SUPPLEMENTAL STATEMENT OF REASONS

California Code of Regulations
TITLE 19. Public Safety
Division 1. State Fire Marshal
CHAPTER 14. Hazardous Liquid Pipeline Safety
ARTICLE 9. Carbon Dioxide Pipelines

Carbon Dioxide Pipelines

STATUTORY AUTHORITY

Authority cited: Sections 51010, 51010.5, 51011.5, 51013.5, 51015, 51015.4, 51015.5, 51016, 51018.6, 51018.9 Government Code; and Sections 60104 and 60105, Title 49 of the United States Code.

Reference: Sections 51010, 51010.5, 51011.5, 51011.6, 51013, 51013.5, 51014.3, 51014.5, 51015, 51015.06, 51015.4, 51015.5, 51016, 51018, 51018.6, 51018.8, 51018.9; and Sections 60104 and 60105, Title 49 of the United States Code

SPECIFIC PURPOSE AND RATIONALE

Reference: Government Code Section 11346.2(b)(1)

Pursuant to Government Code Section 51011.5 and 51018.9, the California Office of the State Fire Marshal - Pipeline Safety Division (OSFM) is authorized to adopt emergency regulations for the implementation of regulations governing the safe transportation of carbon dioxide in pipelines that are at least as protective as draft regulations set forth in the unofficial version of the Notice of Proposed Rulemaking issued by the Pipeline Hazardous Materials Safety Administration (PHMSA) on January 10, 2025 (RIN 2137-AF60).

OSFM proposes a series of additional sections to Title 19 CCR 2170 et seq., to pipeline safety regulations in response to recently adopted legislation directing the office to regulate carbon dioxide. The anticipated significant expansion of pipeline infrastructure transporting carbon dioxide in all phases due to private sector, State, and Federal initiatives to address climate change, and lessons learned from the February 22, 2020, rupture of a supercritical-phase carbon dioxide pipeline near Satartia, Mississippi. OSFM proposed rulemaking will bring regulatory definitions to carbon dioxide pipelines within the scope of design, installation, operations, maintenance, and reporting requirements; bolster integrity management requirements; and strengthen emergency response communication and coordination requirements. These regulations will ensure any expansion of carbon dioxide pipeline infrastructure occurs in a manner that is safe for nearby communities and pipeline workers, protective of the environment, transparent, and equitable as it supports the greenhouse gas reduction potential of carbon capture, utilization, and sequestration (CCUS or CCS) efforts.

There are currently no carbon dioxide transportation pipelines in California. The Legislature placed a moratorium on their construction until PHMSA adopted regulations governing the safe transportation of carbon dioxide. However, PHMSA never adopted regulations expanding on the limited existing carbon dioxide pipeline standards. The Legislature and Executive branch have identified carbon capture, use, and sequestration as a necessary component to achieve a net neutrality goal by 2045. In the absence of comprehensive federal safety regulations, the Legislature deemed the OSFM responsible for developing State specific safety requirements. Because there is no comprehensive safety regulation related to carbon dioxide transportation, the OSFM must develop a framework for the safe construction and operation of these pipelines to safeguard the people and property of California. These regulations aim to achieve that framework.

Specific Purpose

Reference: Government Code Section 11346.2(b)(1)

1. Adopting Section 2170 Definitions
   Section 2170 establishes definitions for terms used in Article 9. These definitions are reasonably necessary to create structure and clarity for the proposed regulations. The definitions further avoid confusion regarding terms that may be susceptible to multiple interpretations.

2. Adopting Section 2171 Incorporated by Reference
   Section 2171 states a specific form that must be used, as well as studies, standards, and practices that are incorporated by reference. This section includes the titles and versions of these documents for specificity, as multiple versions of these documents may exist. These technical standards are comprehensive peer reviewed materials that are generally accepted within pipeline safety as accepted standards and practices for the safe operation of pipelines.

3. Adopting Section 2172 Pipelines Subject to This Article
   Section 2172 provides the OSFM's jurisdiction over specific pipelines related to the transportation of carbon dioxide. It also provides exceptions for a variety of pipelines that fall outside the OSFM's statutorily defined authority. This section informs the regulated community of the types and kinds of pipelines that will be subject to this Article. The focus is on transportation pipelines falling outside of facilities.

4. Adopting Section 2173 Carbon Dioxide Pipeline Safety Program
   Section 2173 clarifies and directs readers to the appropriate federal regulations for reference and identifies which rule of law shall apply where multiple standards may exist. This section also specifies timing for compliance relating to written procedures that must be in place 6 months after the effective date of the regulations, January 1, 2027. Operators are required to review their manual and also establish a public engagement program covering construction and throughout the life of the pipeline.

5. Adopting Section 2174 Design Requirements
   Section 2174 specifies that all carbon dioxide pipelines must be constructed of new materials and steel. It also identifies the importance of using materials suited for the use in carbon dioxide transportation, such as varying temperature ranges, chemical interaction, and identifies federally applicable design standards.

6. Adopting Section 2174.1 Fracture mechanics
   Section 2174.1 addresses the effects of fracture propagation in the event of pipeline failure and requires minimum toughness properties. If a pipeline transporting carbon dioxide experiences a failure, it can lead to an explosive decompression due to the sudden release of the highly pressurized gas, potentially causing long-running brittle fractures that travel along the length of a pipeline. Appropriate consideration of the material behaviors when experiencing a failure is a key component to preventing catastrophic failures and limiting the impacts following a failure.

7. Adopting Section 2174.2 Material toughness
   Section 2174.2 describes pipe toughness properties related to fracture initiation, propagation, and arrest of fractures through incorporated reference standards. Some materials may not be suitable for fracture arrest as required by section 2174.1 and this section. In those cases, this section requires operators to use alternative means of achieving the required fracture arrest.

8. Adopting Section 2174.3 Valves
   Section 2174.3 specifies valve design requirements to ensure material compatibility with the carbon dioxide transported in the pipeline. Valve locations, requirements, and studies are included to limit the consequences of a release. The valve studies are required to be reviewed annually as specified within the regulation.

9. Adopting Section 2174.4 Leak detection
   Section 2174.4 requires pipelines to be equipped with leak detection systems and specifies the standards that the system must meet to be considered adequate. This is important because carbon dioxide is an asphyxiant; therefore, notification of a leak is imperative for protecting human health.

10. Adopting Section 2174.5 Fixed Vapor Detection, Alarm Systems, and Safety Devices
   Section 2174.5 establishes standards for the safe operation of particular appurtenances found on carbon dioxide pipelines, such as pumps, compressors, meters, valve stations, and other facilities that may be used in the transport of carbon dioxide. These appurtenances may be susceptible to the buildup of harmful constituents, such as carbon dioxide gas, that could incapacitate or harm persons in the vicinity. This section specifies safety

standards and warning systems that should prevent inadvertent exposure to harmful constituents and a means to remediate those possible events through design and testing.

11. Adopting Section 2175 Construction Requirements
    This section directs the regulated community to specific sections that dictate construction requirements.

12. Adopting Section 2175.1 Construction specifications
    This section identifies specific practices that must be implemented in addition to ASME B31.4 (incorporated by reference) in designing a carbon dioxide pipeline. Specifically, that longitudinal seam welds must be offset and positioned on the upper half of the pipe.

13. Adopting Section 2175.2 Protection from hazards
    Geotechnical analysis is called out in this section to prevent pipeline damage due to washouts, floods, suitable soil, landslides, ground movement, and subsidence. These issues and others may result in the movement or outside forces impacting pipelines, and lead to failure or release.

14. Adopting Section 2175.3 Proximity to sensitive receptors
    Section 2175.3 instructs operators to choose a pipeline route that avoids potential impacts to sensitive receptors (people and places of gathering as defined in statute). In areas where impacts to sensitive receptors could occur within an emergency planning zone, operators must conduct vapor dispersion analysis, provide training to state and local emergency services, provide equipment to those agencies, and distribute emergency preparedness materials to sensitive receptors.

15. Adopting Section 2175.4 Cover over buried pipeline
    Section 2175.4 identifies the depth at which pipelines must be buried to avoid outside damage.

16. Adopting Section 2175.5 Installation of pipe in a ditch
    Section 2175.5 identifies construction, post construction, and remediation techniques aimed at protecting coatings that prevent pipeline corrosion.

17. Adopting Section 2175.6 Additional construction requirements
    This section specifies that operators must develop a quality assurance plan for ensuring that stringent construction standards are adhered to in the construction phase of a pipeline. The testing, examination, and qualifications of personnel involved in the construction and inspection of pipelines are also specified.

18. Adopting Section 2176 Integrity Testing

Section 2176 identifies the applicable federal code sections for pressure testing newly constructed pipelines and relocated pipelines to ensure they will not leak.

19. Adopting Section 2176.1 Pressure testing requirements
    This section specifies that water must be used as a test medium in pressure tests.

20. Adopting Section 2176.2 Spike test requirements
    Section 2176.2 provides detailed procedures for conducting a spike test and applicable time intervals for an acceptable test. It also identifies the appropriate federal regulations that must be followed when conducting a spike test.

21. Adopting Section 2176.3 Integrity testing notification
    Section 2176.3 requires operators to notify the OSFM of a pressure test or in-line inspection.

22. Adopting Section 2177 Emergency Planning and Preparedness
    This section provides a list of applicable sections in the regulations related to emergency planning requirements, analysis, training, and response.

23. Adopting Section 2177.1 Emergency planning zone inventory and map
    Section 2177.1 provides details to operators on what information must be contained in an emergency planning zone inventory and map. It also specifies that the local lead agency must receive a copy. The material must be updated on a regular basis, with the information being conveyed to sensitive receptors within the emergency planning zone within a specified time frame.

