inch and 2965 psi for the 12"
- Gary Climate Solutions, 14 mi near Garden City, KS, in-service 2012, 4" pipe, 2200 psig MOP with normal operating pressure of 1750 psig

## CO<sub>2</sub> general properties

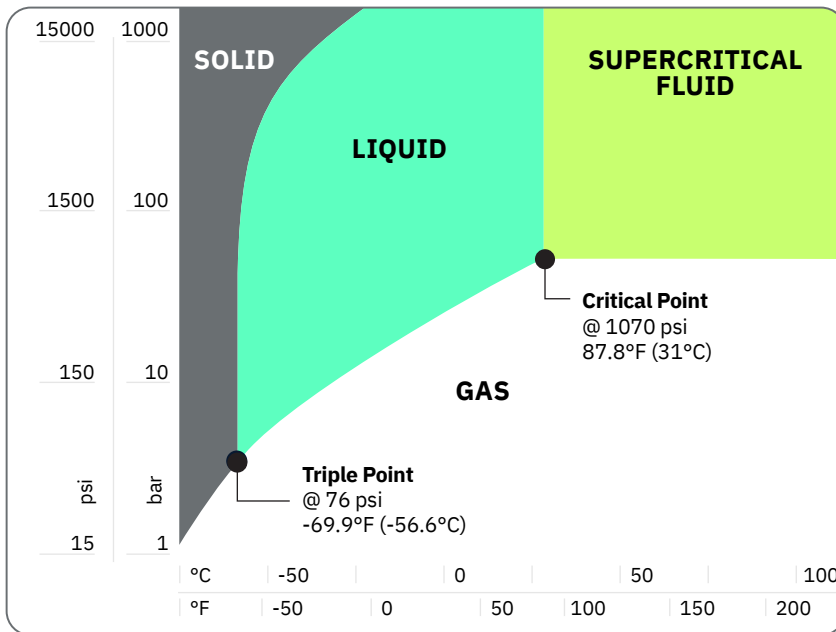
CO<sub>2</sub> is an inert gas that's non-flammable, non-corrosive, and is both colorless and odorless. Based on atmospheric conditions, it may accumulate in low-lying and confined areas if ventilation is insufficient, as it is heavier than air. It is a naturally occurring compound that can displace oxygen where CO<sub>2</sub> concentration is higher than normal atmospheric conditions.

# General CO<sub>2</sub> Transportation

## Considerations when designing and developing CO<sub>2</sub> transportation:

- The quality of metal is critically important to reduce the susceptibility of ductile fractures while in supercritical phase.
- Removal of water (dehydration step) prevents water from forming carbonic acid- which can affect the integrity of the carbon steel.
- Equipment installed at each capture site to continuously monitor CO<sub>2</sub> quality and isolate if any contaminants enter the stream beyond our high quality specification standards.
- In the event of loss of containment, immediate phase change back to gas with dispersion subject to atmospheric conditions.

The following graph represents the phases of CO<sub>2</sub>. Phase change is dependent on temperature and pressure.



## HEARTLAND GREENWAY PIPELINE SYSTEM SPECIFICATIONS

- Minimum 98% pure CO<sub>2</sub> compressed to a supercritical fluid at receipt points
- Line Pipe: steel pipe designed expressly for CO<sub>2</sub> with added toughness parameters (above API-5L PSL2)
- Federal Regulation: design, construct, operate to meet or exceed 49 CFR Part 195
- Include best practices and recommended practices from DNV-RP-F104 as well as some components from Part 192
- Normal Operating Pressure: 1,300-2,100 psig (MOP by design 2,200 psig or ANSI 900)
- Pipe Depth: nominal 5', 12"-24" separation below existing pipelines and utilities
- Pipe Diameter: 6"-20" outside diameter
- Operating Temperature: 40-110°F
- Mainline Valves: strategically located (max interval of 20 mi in non-HCAs and 7.5 mi within Populated HCAs) for control and isolation of the system
- Routing to minimize the collective impact to HCAs, vulnerable places of gathering, and other stakeholder inputs (ongoing from engagement)

