

## The Regulation of CO<sub>2</sub> Pipelines and Ensuring Public Safety

By Dwi Nuraini Siregar and Anna Littlefield

The 45Q tax credit is anticipated to play an important role in accelerating the expansion of the CO<sub>2</sub> pipeline network in the United States by providing a financial incentive for businesses to invest in carbon capture utilization and storage (CCUS) technologies and supporting infrastructure. The Inflation Reduction Act's amplification of this credit has already increased the number of CCUS projects. This activity, in addition to continuing demand for CO<sub>2</sub> for oil and gas operations, will require an expansion of the US CO<sub>2</sub> pipeline network. This expansion has raised questions and concerns among landowners, project stakeholders and the public regarding the safety of these pipelines and to what extent regulations should be consistent with or more stringent than those for the more abundant natural gas pipelines.

CO<sub>2</sub> pipelines differ from natural gas pipelines in both their design and operation. CO<sub>2</sub> is mostly transported in a supercritical fluid state, requiring more robust steel and operating under greater pressure. Unlike natural gas, (which also poses higher risks for corrosion, requiring chrome or other corrosion resistant materials) CO<sub>2</sub>'s higher density affects flow dynamics, requiring additional measures for safe operation and the prevention of ductile fractures. Differences also exist between natural gas and CO<sub>2</sub> that change the dynamics and consequences of a hypothetical pipeline failure. For example, a study conducted by the UK Health and Safety Executive has determined that the risk associated with CO<sub>2</sub> pipelines is higher than those associated with natural gas pipelines due to the absence of an ignitable hazard associated with CO<sub>2</sub> (i.e. unlike natural gas, CO<sub>2</sub> does not require ignition to cause harm). In a gaseous state, CO<sub>2</sub> is odorless, colorless, and heavier than air, enabling a plume to travel for miles, depending on wind and terrain, and settle into low-lying areas. In certain conditions, this may allow CO<sub>2</sub> to spread further than a plume of natural gas, exacerbating containment efforts.

Ensuring the safety of CO<sub>2</sub> pipelines is essential in safeguarding the environment, human health, and property as leaks or spills from these pipelines can lead to significant damage. Exposure to CO<sub>2</sub> concentrations between 2-10%, may result in adverse health impacts such as dizziness, headache, nausea, mental confusion, increased blood pressure and increased respiratory rate. A leak of any size is problematic, but concentrated volumes associated with a large rupture or pipeline failure can lead to asphyxiation when oxygen is displaced by CO<sub>2</sub>.

There are regulations for CO<sub>2</sub> pipelines at both the federal and state levels in the United States. At the federal level, CO<sub>2</sub> pipelines are regulated by the Pipeline and Hazardous Materials Safety Administration (PHMSA) under the Department of Transportation (DOT). PHMSA sets safety standards for pipeline design, construction, operation, and maintenance and conducts inspections to ensure that these standards are being met.

PHMSA will ensure the safety of CO<sub>2</sub> pipelines through:

1. Setting safety standards: PHMSA, under the DOT, sets safety standards for the design, construction, operation, and maintenance of CO<sub>2</sub> pipelines. These standards can ensure that pipelines are built to withstand potential hazards, such as corrosion and ground movement, and that operators have procedures in place to respond to incidents.
2. Inspection and enforcement: PHMSA conduct inspections of CO<sub>2</sub> pipelines to ensure they follow safety standards. The agency may levy fines or revoke the operating permits if violations are found.
3. Emergency response planning: The PHMSA requires the CO<sub>2</sub> pipeline operators to have emergency response plans to address potential incidents. These plans should include procedures for responding to and mitigating the effects of incidents, such as leaks or spills.
4. Public Information: PHMSA also requires pipeline operators to communicate safety-related information, such as emergency response plans and inspection results, to the public.
5. Collaboration with other agencies: PHMSA works collaboratively with Federal Energy Regulatory Commission (FERC) and Environmental Protection Agency (EPA) regarding CO<sub>2</sub> pipeline safety and compliance with all applicable laws and regulations.
6. Review and update: PHMSA should review and update the regulations regularly to ensure that they keep up with new technologies and best practices and address new safety concerns.