24. Adopting Section 2177.2 Vapor dispersion analysis
    This section provides detailed information to operators on when, how, and what data must be incorporated in a vapor dispersion analysis. The analysis must be reviewed and updated annually and account for changes in the modeling program.

25. Adopting Section 2177.3 Emergency training
    Section 2177.3 details mandatory trainings that operators must engage in with first responders, interested parties, and other persons or entities that are located within an emergency planning zone. Training must include how to identify a carbon dioxide release, evacuation routes, and symptoms of carbon dioxide exposure, among others. Each training must be recorded and posted online for review at any time by interested parties.

26. Adopting Section 2177.4 Emergency preparedness materials
    Section 2177.4 specifies that operators must develop emergency

preparedness materials for distribution to sensitive receptors within an emergency planning zone. Data collection related to the number of affected entities and language, as well as contact information, is needed so that operators can implement this information into communication materials and evacuation planning.

27. Adopting Section 2177.5 Emergency response
This section directs operators to plan and prepare ahead of time to have the necessary tools and materials to respond to an emergency. This also requires operators to send an automatic notification to sensitive receptors in an emergency planning zone. The message must notify that an emergency exists and what steps to take until the emergency is over. Notification should be made in English and other languages commonly understood in the area. A pipeline rupture will result in the pipeline remaining non-operational until approval for restart is obtained from the OSFM.

28. Adopting Section 2177.6 Effectiveness Review
This section directs operators to review and update their emergency training, preparedness, and response plans on a 4-year basis.

29. Adopting Section 2178 Operations and Maintenance
This section specifies the level of purity of carbon dioxide transported by pipeline and prohibits the operation of a carbon dioxide transportation pipeline that does not meet the specifications of these regulations.

30. Adopting Section 2178.1 Signs
Section 2178.1 requires the posting of signs and contact information along pipeline rights of way where operators may be reached at all times.

31. Adopting Section 2178.2 Security of facilities
Section 2178.2 mandates that security measures be taken to prevent unauthorized entry into pump and compressor stations.

32. Adopting Section 2178.3 Smoking or open flames
This section prohibits smoking and open flames in pump and compressor stations or other facilities where flammable liquids and vapors could exist.

33. Adopting Section 2178.4 Excavated trenches
This section is designed to ensure appropriate safety precautions are taken to protect personnel from hazardous vapors through proper equipment, tools, and rescue harnesses.

34. Adopting Section 2178.5 Inspections
Section 2178.5 sets minimum scheduled inspections for pipelines right-of-way and specifies what must be inspected.

35. Adopting Section 2178.6 Land movement
    Section 2178.6 focuses on geologic hazards such as land subsidence on or adjacent to pipeline rights of way.

36. Adopting Section 2178.7 Depth-of-cover survey
    This section directs operators to conduct a depth of cover survey at least once every 5 years to confirm that the depth of cover over a pipeline complies with the regulations. Areas identified as having instances of washout, flood, or other geologic conditions that lend themselves to the removal of cover, pipelines must be inspected at least every 3 years. Where deficiencies are identified, remedial action must take place within 1 year of completing inspections.

37. Adopting Section 2179 Internal Corrosion Control
    This section requires operators to establish a monitoring and mitigation program to address corrosive effects on internal portions of pipelines and implement technologies to mitigate those corrosive effects. This includes the limitation of water and hydrogen sulfide within the product stream. Evaluation time frames are also established.

38. Adopting Section 2180 Notifications and Submissions
    This section directs operators to a monitored email address for required notifications that have been identified throughout the regulation language.

39. Adopting Section 2180.1 New construction, replacement, or relocation
    This section specifies the form that must be filled out and filed with the OSFM prior to construction, replacement, or relocation of a pipeline.

40. Adopting Section 2180.2 Notification of Rupture or Potential Rupture
    This section describes what instances of a rupture or potential rupture require notification to the OSFM and what process to follow when making those notifications. A definition of rupture is also provided.

41. Adopting Section 2181 Record Retention
    This section explains that records must be maintained for the life of the pipeline that demonstrate compliance with the regulations, as well as basic pipeline information related to construction, design, sensitive receptors, testing, inspections, and review. All records must be transferred to a subsequent owner or operator if the asset is sold or transferred.

42. Adopting Section 2182 Enforcement
    This section identifies where OSFM enforcement authority can be found in relation to process and penalties within the existing statutory authority to regulate pipelines.

Problem Intended to be Addressed

Reference: Government Code Section 11346.2(b)(1)

On January 1, 2026, Senate Bill 614 (SB 614) became effective. As SB 614 applies to OSFM, it amended Government Code Section 51010.5 to include relevant definitions for the regulation of carbon dioxide pipelines. It also enacted Government Code Sections 51011.5, 51011.6, 51015.06, and 51018.9 to the existing California Pipeline Safety Act. SB 614 directs the OSFM to adopt regulations for the safe transportation of carbon dioxide that are, at a minimum, as protective as federal PHMSA draft regulations published on January 10, 2025 (RIN 2137-AF60). Ultimately, the PHMSA regulations were never adopted. SB 614 also established that regulations adopted by OSFM are considered emergency regulations for purposes of the Administrative Procedures Act, exempt from time limited renewal under emergency regulation, are not considered major regulations, and that regulations must be adopted by July 1, 2026. Subsequent amendments to the regulations may be made as the OSFM sees fit.

Prior to the passage of SB 614, statutes were put in place by the legislature preventing the construction and operation of carbon dioxide transportation pipelines, until PHMSA adopted regulations governing their operation and additional safety measures. Because PHMSA never adopted those regulations, the moratorium remains in effect until the OSFM adopts the proposed regulations. Once adopted, the moratorium will be lifted, and operators can begin the necessary steps and processes to permit and construct carbon dioxide transportation pipelines within California.

The Legislature and the Executive branch recognize the importance of reducing emissions, and carbon capture and sequestration are an important component to reaching that goal. California has set a net neutrality emissions date of 2045. To reach that goal, carbon dioxide pipelines will need to be constructed to transport carbon dioxide from point sources or through direct air capture and move the product to designated sequestration locations throughout the State. Currently, there are no carbon dioxide transportation pipelines in California.

Carbon dioxide is an asphyxiant and presents unique challenges, such as preventing internal combustion engines from operating above certain concentrations. Furthermore, should a carbon dioxide pipeline fail, the resultant release poses an immediate threat to the health and safety of people located in the impacted release area. Adverse health effects can result, such as confusion, unconsciousness, and potential death, as carbon dioxide is an asphyxiant and heavier than air. Because there is no existing comprehensive safety regulatory scheme at the federal level, the Legislature tasked OSFM with developing the necessary regulations to establish such a program. The broad objective of the proposed regulations is to fulfill the mandate to adopt comprehensive carbon dioxide regulations for the safe operation of these pipelines and the preservation of the public peace, health, safety, and general welfare of the citizens of California.

Carbon dioxide, also known as CO2, is an odorless, colorless, and non-flammable gas at standard atmospheric temperature and pressure. Depending on the pressure and temperature, carbon dioxide may exist in the solid, liquid, gas, or supercritical phase, or some combination of the above. Depending on the source, end-use application, and operating conditions, carbon dioxide may be transported by pipeline in the gas, liquid, or supercritical phases, or some combination of these phases. Regardless of phase, exposure to carbon dioxide can entail public safety and environmental risks. When released from a pressurized system, carbon dioxide vaporizes immediately upon release. Because carbon dioxide has a density of 1.5 times that of air at standard temperature and pressure, released carbon dioxide vapor clouds can sink and displace oxygen before dissipating, potentially resulting in asphyxiation of human life. Asphyxiation can result in a range of adverse health consequences, ranging from the mild or transient (including light-headedness, nausea, headache, sweating, rapid breathing, increased heartbeat, shortness of breath, dizziness, mental depression, visual disturbances, or shaking) to more severe or permanent (short-term unconsciousness, permanent brain damage, or death), depending on the exposure duration and concentration. Hazardous levels generally start at approximately 7 percent carbon dioxide in the atmosphere, with more acute consequences at higher concentrations. Animals are also susceptible to the consequences of carbon dioxide asphyxiation.

As with carbon dioxide transported by other modes of transportation, the principal risks to public safety and the environment associated with carbon dioxide pipeline transportation arise from the asphyxiation hazard in the event of a release. Pipeline transportation of carbon dioxide generally occurs at pressures well in excess (generally above 1,200 pounds per square inch, or psi) of standard, atmospheric pressure (14.7 psi), resulting in particularly severe hazards. Releases from pipelines operating under such high pressures, combined with the inherent properties of carbon dioxide (i.e., vapor pressure of carbon dioxide and the corresponding partial pressure of carbon dioxide in air), result in rapid de pressurization and expansion, potentially creating odorless, invisible vapor cloud(s) of carbon dioxide that will generally displace oxygen within the area (due to the relative density of carbon dioxide as compared to air). Compounding this concern, simulated ruptures with identical characteristics (location, length, duration, etc.) on pipelines with identical operating parameters (pressure, temperature, etc.) indicate that a significantly larger percentage of the initial mass of carbon dioxide in the pipeline will be immediately released from a rupture on a carbon dioxide pipeline than the percentage of the initial mass of natural gas in the pipeline that would be released from a natural gas pipeline. The released vapor cloud of carbon dioxide, which is larger (as a percentage of the initial amount of carbon dioxide in the pipeline) than a corresponding natural gas release, may not dissipate to safe levels quickly. In addition, the vapor cloud may travel a significant distance from the release location before enough dispersion into the surrounding atmosphere occurs to reach a safe concentration. This risk is exacerbated in low lying areas by the potential for settling (due to carbon dioxide’s relatively high density). The above discussion corresponds with real-life conditions observed during a 2020 accident on a supercritical-phase carbon dioxide pipeline near Satartia, Mississippi.