## Indications of a CO<sub>2</sub> Release



### You may HEAR:

- A hissing or whistling noise
- OR a loud jet engine roar



### You may SEE:

- White vapor cloud
- Dirt blowing from a hole in the ground
- An area of frozen ground in the summer
- An area of dead vegetation
- An unusual area of melted snow in the winter
- Bubbling in pools of water



### You may SMELL:

- A strong garlic odor (\*specific to HGS pipelines)

## PIPELINE RESOURCES

1-833-NAV-3CO2

**In case of emergency on the pipeline**  
For use by the general public



CHEMTREC 1-800-424-9300

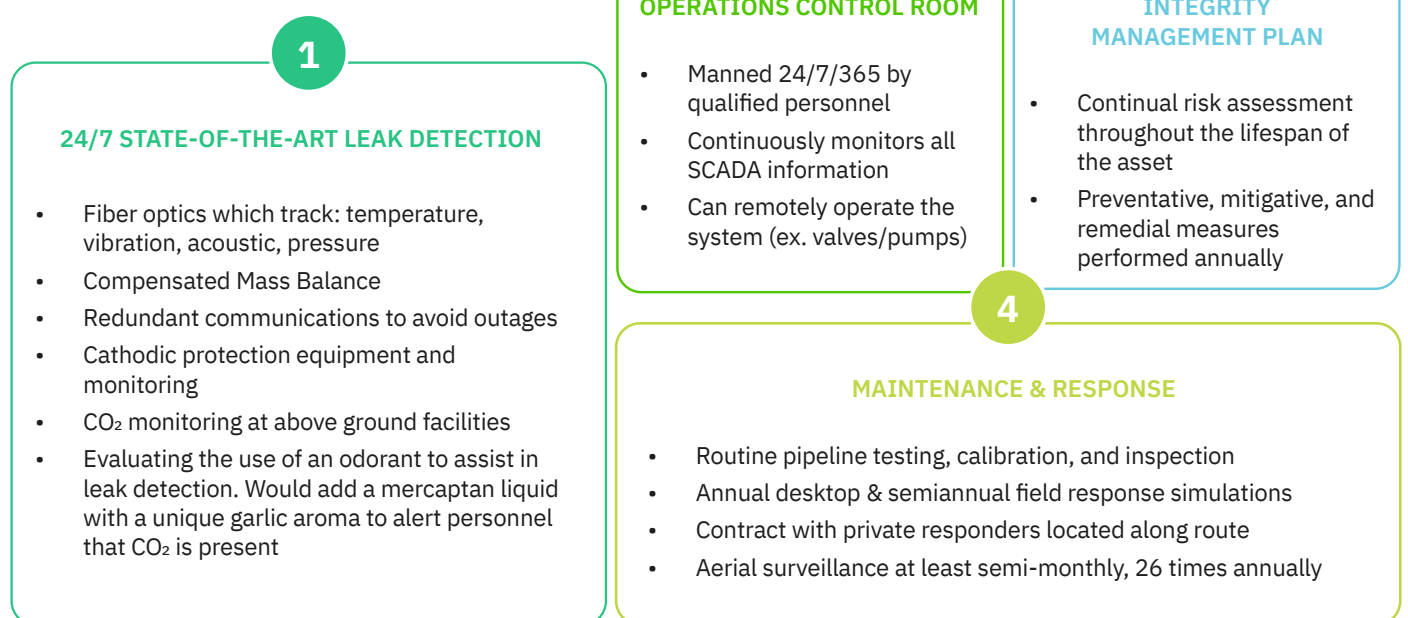
**Free resource for emergency responders**  
Provides healthy and safety guidance to emergency responders and general public