Over the last 20 years, there have been an average of 8 significant CO<sub>2</sub> pipeline incidents each year, according to PHMSA. On February 22, 2020, a 24-inch pipeline transporting liquid CO<sub>2</sub> ruptured near Satartia, Mississippi. Approximately 300 people were evacuated, and 49 were hospitalized, but no fatalities were reported. Incident reports suggested the possibility of casualties if the incident had occurred at night rather than during the day (with people asleep in their homes) or if the wind direction had been less favorable. The rupture was caused by heavy pressure from soil movement after persistent rain, according to a PHMSA investigation.

PHMSA currently applies safety requirements to CO<sub>2</sub> pipelines similar to those of other hazardous materials, such as Class 2.2 non-flammable gas. However, after the accident in Mississippi, the agency announced new safety measures to prevent such incidents and ensure readiness in the event of a pipeline failure. Among the new regulations is an integrity management measure requiring operators to take additional preventative and mitigative steps to address potential damage caused by earth movement. The revision also included improvement to standards pertaining to emergency preparedness and response plans.

Proponents of existing PHMSA regulations argue they are sufficiently safe, based on accepted industry standards, and regularly reviewed and updated to ensure safety, citing these recent updates of the agency's rigor. However, the sufficiency of current CO<sub>2</sub> pipeline safety regulations is a subject of debate.

Critics of PHMSA guidelines argue that regulations are not stringent enough and fail to adequately address the unique risks of CO<sub>2</sub> pipelines. A 2022 report by the Pipeline Safety Trust suggests that the current CO<sub>2</sub> pipeline regulations are insufficient for safe operation, placing the public at risk. This report calls for specific emergency planning and training, as well as new tools to monitor and improve safety. This report specifically outlines the need to address the risk of ductile fractures that “can ‘unzip’ a CO<sub>2</sub> transmission pipeline for extended distances, exposing great length of the buried pipeline” and the corrosion risks introduced when water is associated with CO<sub>2</sub>, generating carbonic acid “which has a ferocious appetite for carbon steel.”

Another issue addressed in this report is the federal definition of carbon dioxide: “Carbon Dioxide means a fluid consisting of more than 90 percent carbon dioxide molecules compressed to a supercritical state.” This relatively limiting definition leaves out supercritical CO<sub>2</sub> in any lesser concentration, as well as CO<sub>2</sub> in a gaseous or liquid state. There is also no language addressing the 10% of non-CO<sub>2</sub> impurities which can include hydrogen sulfide, methane, carbon monoxide, oxygen, nitrogen oxide, sulphur oxide, hydrogen, or water. The source of the CO<sub>2</sub> and the type of upstream treatment influences what other gases may be present. Understanding this mix is important as impurities can impact critical pressure, critical temperature, and induce unexpected phase changes which impact system hydraulics. While some emitters associated with CCS projects may produce very pure CO<sub>2</sub> (such as ethanol plants), the variety of emitters and their unique emission mixes could create issues if the types and levels of impurities are not regulated. Getting ahead of this policy gap is critical, given the anticipated boom in CCS project development under the IRA incentives.

Even with policy changes to address these existing gaps, PHMSA also faces the monumental task of ensuring compliance. It is important to note that regardless of regulations, the safety of the public depends on the compliance of operators in construction, maintenance, and emergency preparedness. Emergency preparedness and response planning is another point addressed in the Pipeline Safety Trust report. Specific issues addressed include the need for PHMSA to identify potential impact areas in the event of a pipeline rupture, the inclusion of an odorant injectant into the CO<sub>2</sub> stream, and a requirement that operators update procedural manuals to coordinate with local emergency response agencies.

Ensuring the safety of CO<sub>2</sub> transportation requires a balance between protecting the public, the environment, and continued industrial development. Protecting human health and safety as well as avoiding environmental contamination are the primary drivers for improving CO<sub>2</sub> pipeline regulations, but a failure to do so may have ripple effects beyond local communities. With a public already wary of CO<sub>2</sub> pipeline transmission, even a small failure has the potential to sway communities away from involvement in CCS projects. For an industry that is simultaneously booming and vulnerable, operators, regulators, and policy-makers alike must recognize the importance of ensuring critical systems like pipelines are held to the highest safety standards.

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