In addition to the asphyxiation hazard, releases from carbon dioxide pipelines also entail other risks to public safety and the environment. Rapid depressurization of carbon dioxide upon release results in sharp, significant localized temperature drops, which compound pipeline integrity concerns by making the pipeline more prone to brittle fracture and creating additional hazards (e.g., frostbite) for emergency response and maintenance personnel. The initial force of the rupture itself can also create pressure waves that may present internal hemorrhaging hazards for operator personnel and the public and damage equipment in the immediate vicinity. Additionally, although much existing carbon dioxide pipeline infrastructure transports relatively high concentrations of naturally occurring carbon dioxide, the increasing interest in carbon dioxide pipeline infrastructure supporting carbon capture, utilization, and storage applications is expected to involve pipeline transportation of carbon dioxide commodity streams containing a greater proportion of, or more diverse, hazardous constituents that (when released) would themselves pose significant public safety and environmental risks.

The public safety and environmental risks of carbon dioxide pipelines described above are potentially amplified depending on their location. The 2021 PHMSA annual report data notes that operators report approximately 10 percent of existing pipelines transporting supercritical-phase carbon dioxide as located in areas that could affect High Consequence Areas (HCA): areas defined by PHMSA regulations at 49 CFR § 195.450 as commercially navigable waterways or densely populated urban areas and other populated areas. According to PHMSA, this value could understate the existing carbon dioxide pipelines from which a release could, in fact, affect an HCA, given that some operators (including the operator involved in the 2020 Satartia accident) have misidentified pipeline segments that could affect HCAs. PHMSA anticipates other carbon dioxide pipeline operators may be similarly understating the mileage of their pipeline systems that could affect HCAs; operators of hazardous liquid and Highly Volatile Liquid (HVL) pipelines (such as anhydrous ammonia, liquified petroleum gas, propane, butane, and ethane, among others) report approximately 40 percent of their pipelines are located in areas that could affect HCAs, and carbon dioxide pipeline transportation is not inherently more remote in nature than hazardous liquid and HVL pipeline transportation. Should new carbon dioxide pipelines be located disproportionately near communities with environmental justice concerns, those communities (many of whom have limited adaptive opportunities due to more limited economic opportunities and limited access to social and information resources) would be more likely to suffer acute adverse impacts of a pipeline failure. The addition of a new requirement for vapor dispersion analysis is designed to reduce any risks disproportionately borne by those communities.

The anticipated benefits, including non-monetary benefits to the protection of public health and safety, and the State’s environment, include:

- Removing or preventing the emission of carbon dioxide to the atmosphere.

- Established safety standards for pipeline design, fracture mechanics, pipeline materials, valve materials, pipeline location, potential impact areas of a release, land movement, potential future odorant requirements, operation, leak detection, emergency response, carbon dioxide contaminants, and maintenance.

Proposed Action is Reasonably Necessary

Reference: Government Code Section 11346.2(b)(1)

1. Adopting Section 2170 Definitions
   Section 2170 establishes definitions for terms used in the proposed regulations specifically related to Article 9. These definitions are reasonably necessary to create structure and clarity for the proposed regulations. The definitions further avoid confusion regarding terms that may be susceptible to multiple interpretations.

   Until the passage of SB 614, the OSFM's jurisdiction was limited to hazardous liquid transportation pipelines. The expansion of its oversight into carbon dioxide necessitates the addition of definitions related to the new functions of the OSFM, and is designed to assist the regulated community in understanding what pipelines are covered by these regulations.

   For example, the OSFM must adopt PHMSA's minimum standards as directed by California statute. That means that our definition of Carbon Dioxide must be "a fluid consisting of more than 50 percent carbon dioxide molecules in any combination of gas or dense phases." This definition brings all carbon dioxide transportation pipelines under the OSFM's jurisdiction, regardless of phase transported, but it must also be a majority composition of carbon dioxide. In subsequent regulation language below, the OSFM elected to restrict the transportation of carbon dioxide by pipeline to a dense phase consisting of 90 percent carbon dioxide molecules. Similarly, the OSFM restricted its jurisdiction over facilities. This was done for safety purposes and to clarify and eliminate overlapping jurisdiction between production, processing, and transportation.

   However, in crafting the definitions section, the OSFM recognized that certain terms needed to be defined to address later requirements in the regulations and avoid confusion.

2. Adopting Section 2171 Incorporated by Reference
   Section 2171 states specific forms that must be used, as well as studies, standards, and practices that are incorporated by reference. This section includes the titles and versions of these documents for specificity, as multiple versions of these documents may exist. These technical standards are comprehensive peer reviewed materials that are generally accepted within pipeline safety as accepted standards and practices for the safe operation of

pipelines.

API Specification 5L, “Specification for Line Pipe,” which is already incorporated by reference into federal regulations at 49 CFR part 195, prescribes the minimum requirements for the manufacture of new seamless and welded steel line pipe. OSFM proposes to incorporate this standard by reference into the regulations, and it is relevant to “Fracture propagation” and the sections within 2174. Within API Specification 5L, requirements for toughness testing are specified, including Charpy v-notch testing and drop weight tear testing, both of which are required for certain carbon dioxide pipelines in federal regulation at 49 CFR § 195.111.

This section also incorporates the PSD-104 form for construction related activities. Operators are required to fill out this form and submit it to the OSFM, and denote necessary information pertinent to conducting inspections. Information about the operator, product in the pipeline, reasoning behind the construction project, scope of work, drawings, data sheets, schedule, approved permits, vapor dispersion and plume modeling, EFRD study and risk analysis, emergency planning zone inventory and map, and emergency preparedness materials are all required under the proposed regulations. This form will assist the OSFM and operators in ensuring all facets of the proposed regulations are met, while providing the OSFM with the needed information to conduct inspections on construction projects. Importantly, this data can then be collected and analyzed to determine what areas of pipeline operations should be focused on in subsequent years. Additionally, this information can be used by the OSFM in crafting revisions to its regulatory programs to more appropriately address known or possible safety concerns or eliminate redundant or ineffective regulatory requirements.

3. Adopting Section 2172 Pipelines Subject to This Article
Section 2172 provides the OSFM’s jurisdiction over specific pipelines related to the transportation of carbon dioxide. It also provides exceptions for a variety of pipelines that fall outside the OSFM’s statutorily defined authority. This section informs the regulated community of the types and kinds of pipelines that will be subject to this Article. The focus is on transportation pipelines falling outside of facilities, and it is necessary to ensure both operators and OSFM properly delineate the scope of the regulations' applicability. The definition further prevents jurisdictional overlap between the OSFM and other state, local, or federal agencies where possible.

OSFM understands that there is no explicit statute allowing the Office to regulate the storage of carbon dioxide in long-term underground storage facilities. OSFM also recognizes that production side piping falls outside of its authority. Long-term underground carbon dioxide storage facilities are already subject to regulatory oversight by other authorities. For example, long-term, geologic sequestration facilities and the fluids that are injected into them are regulated by the U.S. Environmental Protection Agency (EPA), which regulates underground injection through its Underground Injection Control (UIC) program, the Greenhouse Gas Reporting Program (GHGRP) and associated regulations, as well as other regulatory authorities. While the EPA establishes minimum standards and criteria for UIC programs, most States are responsible for regulating and permitting wells designated as Class I through V, including Class II recovery wells. In 2010, the EPA added Class VI wells to the UIC program specifically to regulate the underground injection of carbon dioxide for geologic sequestration.

The OSFM therefore proposes to add an exception at 2172(b)(1) that exempts production and processing facilities pipelines "Through piping or equipment used in the production (including flow lines), extraction, recovery, lifting, stabilization, separation, or treatment of carbon dioxide or the preparation of carbon dioxide for transportation by pipeline at production (including flow lines), refining, or manufacturing facilities. This exception does not apply to any device and associated piping that are necessary to control pressure in the pipeline under 49 CFR § 195.406(b)." And exempts pipe at 2172(b)(2) "Transportation of carbon dioxide downstream from the outlet of the pipeline isolation valve located at the wellhead of an injection well used for long-term carbon dioxide storage."

The exemptions above notably include an exception to the exemption. Specifically, any device necessary to control pressure in the pipeline falls under OSFM jurisdiction. This is a safety measure to ensure our office inspects and oversees equipment that can impact the safe operation and pressurization of a pipeline.

This section is necessary to ensure operators understand what facilities are and are not regulated, while also recognizing OSFM's existing statutory limitations on what pipelines fall under its jurisdiction. This section furthers that purpose, and should the Legislature determine that authority over production or inplant piping is necessary in the future, those changes may be made legislatively.

4. Adopting Section 2173 Carbon Dioxide Pipeline Safety Program
   Section 2173(a) clarifies and directs readers to the appropriate federal regulations for reference and identifies which rule of law shall apply where multiple standards may exist.

   Section 2173(b) This section specifies timing for compliance relating to written procedures that must be in place 6 months after the effective date of the regulations, January 1, 2027. Operators are required to review their manual and also establish a public engagement program covering construction and throughout the life of the pipeline. This information is the necessary groundwork for the OSFM to ensure the proper start and continuation of a newly regulated industry within the OSFM purview and ongoing jurisdiction. This section also provides one of the primary inspection tools that OSFM uses when conducting inspections, written procedures. The OSFM reviews written procedures to ensure compliance with State and federal laws.

Section 2173(c) requires the development and implementation of an engagement program. Operators are required to communicate with the public at various phases of construction and throughout the operation of pipelines. This requirement leads to an informed public and general awareness of the hazards presented when living in an emergency planning zone as a sensitive receptor.