# Safety Principles

## Pre-Construction Design Safety Elements

<b>MINIMIZE COLLECTIVE IMPACT</b>	<ul style="list-style-type: none"> <li>• Avoid and/or minimize High Consequence Areas (HCAs are defined by PHMSA)</li> <li>• Multiple plume dispersion models under various scenarios (ALOHA/PHAST)</li> <li>• Strategically located mainline valves, remotely monitored 24/7/365, and utilizing valves that require no actuation (immediate closure – check valves)</li> </ul>
<b>MEET AND EXCEED REGULATORY STANDARDS</b>	<ul style="list-style-type: none"> <li>• Utilize guidance from 49 CFR Part 192 (natural gas) and international recommended practices (DNV-RP-F104) in design &amp; construction to meet and exceed Part 195 (hazardous liquid pipelines)</li> <li>• State, county and local applicable permits and statutes</li> </ul>
<b>MITIGATE RISK</b>	<ul style="list-style-type: none"> <li>• Increased depth of cover to <math>\geq 5'</math> to reduce risk of 3rd party damage and stay beneath existing drain tile and utilities</li> <li>• Follow other existing utilities when practical (increased public awareness and damage prevention plans)</li> <li>• Warning tape installed 2' above pipeline as a proactive warning measure for 3<sup>rd</sup> party damage</li> <li>• Increased factor of safety/enhanced line pipe specs to protect from external forces and fracture propagation</li> <li>• 24/7 monitoring of CO<sub>2</sub> composition before entering pipeline</li> <li>• Geological hazard analysis and assessment to safeguard the system from external forces/stress</li> </ul>
<b>PRE-COMMISSIONING</b>	<ul style="list-style-type: none"> <li>• Hydrostatic testing above max operating pressure, (<math>\sim 1.25 \times 2,200</math> psig = 2,750 psig)</li> <li>• Coordination with local first responders and public awareness</li> <li>• System-wide pre-startup and safety review</li> </ul>

## Post-Construction Operational Safety Measures



# Emergency Response Development

## Engagement and development plan prior to putting a pipeline in service:

- Train** Conduct stakeholder and emergency/first responder proctored CO<sub>2</sub> training – Q1 2023
- Plan** Develop a preliminary Emergency Response Plan between NCO2V and external stakeholders approx. 3-6 months after initial training
  - NAV911 outcall system training
- Equip** Identify and obtain necessary resources to execute the preliminary plan approx. 2-3 months after local/regional plans are compiled
  - Equipment
  - HGS Ops personnel and/or 3rd party response team to supplement regional first responders
- Test**
  - Perform drills to measure the effectiveness of the plan and adjust accordingly prior to placing in-service and assets are established (Covers 49 CFR 195.402.15)
  - Annual drills will also be performed upon being placed in-service

### CO<sub>2</sub> TOXICITY

CO<sub>2</sub> can be mildly toxic and potentially an asphyxiant, but is influenced by two factors:

- The concentration of CO<sub>2</sub> in the atmosphere (normal is 300 - 1000 ppm)
- The time duration of exposure to elevated levels of CO<sub>2</sub>

CO <sub>2</sub> Concentration (ppm)	Time	Effects
170,000 - 300,000 ppm	Within 1 minute	Loss of controlled and purposeful activity, unconsciousness, convulsions, coma, death
> 170,000 ppm	< 1 minute	Convulsions, coma, death
> 10,000 - 150,000 ppm	1 minute to several minutes	Dizziness, drowsiness, severe muscle twitching, unconsciousness
70,000 - 100,000 ppm	1.5 minutes to 1 hour	Headache, increased heart rate, shortness of breath, dizziness, sweating, rapid breathing
60,000 ppm	1-2 minutes	Hearing and visual disturbances
	≤16 minutes	Headache, dyspnea <sup>1</sup>
	Several hours	Tremors
40,000 - 50,000 ppm	Within a few minutes	Headache, dizziness, increased blood pressure, uncomfortable dyspnea
30,000 ppm	1 hour	Mild headache, sweating, and dyspnea at rest
20,000 ppm	Several hours	Headache, dyspnea upon mild exertion

Sources: (USEPA 2000), (Langford 2005)

<sup>1</sup> The clinical definition of dyspnea is an uncomfortable awareness of one's breathing effort. It is a normal symptom of heavy exertion but becomes pathological if it occurs in unexpected situations (Shiber and Santana 2006).