5. Adopting Section 2174 Design Requirements
   Section 2174(a) specifies that all carbon dioxide pipelines must be constructed of new materials and steel. Pipelines previously used to transport materials other than carbon dioxide are not well suited for this service. Previously used pipe and appurtenances demonstrate failure when converted to service through a variety of phenomena, including cracking. This provision is not only required by statute but also ensures that known failure mechanisms are prevented from initial construction and operation, and acts as a general safety measure.

   Subparts C, D, and E of 49 CFR Part 195 contain the design, construction, and pressure testing requirements for hazardous liquid and carbon dioxide pipelines, respectively. When considering how a pipeline is designed and constructed, and any pressure testing performed as part of start-up activities or subsequently, it is important to consider the product transported, including all constituents of the product stream. The properties of carbon dioxide are unique when compared to most hazardous liquids. Due to these characteristics and those of the possible constituents in the product stream, the OSFM proposed (1) enhanced pipeline design requirements to mitigate fracture propagation at section 2174.1, and (2) enhanced valve design requirements to ensure material compatibility at section 2174.3.

   OSFM and the Legislature recognized the safety risks associated with leaks of hazardous liquids and the need for effective leak detection systems on those pipelines. Leaks of any type can degrade into catastrophic failures—sometimes referred to as the “leak-before-break” concept—and may be a particularly significant concern for carbon dioxide pipelines because of the increased potential for brittle fracture due to the Joule-Thomson effect – also referred to as throttling or the cooling of a fluid due to rapid reduction in pressure – at the leak location. Therefore, OSFM proposed leak detection system requirements include all carbon dioxide pipelines. These proposals are covered in more detail below.

   Section 2174(b) identifies the importance of using materials suited for use in carbon dioxide transportation, such as varying temperature ranges, chemical interaction, and identifies federally applicable design standards. This section also references standards from 49 CFR part 195 and ASME B31.4 related to materials and pipe components. These standards ensure proper pipeline design and elimination of potential failure points as much as possible to ensure pipeline integrity and safety. Proper material selection and design further ensure that outside forces such as earthquakes or land movement are accounted for in planning phases.

6. Adopting Section 2174.1 Fracture mechanics
   Section 2174.1 (a) addresses known issues related to material testing for fracture toughness and fracture propagation in the event of pipeline failure. Pipelines in carbon dioxide service that experience failures tend to see a rapid, explosive expansion of gas that may create fracturing that runs the length of the pipeline, known as fracture propagation. Appropriate consideration of the material behaviors when experiencing a failure is a key component to preventing catastrophic failures and limiting the impacts following a failure. Fracture toughness testing is one way to ensure pipeline ductility and fracture propagation resistance under real life release conditions with extreme temperature changes at a pipeline release point. These additional material testing methods and considerations build in an additional safety measure to mitigate adverse impacts in the event of failure.

   Carbon dioxide pipeline operators must consider the full range of relevant parameters to which the pipe will be exposed over its operating lifetime when evaluating resistance to fracture initiation. If unexpected situations or changes in operating conditions result in a change in these parameters during operation, such that they are outside the bounds of those that an operator had previously analyzed, operators will be required to review and update their evaluations and implement remedial measures to ensure continued resistance to fracture initiation. This requirement would require operators to adjust the pipe toughness based on the pipe grade and operating parameters to ensure the pipe toughness is adequate for those factors.

   Operators would also be required to ensure fracture arrest within certain lengths of pipe to prevent long running fractures. Proposed subparagraph section 2174.1(a)(3) would require operators of newly constructed, replaced, relocated, otherwise changed, or converted carbon dioxide pipelines to ensure at least a 99 percent probability of fracture arrest within 8 pipe lengths (not to exceed 320 feet) and at least a 90 percent probability of fracture arrest within 5 pipe lengths (not to exceed 200 feet). Operators can meet this requirement through sufficient pipe toughness and the use of crack arrestors. This proposal would prevent uncontrolled, extensive running fractures, which are fractures that continue from pipe joint to pipe joint uninterrupted.

   Carbon dioxide pipelines would have to pass several tests to demonstrate that the pipeline metal would deform plastically before fracturing and reduce the risk that fractures would initiate. Proposed section 2174.1(a)(4) would require operators of newly constructed, carbon dioxide pipelines to perform toughness testing consistent with industry best practices contained within Annex G of API Specification 5L, including testing methods, acceptance criteria for testing, and required inspection documents

7. Adopting Section 2174.2 Material toughness
   Section 2174.2 describes the toughness properties for pipe related to fracture initiation, propagation, and arrest of fractures through incorporated reference standards. Some materials may not be suitable for fracture arrest as required by section 2174.1 and this section. However, alternative means of achieving fracture arrest must be used, and this section specifies how operators can achieve compliance. This section allows operators flexibility in designing a pipeline to achieve the overarching goal of preventing catastrophic failure and achieving fracture arrest as intended for the protection of health and safety.

   The toughness properties for carbon dioxide pipelines must meet the requirements of Annex G of API Specification 5L, "PSL 2 pipe with resistance to ductile fracture propagation," including the minimum Charpy v-notch absorbed energy requirements. These toughness properties address the potential for the initiation, propagation, and arrest of fractures, and consider any correction factors needed to address the pipe grade, operating conditions, or product compositions that may not be specified in that standard.

   Lastly, to the extent it would be physically impossible for pipe to meet toughness standards under certain conditions, the OSFM requires crack arrestors to halt fractures within the lengths of pipe (i.e., joints of pipe separated by girth welds) specified at proposed section 2174.1(a)(3). Operators would be required to design their pipeline so that, in the case of a failure involving a fracture, the fracture is arrested within five pipe lengths (typically around 200 feet or 61 meters) 90 percent of the time and is arrested within eight pipe lengths (typically around 320 feet or 98 meters) 99 percent of the time. This would allow operators to use alternative means of crack arrest, which could include mechanical means of arrest or design features, such as the use of composite sleeves, spacing, increases in wall thickness at appropriate distances, or other methods to comply with the requirement.

8. Adopting Section 2174.3 Valves
   Section 2174.3(a) specifies the design factors and materials that valves shall be constructed in a manner that is compatible with the carbon dioxide in the pipeline.

   Section 2174.3(b) specifies valve locations, studies, and types of valves as necessary compliance items on the pipelines. Location, studies, and types of valves directly impact the size and impact of a release in the event of pipeline failure. Properly placed valves will limit the amount of product released and therefore the potential impact, harm, radius, and potential evacuation area. This information and implementation of appropriate valves and locations directly correlate to pipeline safety and the health and welfare of sensitive receptors within an impact area. This data can then be used to mitigate those harms, as well as be used in emergency planning and preparedness. These studies are required to be reviewed on occasion as specified within the regulation. Periodic review will ensure that the best safety practices are in place as newer technologies are implemented and developed.

Valve design is a core consideration in the adequacy and safety of design requirements. Non-steel components that are part of the valve trim, such as gaskets, have different chemical properties than the main valve body. Hydrogen sulfide, a common contaminant in both carbon dioxide and hazardous liquid product streams, is corrosive and can degrade incompatible materials. Thus, it is prudent that all parts of valves that are in contact with the product stream be designed for compatibility with the entirety of the product stream, not solely the main commodity being transported. Non-compatibility can result in product leakage, which can harm the environment or persons in the area.

9. Adopting Section 2174.4 Leak detection
Section 2174.4(a) requires pipelines to be equipped with leak detection systems that include a computational pipeline monitoring (CPM) system and a continuous externally based leak detection system that directly detects the presence of carbon dioxide or physical changes in the environment due to a leak. There are numerous ways to determine leak detection on a pipeline. CPM with an externally based leak detection system has proven to be highly effective at quickly identifying and responding to a leak, leading to quicker shutdown times and mitigated harm. OSFM is requiring that each new CPM leak detection system comply with the applicable requirements of the API RP 1130 standard.

CPM systems are algorithmic monitoring tools used by pipeline operators to enhance their ability to recognize hydraulic anomalies on pipelines that may indicate a release of product. CPM systems are used for leak detection purposes and can vary in sensitivity, reliability, accuracy, and robustness performance measures. On liquid pipelines, API RP 1130 is the most widely used industry recommended practice related to CPM leak detection systems. CPM systems can include line balance methods, real-time transient models, pressure and flow monitoring, acoustic and negative pressure wave monitoring, and statistical analysis. CPM systems are not one-size-fits-all; varying types of CPM systems or combinations of CPM systems may be better suited to different operating conditions and pipeline configurations. An ideal CPM leak detection system has a high sensitivity to leaks, timely detection of leaks, accurate alarms, and a robust and reliable algorithm.

PHMSA commissioned a 2012 report evaluating operational experience, utility, feasibility of integration on existing pipelines, and cost-effectiveness of leak detection systems on part 192-regulated gas and part 195-regulated hazardous liquids (as well as carbon dioxide pipelines) produced by Kiefner and Associates, Inc. (Kiefner). The Kiefner report noted that a "leak detection system is the first line of defense in reducing [a leak's] impact" and found that integration of leak detection systems, including CPM leak detection systems, on existing pipelines was generally technically feasible and cost-effective given the existing requirement at 49 CFR § 195.446 for operators to have a supervisory control and data acquisition (SCADA) system that could provide inputs to a CPM leak detection system. Additionally, PHMSA's review of accident data yields that 49 (87.5 percent) of the 56 accidents reported by carbon dioxide operators between 2013 and 2022 involved leaks. Forty two of those accident reports pointed to causes that could have degraded over time, suggesting that earlier leak detection would have resulted in potential avoidance of leak degradation, which ultimately resulted in reportable accidents. As carbon dioxide is denser than air at atmospheric pressure and asphyxiating for people and animals, carbon dioxide is also a GHG and contributes to global climate change. Additionally, other constituents in a carbon dioxide product stream may themselves be hazardous to public safety and the environment or (due to their corrosive properties) further degrade any leak. Leaks from carbon dioxide pipelines also entail a risk of brittle fracture at the leak location due to the rapid temperature drop when carbon dioxide depressurizes upon release, thereby increasing the possibility that a leak can degrade. Recognizing the extensive research and analysis by PHMSA, the OSFM will require leak detection systems on carbon dioxide pipelines.

Section 2174.4(b) identifies the standards that the system must meet to be considered adequate, API RP 1130. This standard requires operating, maintaining, testing, record keeping, and dispatcher training that lead to safer pipeline operations. Leaks on carbon dioxide pipelines can degrade into catastrophic failures because of the increased potential for brittle fracture. The resulting plume can spread over long distances, displacing oxygen and impacting people, wildlife, and the environment. It is important to have a continuous internal and external leak detection system on carbon dioxide pipelines to ensure operators are alerted to leaks and emergency notification systems are activated to limit the consequences of a release and protect human health.

10. Adopting Section 2174.5 Fixed vapor detection, alarm systems, and safety devices

Section 2174.5(a) establishes standards for the safe operation of particular appurtenances found on carbon dioxide pipelines, such as pumps, compressors, meters, valve stations, and other facilities that may be used in the transport of product. These appurtenances may be susceptible to the buildup of harmful constituents, such as carbon dioxide gas, that could incapacitate or harm persons in the vicinity.

Section 2174.5(b) This section specifies safety standards and warning systems that should prevent inadvertent exposure to harmful constituents and a means to remediate those possible events through design and testing. This is achieved through the requirement of monitoring to not more than 25 percent of the NIOSH IDLH for asphyxiation and toxicity of carbon dioxide. This builds in a safety factor to alarm or warn persons through visible or audio means. This warning is designed to protect people from succumbing to environmental hazards that they would otherwise be unaware of and allow them to take steps to prevent harm to themselves or others.

Section 2174.5(c) These alarms may also be an early indicator of a larger problem at facilities, and proper procedures in place and design of facilities should allow for ventilation, emergency shutdown, and equipment shutdown.

Section 2174.5(d) requires that pumping and compressing equipment be located on property under the control of the operator. This requirement ensures that, should an emergency arise, properly trained operator personnel can quickly access the equipment and commence actions to shut down or mitigate potential dangers as quickly as possible.

Section 2174.5(e) requires fire protection to be installed at each pump and compressor station. Fire in a facility that operates via motive power must provide an alternative power source to close pumps that do not power the station. For example, if the station is operated by electrical power, fire equipment must be powered through a battery or compressed gas to actuate necessary fire protection equipment. This is necessary to ensure proper pipeline shutdown and worker protection.

One tool commonly used in industrial applications to identify hazardous concentrations of carbon dioxide in working environments (as well as provide defense-in-depth to other real-time release monitoring systems) is a fixed vapor detection and alarm system. These systems are currently used in a wide range of industries, including the chemical and petrochemical refining industries, large-scale agricultural operations, chemical feedstock production, small- and large-scale laboratories, and food and beverage production and service industries. Depending on the scale of the facility, vapor detection and alarm systems typically have four main components: (1) sensors capable of detecting hazardous concentrations of vapors in the area; (2) a communication system to relay information from the sensors to other systems; (3) a control center to receive alerts of hazardous concentrations; and (4) warning mechanisms for staff in the area.

Sensors used in fixed vapor detection and alarm systems can detect a wide range of hazardous airborne chemicals transported in pipelines, including carbon dioxide. In fixed vapor detection and alarm systems, the sensors are permanently installed at the facility to continuously monitor for hazardous vapor concentrations of all flammable, asphyxiating, and toxic chemicals that are present in the pipeline stream. Depending on the chemical being monitored, sensor technology can include photoionization detectors, infrared analyzers, and combustible gas monitors.

Leaks from pipelines of carbon dioxide are most likely to occur at facilities where personnel may be present intermittently, including pump or compressor stations, meter stations, valve stations, and other facilities (such as launcher and receiver sites for ILI tools, instrumented internal inspection devices, and maintenance activities). Depending on the release rate from the leak and local conditions, personnel entering one of these facilities, whether they are enclosed spaces or not, may unknowingly enter a hazardous situation. For example, if a leak occurred at a meter station transporting carbon dioxide where the concentration in the area exceeded specified limits, a measurement technician entering the station to perform routine maintenance could rapidly asphyxiate and become seriously injured, as the vapor cloud from the released carbon dioxide would not be visible. These types of accidents are preventable through the use of fixed vapor detection and alarm systems, which alert local personnel already working in or about to enter the area of hazardous concentrations through audible and visual alarms. As the system is a fixed system, alarm mechanisms (such as bells, sirens, and flashing lights) are permanently installed at the facility and activate whenever a hazardous concentration is identified by the vapor detection sensors. Operators would be expected to install vapor detection sensors with sufficient capabilities and in adequate numbers and locations to meet the capability requirements of the fixed vapor detection and alarm system described in section 2174.5. These warning alarms occur well before levels reach the specified asphyxiation or toxicity levels. Additionally, as these systems notify a control center of any received alarms regardless of whether personnel are on site, fixed vapor detection and alarm systems forewarn operator personnel of the situation and allow for informed decision-making and preparation in advance of operator personnel entering the hazardous environment. SCADA and CPM systems often do not identify leaks on carbon dioxide pipeline systems prior to personnel working in or near the area or prior to the receipt of notifications of a release from the public or first responders. Hence, these requirements provide further information on potential pipeline leaks not available through traditional CPM or SCADA systems.

In addition to personnel safety, leaks at facilities—including pump or compressor stations, meter stations, valve stations, and other facilities (such as launcher and receiver sites). As these sites may or may not be occupied by personnel, releases can continue for days or weeks before they are identified. As discussed throughout this NPRM, releases of carbon dioxide can contribute to environmental damage through a number of mechanisms, including contributions to climate change. The health and welfare of workers and nearby residents can also be impacted by releases of carbon dioxide, as noted above. Fixed vapor detection and alarm systems would allow operators to identify and correct these releases faster, resulting in reduced volumes of leaked product and fewer consequences to the environment and sensitive receptors.

11. Adopting Section 2175 Construction Requirements
This section directs the regulated community to specific sections that dictate construction requirements.

12. Adopting Section 2175.1 Construction specifications
This section identifies specific practices that must be implemented in addition to ASME B31.4 (incorporated by reference) in designing a carbon dioxide pipeline. Specifically, that longitudinal seam welds must be offset and positioned on the upper half of the pipe. These design requirements set forth extensive construction practices that are developed to prevent known design problems from impacting the safe design of a pipeline. For example, long seams designed to be offset prevent a failure along one pipe length, so that the long seam continues down the length of a connected pipe length. This prevents a “unzippering” of a pipeline that can occur when long seams are aligned. Similarly, corrosion tends to occur more aggressively along long seam welds that are positioned on the lower half of the pipe when it is installed in a trench. These requirements are necessary to prevent known design flaws from compromising the safety and integrity of a pipeline.

13. Adopting Section 2175.2 Protection from hazards
Geotechnical analysis is called out in this section to prevent pipeline damage due to washouts, floods, unstable soil, landslides, ground movement, and subsidence. These issues and others may result in the movement or outside forces impacting pipelines, and lead to failure or release. This is necessary to ensure pipelines are constructed in a manner to avoid the types of geologic loads and forces that are prevalent in California and provide additional safety measures through proactive management.

14. Adopting Section 2175.3 Proximity to sensitive receptors
Section 2175.3(a) instructs operators to choose a pipeline route that avoids potential impacts to sensitive receptors (people and places of gathering as defined in statute) as far as practicable. This language was chosen because carbon dioxide pipeline failures could result in asphyxiation or adverse health impacts. These pipelines should avoid sensitive receptors where possible, but it may be impossible to do so depending on permitting and routing related to a pipeline that are outside of OSFM control.

    PHMSA has a longstanding requirement at 49 CFR § 195.210 that directs operators of new carbon dioxide and hazardous liquid pipelines to select pipeline right-of-way to avoid, as far as practicable, areas containing private dwellings, industrial buildings, and places of public assembly. This is similar to the definition of “Sensitive Receptors” and the “Emergency Planning Zone” identified in the State statute. In keeping with this requirement, and considering the unique risks presented by carbon dioxide pipelines, these regulations propose to add a new requirement for operators of newly constructed pipelines to select a right-of-way (or exist in an existing right-of-way) located within two miles of any residence, business, or place of public assembly to document the reasons such a location was impracticable to avoid. This regulation also requires those operators to perform a population density survey, in accordance with section 2177.4, along the pipeline route to establish an emergency planning zone and distribute emergency preparedness materials. Further details on the proposed population density survey, required communications within the emergency planning zone, and other associated requirements are located within section 2177.4 below.

Section 2175.3(b) In areas where impacts to sensitive receptors could occur within an emergency planning zone, operators must conduct vapor dispersion analysis, provide training to state and local emergency services, provide equipment to those agencies, and distribute emergency preparedness materials to sensitive receptors. These factors are necessary to inform sensitive receptors of dangers, allow emergency responders to plan for an emergency, and provide them with the necessary tools and equipment to address the emergency.

15. Adopting Section 2175.4 Cover over buried pipeline
    Section 2175.4 identifies the depth at which pipelines must be buried to avoid outside damage. A minimum of 48 inches of cover is required. This cover is designed to prevent impacts from agricultural activities or construction activities in a right of way (such as construction in a city street). The vast majority of pipeline failures are the result of impacts from outside forces such as excavation. This section specifying the necessary depth of coverage is designed to protect individuals from harm through pipeline impacts.