### OCCUPATIONAL EXPOSURE LIMITS

	STEL	TWA
<b>ACGIH TLV</b> (United States, 3/2017) Oxygen Depletion [Asphyxiant]	54000 mg/m <sup>3</sup> 15 minutes 30000 ppm 15 minutes	9000 mg/m <sup>3</sup> 8 hours 5000 ppm 8 hours
<b>NIOSH REL</b> (United States, 10/2016)	54000 mg/m <sup>3</sup> 15 minutes 30000 ppm 15 minutes	9000 mg/m <sup>3</sup> 10 hours 5000 ppm 10 hours
<b>OSHA PEL</b> (United States, 6/2016)		9000 mg/m <sup>3</sup> 8 hours 5000 ppm 8 hours
<b>OSHA PEL 1989</b> (United States, 3/1989)	54000 mg/m <sup>3</sup> 15 minutes 30000 ppm 15 minutes	18000 mg/m <sup>3</sup> 8 hours 10000 ppm 8 hours

STEL= a short-term exposure limit is a 15-minute TWA exposure that should not be exceeded at any time during a workday

TWA= a time-weighted average concentration for up to a 10-hour workday during a 40-hour workweek.

## Emergency Response Checklist

This is an overview of the responsive process that is followed in the event of an emergency or unplanned release of CO<sub>2</sub> from the pipeline system. This process will form the basis of a formal written plan.



**CONCERN IDENTIFIED**  
Incident identified by control center, field employee, or member of the public



**SHUT DOWN LINE**  
Pipeline is safely shut down by Navigator personnel



**CONTACT FIRST RESPONDERS**  
Includes emergency personnel and employees who are trained to manage response efforts, including the notification of affected parties