16. Adopting Section 2175.5 Installation of pipe in a ditch
    Section 2175.5(a) identifies construction, post construction, and remediation techniques aimed at protecting coatings that prevent pipeline corrosion. Pipeline corrosion is a significant factor that leads to pipe failure. It is necessary to take measures to ensure coating integrity and, therefore, protective action preventing unintended corrosion during construction activities.

    Section 2175.5(b) requires operators to conduct voltage gradient testing within 6 months of placing a pipeline in service. The voltage gradient testing is another method of ensuring the coating on a pipeline is intact. Again, this is necessary to prevent corrosion on the exterior of a pipeline, leading to increased pipeline integrity.

Section 2175.5(c) allows operators to assess coating integrity through other methods, such as through an in-line inspection. However, our office must be notified 90 days in advance of using such alternative methodologies. This will allow the OSFM the time needed to assess the alternative method and raise any concerns with an alternative method. This will also allow our office time to schedule inspections and observe these alternative methods to ensure they meet the intent of the regulation, the prevention of external corrosion, and coating assessment accuracy.

17. Adopting Section 2175.6 Additional construction requirements
Section 2175.6(a) specifies quality assurance and that operators shall develop a quality assurance plan for ensuring that stringent construction standards are adhered to in the construction phase of a pipeline. Pipe inspection, hauling and stringing, field bending, welding, non-destructive examination of girth welds, field coatings, lowering pipe into ditch, padding and backfilling, and hydrotesting are all significant phases in pipeline construction. Inadequate procedures at any one of these phases can result in defects that may ultimately result in a pipeline failure. Starting with comprehensive plans and procedures ensures that a pipeline is built well from the start.

Section 2175.6(b) specifies the requirements for girth welds to be tested in accordance with written procedures, by properly trained personnel, and inspected by a weld inspector, and supplemented by nondestructive testing in accordance with Section 9 of Appendix A of API Std 1104 (except for application to cracks). These requirements are necessary to ensure proper welding that meets acceptable industry standards and will ensure against pipeline failure. Review by trained personnel and nondestructive examination, such as with X-ray, will further ensure proper welding has occurred.

18. Adopting Section 2176 Integrity Testing
Section 2176 identifies the applicable federal code sections, 49 CFR Part 195, Subpart E, for pressure testing newly constructed pipelines and relocated pipelines to ensure they will not leak. It also specifies locations where the public is most likely to encounter a pipeline and imposes integrity testing requirements on those pipe sections. This is necessary to ensure maximum safety to members of the public who are unaware of a pipeline in the area and the risk a failure of one of those pipelines entails. Integrity testing ensures that a pipeline can hold pressure at that moment in time and adds an additional layer of safety through test confirmation.

19. Adopting Section 2176.1 Pressure testing requirements
    This section specifies that water must be used as a test medium in pressure tests. Also, a drying process must take place prior to returning the pipeline to service.

    Pressure tests can be used for a variety of purposes, including establishing MOP and detecting certain anomalies. In a traditional pressure test, the pipeline is filled with a fluid (often water or the transported product), which is then raised to a prescribed pressure and held for an extended duration; loss of pressure during this period may indicate leaks or fracture of the pipeline. Water is an excellent test medium for pressure testing for a number of reasons, including ease of access to the test medium and relative ease when determining the precise location of any test failures through the visible presence of water. In addition, the consequences of a failure during a pressure test using water as a test medium are significantly less than when using the transported product, due to reduced environmental impact and the absence of the threats of flammability, asphyxiation, and intoxication that may be presented by the product stream.

    Carbon dioxide pipelines will operate at very high pressures. And though water and carbon dioxide, when mixed together, can develop carbonic acid that impacts the integrity of a steel pipe, water was still required for pressure testing. This medium was chosen over inert gas because inert gas is more compressible than water and consequently stores a significant amount of energy during the test. This essentially means that if a pipeline undergoing a pressure test with an inert gas failed, the resulting failure would be uniquely catastrophic compared to water. The stored energy in the compressed inert gas is many times more than that of water. The pipe failure would incur a massive explosion that could extend unknown distances down the length of the pipe, similar to a bomb. The material and shockwave from the explosion would be multiple times worse than a failure with water and place sensitive receptors at unnecessary risk. Proper dewatering of a pipeline will be necessary to ensure no adverse effects, such as corrosion, following testing. Pressure testing is necessary because there is no real way to determine if a pipe has no leaks or cracks prior to operation. This is a safety measure.

20. Adopting Section 2176.2 Spike test requirements
    Section 2176.2 provides detailed procedures for conducting a spike test when a hydrostatic pressure test is used as a continual integrity assessment method and provides applicable time intervals for an acceptable test. It also identifies the appropriate federal regulations that must be followed when conducting a spike test.

    Spike hydrostatic pressure tests (spike tests) are a specialized subset of pressure tests and are a useful tool to detect cracks or crack-like defects. In a spike hydrostatic pressure test, the test medium (water) within the pipe is pressurized to a baseline pressure, which is usually the pressure required to establish the maximum operating pressure. Once the pressure is stabilized within the first portion of the baseline pressure test, the pressure is then raised for a short time period to the spike pressure, after which the pressure is lowered to the baseline test pressure for the remainder of the test, which is longer in duration than the spike portion of the test. Using water when performing a spike test results in a lower risk to the public and the environment than using a commodity product. OSFM recognizes that water remaining in the pipeline after a hydrostatic pressure test can result in higher-than-normal levels of internal corrosion due to the reaction of water with the carbon dioxide and the formation of hydrates. OSFM urges operators to adequately dewater until dry any pipeline that is intended to transport carbon dioxide and is pressure tested using water to prevent the acceleration of internal corrosion. Operators are also required to develop a procedure to address dewatering following a pressure test at section 2176.1.

The spike test is a safety measure that further demonstrates integrity when operators use hydrostatic pressure testing as a continual assessment method. A spike test is necessary to determine that a pipeline can safely operate under standard conditions but it also establishes a pipeline can operate in abnormal operating conditions. All new pipelines are required to undergo pressure testing prior to commencing operation. The addition of a spike test further ensures that any defects on the pipeline are revealed before an incident happens.

21. Adopting Section 2176.3 Integrity testing notification
    Section 2176.3 requires operators to notify the OSFM of a pressure test or in-line inspection. The OSFM regularly inspects and attends these types of tests as regular functions of an oversight agency. The notification allows us time to schedule meetings and observe the testing process to ensure compliance with applicable code sections, further ensuring pipeline safety.

22. Adopting Section 2177 Emergency Planning and Preparedness
    This section provides a list of applicable sections in the regulations related to emergency planning requirements, analysis, training, and response.

    Federal regulations at 49 CFR Part 195 require operators to have written procedures for responding to emergencies involving their pipeline system to ensure a coordinated response to a pipeline emergency. This response includes communicating with fire, police, and other public officials promptly in the event of an emergency and establishing communications with emergency response organizations for mutual preparedness.

    OSFM is requiring emergency response plan requirements through additional measures to ensure prompt and effective emergency response coordination and address the unique risks to public safety and the environment posed by pipeline transportation of carbon dioxide. Those risks were underscored by the 2020 Satartia accident; inadequate emergency response figured prominently in PHMSA's failure investigation report, which found that the operator did not promptly notify local emergency responders of the carbon dioxide release on their pipeline or establish appropriate communication prior to the accident with all organizations that responded to the accident.

The subsequent sections propose additional training for emergency responders. Also, the regulations propose that carbon dioxide pipeline operators provide local emergency response organizations with equipment, instruments, tools, and materials needed to respond to an emergency on a carbon dioxide pipeline and train those personnel on the proper use of such equipment, instruments, tools, and materials.

Carbon dioxide pipeline operators must communicate with the affected entities, including the general public (using data collected from population density surveys), during an emergency to inform them of the emergency and provide public safety information, coordinating with emergency response organizations for a consistent and clear message to the public. The sections below discuss each of these proposals in more detail.

23. Adopting Section 2177.1 Emergency planning zone inventory and map
Section 2177.1(a) provides details to operators on what information must be contained in an emergency planning zone inventory and map. It also specifies that the local lead agency shall receive a copy. The information contained within this section is necessary to assess emergency preparedness and ensure sensitive receptors identified within emergency planning zones are communicated with effectively and notified in the case of an emergency in a language or format of communication that is understandable to them. Simply knowing a sensitive receptor is in the area is insufficient if you cannot effectively communicate with them.

    2177.1(b) specifies that the material must be updated on a regular basis, with the information being conveyed to the OSFM every three years, at a minimum. The OSFM is tasked with reviewing this information for accuracy and, therefore, must receive it on a regular basis for assessment.

    2177.1(c) and (d) direct operators to review their data every year, not to exceed 15 months. It also requires operators to annually update sensitive receptors within the emergency planning zone. These time frames recognize that people and sensitive receptors are not stationary and may come and go, requiring updates and keeping those parties informed.

24. Adopting Section 2177.2 Vapor dispersion analysis
Section 2177.2(a) states that operators must complete a vapor dispersion

analysis where other sections of this Article have identified that one is needed. Because a vapor dispersion analysis may be called for in multiple instances, it was logical to create a section specific to those requirements and refer to this section for execution of an analysis.

Section 2177.2(b) requires an engineering based model and analysis to determine the distance a release could affect sensitive receptors within the emergency planning zone. This model and analysis must consider a host of factors, including physical and thermodynamic properties of carbon dioxide, to include operating pressure, temperature, flow rate, density, vapor pressure, diameter of the pipeline, release volume, distance between isolation points, release rates, composition, concentration, asphyxiation, toxicity, topography, weather, wind, and other factors. This is an extensive list, but given the complex nature of a carbon dioxide pipeline failure, many factors must be considered. Importantly, these measures are necessary because carbon dioxide gas is heavier than oxygen and will displace it while following the topography of the area where a release has occurred. This means that carbon dioxide can pool in valleys or low lying areas near a release and remain in high concentrations while being invisible to the naked eye. A thorough vapor dispersion analysis will inform emergency planning, sensitive receptors, and emergency response in properly responding to an emergency to mitigate potential harms.

This is necessary for safety related purposes and notifying decision makers in permitting but also sensitive receptors and emergency planning. For example, in the Satartia, Mississippi incident, the operator’s carbon dioxide vapor dispersion model significantly underestimated the potential area that could be impacted by a release. Prior to the accident, the operator had used a third-party vapor dispersion model to determine the areas around the pipeline that could be affected by a pipeline release. That model—performed nearly a decade (in 2011) before the accident and based on an airborne concentration limit (30,000 ppm) well below NIOSH’s 40,000 ppm IDLH threshold—significantly underestimated the area that could be affected. The operator had not supplemented that vapor dispersion modeling with an overland spread analysis. As a result, the operator did not identify the ruptured pipeline segment as a pipeline segment that could affect an HCA (namely, Satartia, Mississippi). In addition, the operator did not include Satartia in its public awareness plan. In the hours after the accident, local emergency responders used a plume model generated by the National Weather Service when deciding to evacuate Satartia after determining the released carbon dioxide would move directly toward the town. Air sampling conducted in Satartia (roughly a mile from the accident), which began roughly three hours following the accident and ended the next day, showed outdoor carbon dioxide concentrations as high as 26,000 ppm and indoor concentrations as high as 28,000 ppm.

Operators are required to conduct a vapor dispersion analysis where sensitive receptors could be impacted within an emergency planning zone. But as noted above, gas clouds do not respect manmade or arbitrary delineations of distance (such as within 2 miles of a pipeline on either side). This is relevant because vapor dispersion analysis may reveal impacts to sensitive receptors outside of the emergency planning zone. The mere fact that a sensitive receptor resides outside of the emergency planning zone does not negate an operator's responsibility to respond accordingly. It is the responsibility of the operator to take appropriate actions to notify and minimize harm to those areas projected to be impacted by the vapor dispersion analysis, regardless of proximity to a pipeline.

Section 2177.2(c) requires updates to the vapor dispersion analysis on an annual basis, not to exceed 15 months. This will allow operators to incorporate newer or better modeling techniques while also incorporating data from updated emergency planning zones and sensitive receptors. This will maximize the accuracy of the analysis and, in turn, inform emergency planning to address potential pipeline failures in the safest manner possible.

This section is exceptionally important, as evidenced by the 2020 Sartatia accident. There, the operator performed a vapor dispersion analysis to determine whether its carbon dioxide pipeline could affect HCAs, similar to sensitive receptors in an emergency planning zone. However, that analysis employed a software model lacking the ability to account for changes in terrain affecting the movement and channeling of the released carbon dioxide vapor (including trees and local topography), such that its results did not predict the possibility of released carbon dioxide affecting HCAs (namely, the nearby village of Satartia). In addition to that modeling limitation, the operator chose assumptions when performing its vapor dispersion analysis that were similarly were inadequately conservative to result in modeling that correlated to the real-world event; this was shown by carbon dioxide concentration readings taken in occupied buildings nearly four hours after the accident, which nearly exceeded the operator’s chosen exposure limit. The operator similarly did not update its vapor dispersion analysis to reflect updates to that software by its vendor in the years between the initial completion of the analysis in 2011 and the accident in 2020. The operator also did not perform an overland spread analysis before the accident; rather, the operator initiated that analysis after the accident and completed it a year later. As a result, the operator failed to identify that pipeline segments nearest to Satartia could affect the village.

25. Adopting Section 2177.3 Emergency training
Section 2177.3(a) details mandatory trainings that operators must engage in with first responders, interested parties, and other persons or entities that are located within an emergency planning zone.

Training shall be offered to all emergency responders and interested parties, including hospitals and residents, local businesses, and other utilities within the emergency planning zone. The training must include how to identify a carbon dioxide release, alarms and alerts, evacuation routes, and symptoms of carbon dioxide exposure, among others. These trainings are imperative to prepare a community for the potential life threatening hazards present in a carbon dioxide pipeline failure. This information is necessary to plan for individuals and at the local level. Not only are first responder trainings needed about the unique challenges, such as combustion engines not working in a carbon dioxide gas cloud, but hospitals and medical personnel must be ready to address large scale triage for impacts where high volumes of sensitive receptors are impacted. These trainings are fundamental to mitigating the health and safety impacts of a pipeline failure.

Local emergency response organizations, especially those in disadvantaged or low-income areas, may be less familiar with carbon dioxide pipeline emergencies and the proper equipment, instruments, tools, and materials necessary for responding to such events. Thus, filling this knowledge gap by requiring operators of carbon dioxide pipelines, who are best positioned to have expertise and familiarity with carbon dioxide pipeline emergency response, to train local emergency response personnel on how to use the equipment, instruments, tools, and materials necessary when responding to a carbon dioxide pipeline emergency is prudent both for emergency responder safety and public safety. Some emergency response organizations may not be equipped with these devices; thus, emergency responders may be unfamiliar with their proper use. The needed equipment, instruments, tools, and materials for a carbon dioxide pipeline emergency can be costly. Local emergency response organizations, many staffed primarily by volunteers, may not have sufficient resources to acquire the needed equipment, instruments, tools, and materials to respond properly to an emergency on a carbon dioxide pipeline. This section would require carbon dioxide pipeline operators to provide local emergency response organizations with the equipment, instruments, tools, and materials necessary for responding to an emergency on a carbon dioxide pipeline.

2177.3(b) requires each training to be recorded and posted online on the operator's website, the OSFM website, and shall be provided to State and local emergency management agencies. The posting will allow for sensitive receptors to review the training at any time, ensuring they are aware of the steps to take in a declared emergency.

2177.3(c) requires pipeline operators to provide local emergency response teams with training on equipment, instruments, tools, and materials necessary for use in the event of an emergency. Giving first responders the proper tools to address a pipeline failure will help mitigate the potential threats to the health and welfare of sensitive receptors.

26. Adopting Section 2177.4 Emergency preparedness materials
Section 2177.4 specifies that operators must develop emergency preparedness materials for distribution to sensitive receptors within an emergency planning zone. Data collection related to the number of affected entities and language, as well as contact information, is needed so that operators can implement this information into communication materials and evacuation planning. The materials shall also include information on what to do in the event of a carbon dioxide release, such as evacuation or shelter-in-place. The materials shall also describe symptoms of exposure to a carbon dioxide release and recommendations for air monitors and air supply respirators. These factors are essential to increase the chances of avoiding the harmful impacts of exposure to carbon dioxide release.

The initial effects of most pipeline ruptures, including those on pipelines transporting carbon dioxide, hazardous liquid, and natural or other gases, are often energetic and involve an initial explosion followed by the sound of pressurized product escaping from the pipeline. To the public that might be near the pipeline at the time of rupture, these events can be observed and recognized quickly, regardless of the product being transported. However, carbon dioxide has physical characteristics that lead it to be transported to locations well beyond the distance at which the general public would see or hear indications of the initial rupture. Other types of emergencies on pipeline systems, such as overpressure events and equipment failure, may be even more difficult for the public to identify. While most other products transported under Part 195 produce visible signs of a release or an easily recognizable odor, carbon dioxide is both odorless and colorless. Natural gas, which is also naturally odorless and colorless, is often transported near and through populated areas with an odorant to aid in the detection of smaller releases and leaks. In addition, in the event of a pipeline rupture or other emergency, the released natural gas is naturally buoyant in the surrounding air and thus not likely to be transported over a large distance at the ground level, where it could affect an unaware public. There is no commercially available odorant approved for use in carbon dioxide pipeline systems, and no existing guidance or industry standards on odorizing carbon dioxide pipelines. Studies note that “further investigation is needed into the interaction of specific impurities associated with captured carbon dioxide” with odorants, as well as how different phases of carbon dioxide may affect odorization. Some constituents of carbon dioxide product streams, such as hydrogen sulfide, can produce a smell and faint visible color; however, these constituents are unreliable for detecting carbon dioxide vapor clouds and present their own health and safety risks. Without the ability to odorize carbon dioxide, the only reliable method for the public to identify carbon dioxide vapor clouds and potentially hazardous concentrations of carbon dioxide within those clouds is carbon dioxide detectors. While carbon dioxide detectors are commercially available to individual consumers, they are costprohibitive for many families (costs are upwards of $250 per detector), and since carbon dioxide is a normal component of air, those consumer detectors are typically designed for monitoring purposes, not alarm purposes (as opposed to a carbon monoxide or smoke alarm detector). Maximum detection capabilities for commercially available, residential carbon dioxide detectors can be as low as 1,200 ppm (well below concentrations that can cause asphyxiation) and are only intended for use in small, enclosed spaces, such as bedrooms or offices.

Without a readily available method of detection at their disposal, the public is entirely reliant on information provided to them by others to know when emergencies that could affect public safety occur on carbon dioxide pipelines. While the primary responsibility for informing the public about pipeline emergencies in their area, including make-safe actions and areas to avoid, falls upon the appropriate emergency response organizations for that jurisdiction, carbon dioxide pipeline operators are also well-positioned to bear some of the burden of informing the public about ongoing pipeline emergencies. The pipeline operator will often have the most complete and up-to-date knowledge on many aspects of the emergency, including the circumstances of the release, ongoing remediation activities, characteristics of the released product and any deleterious constituents, and potentially hazardous areas. Operators' direct notification to the public of some emergency response information can reduce delay in the distribution of that information by emergency response personnel. Timely receipt of that information, when properly coordinated with emergency response officials for clear and consistent messaging to the public, can help prevent fatalities and injuries by notifying the public of unsafe areas and health conditions to watch for, among other information.