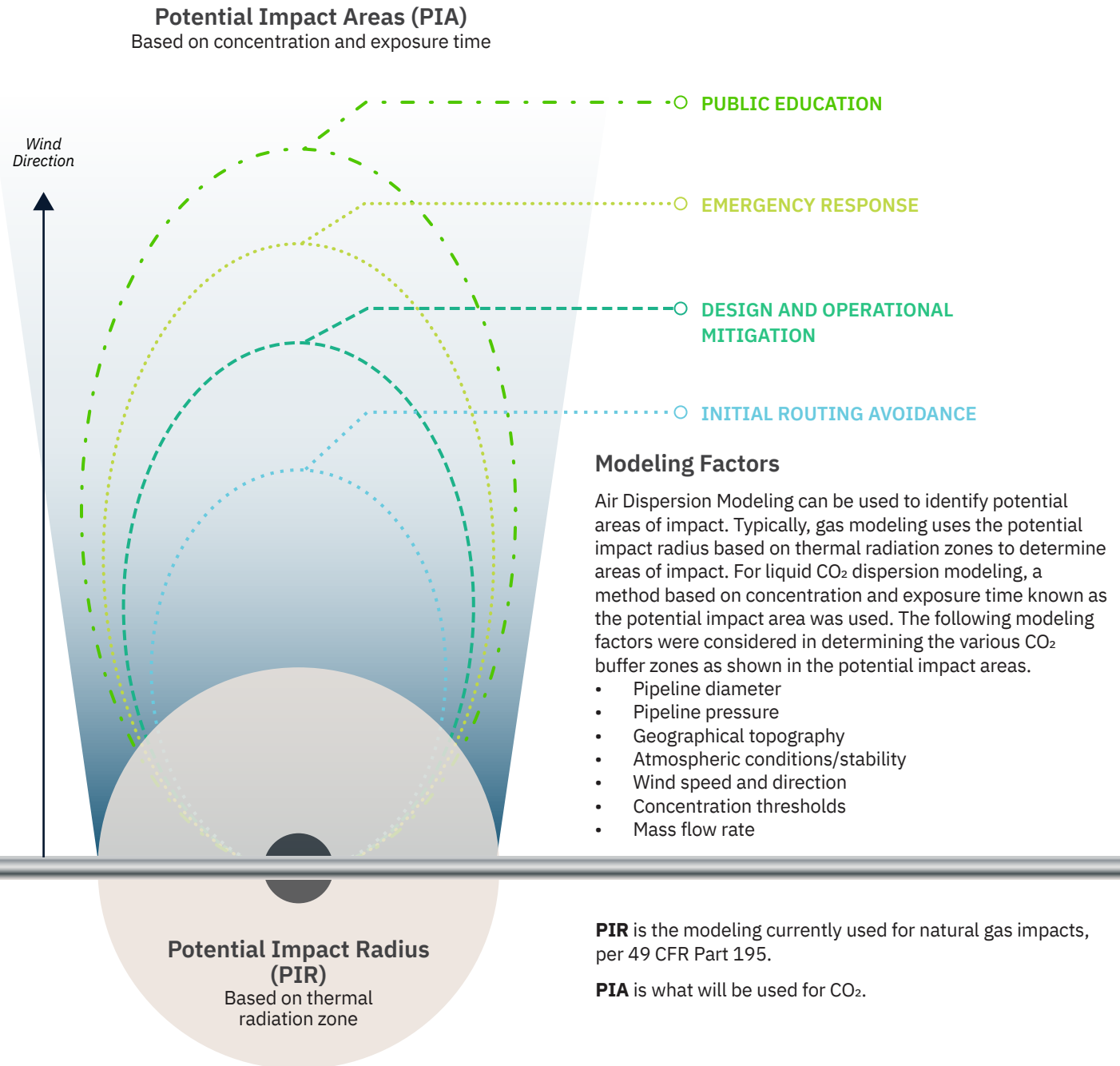
**IDENTIFY & DEPLOY EMERGENCY RESPONSE EQUIPMENT & MEASURES**  
Begin coordination to assess the situation, evacuate area if necessary, and implement safety protocols



**CLOSE OUT RESOLUTION**  
Report to proper authorities. When deemed safe, pipeline and facility operations resume

# CO<sub>2</sub> Air Dispersion and Comparative Plume Modeling

In the event of an unplanned release, a “plume” or cloud of gas will form, then dissipate over time based on weather effects, including wind direction and speed. The modeling shown in this graphic was developed using ALOHA and DNV Phast Software models.<sup>1</sup>



<sup>1</sup> **Area Location of Hazardous Atmosphere's (ALOHA) Software:**

ALOHA was developed and is supported by the Emergency Response Division (ERD), a division within the National Oceanic and Atmospheric Administration (NOAA) in collaboration with the Office of Emergency Management of the U. S. Environmental Protection Agency (EPA). Its primary purpose is to provide emergency response personnel estimates of the spatial extent of some common hazards associated with chemical spills. The ALOHA development team also recognizes that the software can be an appropriate tool for training and contingency planning, but users should remain aware of its primary purpose in spill response.

**DNV Phast Software Model:**

Phast is a globally adopted solution for modeling atmospheric discharge, dispersion, fires, explosions and toxic effects of a wide range of loss of containment scenarios. Process safety professionals benefit from 40 years of development and validation by industry experts and its continued use by more than 10,000 users across 1,000 organizations.

# Effective, More Expansive Safety Controls

## INITIAL ROUTING

Evaluation for Direct High-Consequence Area (HCA) impact to:

- High Populous Areas (HPAs)
  - Other Populous Areas (OPAs)
  - Unusually Sensitive Areas (USAs)
  - Drinking Water (DW)
  - Commercial Navigable Waters (CNW)
  - Structures of high population density
- Utilized for initial routing where possible to maximize spacing between HGS and inhabitable structures.

## ADDITIONAL DESIGN AND OPERATIONAL MITIGATION

Where pipeline falls within “Design and Operational” tolerance, the following additional mitigation measures may be utilized in any combination:

- Design Enhancements
- Increased design factor and wall thickness of pipeline
- Increased interval of Emergency Flow Restriction Device (EFRD) analysis for valve placement
- Increased third party damage mitigation
- Enhanced leak detection and air monitors
- Operational Enhancements
- Increased system surveillance interval
- Redundant control, power, and communication capabilities
- Increased integrity validations and assessments through Integrity Management Plan
- Strategically located HGS personnel or third-party resources

## EMERGENCY RESPONSE

Where pipeline falls within “Emergency Response” tolerance, the following additional mitigation measures utilized:

- Indirect HCA impact to HPAs/OPAs/CNWs
- CO2 training and drills for HGS and First Responders
- First Responder resources (equipment and personnel) verifications and supplements by Navigator
- Current plan is to expand the actual buffer once all Emergency Responder meetings are complete (Currently incorporating county plus any mutual aid partners)

## PUBLIC EDUCATION

Where pipeline falls within “Public Education” tolerance, the following additional mitigation measures utilized:

- NAV911 System will be designed to provide roll out calls based on emergency events. Yearly communications made to ensure accuracy of contact numbers.
- Annual public awareness and training
- Current plan is to expand the actual buffer once all Emergency Responder meetings are complete (~1-10 miles)

## Unplanned CO<sub>2</sub> Releases Are Rare

Pipeline systems transport a variety of products quickly, efficiently, and with far fewer emergency incidents than truck or rail transport of hazardous materials.

Pipelines are the safest way to transport liquid energy with 99.999% of barrels delivered by pipeline arriving at their destinations safely.

<https://liquidenergypipelines.org/page/safety-record>

CO<sub>2</sub> pipelines have a lower incident rate than both crude oil and refined products pipelines.

Over the last 5 years, a CO<sub>2</sub> pipeline is 55% less likely to have an incident than a crude oil pipeline and 37% less likely compared to a pipeline delivering gasoline, diesel or jet fuel.

<https://liquidenergypipelines.org/Documents/en-us/9ace32cb-7b6e-4dc9-84de-7a0505269a40/1>

## Access these resources for the latest information



### EMERGENCY RESPONSE GUIDEBOOK (ERG)

Primarily a guide to aid first responders in quickly identifying the specific or generic hazards of the material(s) involved in the incident and protecting themselves and the general public during the initial response phase of the incident.

This guidebook will assist responders in making initial decisions upon arriving at the scene of a dangerous goods incident.

The ERG is updated every three to four years to accommodate new products and technology.

The guidebook is available from the U.S. Department of Transportation PHMSA website ([phmsa.dot.gov](http://phmsa.dot.gov))

### HAZARD COMMUNICATION STANDARD (HCS) DATA SHEETS

- Safety Data Sheets have been standardized to provide information on a specific chemical by a manufacturer.
- Regardless of the chemical or its manufacturer, each chemical's SDS will contain the same 16 sections of data.
- Sections 1-10 provide much of the critical information necessary to provide emergency response in the event of a release.

Safety Data Sheets can be accessed at the Occupational Safety and Health Administration website ([osha.gov](http://osha.gov)).

### HEARTLAND GREENWAY COMPLIANCE SUMMARY

Visit the Heartland Greenway website to view and download detailed summaries showing how Heartland Greenway will meet and exceed standards for 49 CFR Part 195.



### WANT TO LEARN MORE?

email: [info@heartlandgreenway.com](mailto:info@heartlandgreenway.com)  
phone: 402-702-7089  
web: [heartlandgreenway.com](http://heartlandgreenway.com)