Some members of the public and the working group assembled by the OSFM noted that gathering data on the population could present significant challenges. However, the OSFM believes that the safety of the individuals in proximity to these pipelines is paramount. Gathering data that can help to inform the public in the case of an emergency is an overriding concern that cannot be ignored, given the significant health risks a carbon dioxide failure poses.

OSFM proposes to require all onshore carbon dioxide pipeline operators to notify all affected entities (including, but not limited to, the general public) in the vicinity of the pipeline as soon as practicable during an emergency on a carbon dioxide pipeline. Affected entities include residents, occupants, schools, hospitals, businesses, and other similar institutions. These communications must be conducted in English and in other languages commonly understood by a significant number and concentration of the non-English speaking population in the operator's area. These proposed notifications from the onshore carbon dioxide pipeline operator to the affected entities would be required to be prompt and timely, such that the information provided is useful to the affected entities for accident awareness and the interest of public safety. Affected entities would be taken to mean all members of the public who work or reside in the 2-mile emergency planning zone on either side of the pipeline, as well as any municipalities, school districts, or businesses in those same area(s).

Recent events at a facility in Garden Grove, California, highlighted the importance of notifying residents and surrounding communities when a potential or actual release of hazardous materials exists. Residents in the area are predominantly Vietnamese. Statements by community members reiterated that text communications that were in English were likely ignored by non-English speaking residents. An evacuation notice is only useful to someone who understands what is being communicated. Hence, the requirement to conduct a population density survey and communicate effectively with non-English speaking residents.

The requirements of this section are consistent with the draft PHMSA regulations that require the performance of an annual population density survey within an emergency planning zone, and communication from operators directly with their affected entities (including the general public),

27. Adopting Section 2177.5 Emergency response
Section 2177.5(a) directs operators to plan and prepare ahead of time to have the necessary tools and materials to respond to an emergency specific to carbon dioxide. This includes tools necessary to assess the extent of a vapor cloud. This also requires operators to send an automatic notification to sensitive receptors in an emergency planning zone. The message must notify that an emergency exists and what steps to take until the emergency is over. Notification should be made in English and other languages commonly understood in the area. These measures are necessary to ensure the safety of sensitive receptors in the path of a carbon dioxide cloud are notified of what to do and how to best react, either through evacuation or sheltering in place. These emergency response measures are necessary to mitigate the potential harmful health impacts from a carbon dioxide release.

2177.5(b) A pipeline rupture will result in the pipeline remaining non-operational until approval for restart is obtained from the OSFM. The OSFM may consult other State, federal, and local agencies in making a determination to restart a pipeline. Understanding the reason why a pipeline failed is just as important as responding to an emergency if one fails. This information will inform whether there is a problem in the pipeline that can be fixed or if it is an endemic issue that could occur again. This information is necessary for the OSFM to make the appropriate decision based on human health and safety prior to allowing a pipeline to restart.

28. Adopting Section 2177.6 Effectiveness review
This section directs operators to review and update their emergency training, preparedness, and response plans on a 4-year basis for sections 2177.3, 2177.4, and 2177.5. Requiring an effectiveness review on a minimum basis will ensure operators are incorporating changes in emergency preparedness, response, and training on a regular basis. Adoption of improved approaches and data will result in better effectiveness should an emergency arise, and increase safety.

29. Adopting Section 2178 Operations and Maintenance
This section specifies the level of purity and phase (dense) of carbon dioxide transferred by pipeline and prohibits the operation of a carbon dioxide transportation pipeline that does not meet the specifications of these regulations.

Carbon dioxide must be transported in a dense phase and at a 90 percent purity level. The purity level is necessary to limit the unknown constituents present in the product that can have adverse effects on the integrity of the pipeline. For example, the presence of water or sulfur in the pipeline results in carbonic and sulfuric acid. Neither of these constituents is beneficial to pipeline integrity and may encourage corrosion. Dense phase is the specified composition of carbon dioxide in transportation. This is necessary because the majority of pipelines transporting carbon dioxide have done so historically as a dense phase. Both existing projects in California transport carbon dioxide in a dense phase, and it appears all future projects will be conducted in a dense phase. This is likely because of efficiencies and known factors related to transport in the dense phase. For example, transport in a gas phase would demand more energy to transport and likely further emit carbon dioxide (depending on the energy source). More operational knowledge is available for operation in dense phase composition, and it is largely considered safer and more effective for the transportation of carbon dioxide for sequestration. Operators have conveyed that existing plans are for pipelines to transport in a dense phase and that systems can produce up to 97 percent carbon dioxide purity. Operators have also conveyed that they do not wish to compromise their pipeline integrity or fill up valuable pore space at sequestration sites with material other than carbon dioxide, as that is their primary economic and safety driver.

These limitations are necessary to focus on carbon dioxide transportation that meets the goal of SB 614, carbon sequestration. And does so with the base of knowledge associated with dense phase transport and associated safety measures. For example, leak detection systems are recognized to be more reliable on dense phase transport than in gas transport on carbon dioxide pipelines. Operators and industry engaged in leak detection systems represented this information through multiple conversations with the OSFM. Furthermore, requiring the transport of carbon dioxide at a 90 percent purity level or higher eliminates unknown constituents that can lead to corrosion and compressibility problems that impact safe operations. Importantly, the requirement that carbon dioxide pipelines transport molecules above 90 percent limits the possibility that a pipeline is transporting a hazardous gas or liquid that contains unknown constituents that could be far worse than the impacts of a carbon dioxide release. Such as the release of carbon dioxide mixed with sulfur or water, which could result in an acidic gas release.

30. Adopting Section 2178.1 Signs
    Section 2178.1 requires the posting of signs and contact information along pipeline rights of way where operators may be reached at all times. This information is necessary for quick response in the event someone identifies an unsafe condition, an excavator will see these signs, or an emergency is occurring. These are all safety related conditions that can be mitigated through the simple use of proper signage.

31. Adopting Section 2178.2 Security of facilities
    Section 2178.2 mandates that security measures be taken to prevent unauthorized entry into pump and compressor stations. All pipeline facilities, including carbon dioxide pipelines, pose a risk for bad actors to enter and disrupt the safe transportation of product, or worse. Proper security of these facilities is necessary to ensure safety and prevent unsafe conditions.

32. Adopting Section 2178.3 Smoking or open flames
    This section prohibits smoking and open flames in pump and compressor stations or other facilities where flammable liquids and vapors could exist. A fire at a facility is exceptionally dangerous and poses significant threats to a pipeline and the safety of people and workers in the vicinity of these facilities. Prohibiting smoking and open flames is a safety precaution.

33. Adopting Section 2178.4 Excavated trenches
    Excavated trenches are spaces with limited access points, which can make entering and exiting them when releases or emergencies occur more difficult, and thus, take more time. Decision-making on precisely what emergency rescue equipment is needed as work commences can be dependent on whether personnel are entering a trench that already has hazardous concentrations of vapors and gases. After work commences, recovering injured individuals in excavated trenches can present an additional threat to those operators or emergency response personnel entering the hazardous environment. Therefore, making equipment available to detect hazardous conditions and control fires is prudent for both preventing injuries in excavated trenches and reducing their severity. OSFM is requiring equipment and devices capable of detecting hazardous concentrations of vapor or gas to be made available to the list of equipment operators in excavated trenches, when needed.

49 CFR Part 195.402(e)(3) requires that hazardous liquid and carbon dioxide pipeline operators have personnel, equipment, instruments, tools, and materials available as needed at the scene of an emergency. Depending on the circumstances of the emergency, this may include, but is not limited to: (1) personal safety devices, such as breathing apparatuses and fire-resistant clothing, (2) detection and monitoring equipment, such as air monitoring devices and lower-explosive level detectors, (3) clean-up materials, such as absorbent materials and roll-off boxes, (4) containment equipment, such as booms, (5) access materials, such as gravel and mats, (6) heavy machinery, such as excavators, (7) specialized pipeline tools, such as stopples, and (8) technical response personnel, including technicians, welders, and environmental specialists, among other personnel, equipment, instruments, tools, and materials, as needed. Section 195.402(e)(8) further specifies that operators of HVL pipelines, in addition to the instruments required at the scene of an emergency in accordance with section 195.402(e)(3), are also required to use instruments to assess the extent and coverage of the vapor cloud and determine the hazardous areas. Hazardous areas are locations where the vapor cloud(s) could asphyxiate, intoxicate, or otherwise injure exposed persons, or where ignition is possible.

This section is designed to ensure appropriate safety precautions are taken to protect personnel from hazardous vapors through proper equipment, tools, and rescue harnesses. This is necessary because carbon dioxide is naturally heavier than oxygen and displaces the breathable atmosphere. Without the proper equipment and training, a situation where carbon dioxide pools in a trench can lead to life threatening incidents.

34. Adopting Section 2178.5 Inspections
Section 2178.5(a) provides for the regular inspection of rights-of-way and crossings under navigable waters. These components of a pipeline system must be inspected every 3 weeks for surface leakage, construction activity, geologic hazards, reduced depth of cover, and other factors related to the safe operation of the pipeline. These inspections are particularly effective at identifying excavation or construction work near a pipeline that was not confirmed through 811. They also effectively identify pipelines under navigable waters that have been struck by anchors or dredging activities. These actions are effective means to prevent or preemptively address a possible safety condition or release through proactive management.

Section 2178.5(b) inspection of vapor detection, alarm systems, and safety devices required by 2174.5 must be inspected for proper functioning at least once per calendar year under conditions approximating actual operations that include individual components of the system and the entire system. This is a basic safety requirement to ensure the safety of those persons working in, around, or near carbon dioxide pipeline facilities. Releases on these systems caused by equipment failure and incorrect operation are most likely to occur at facilities where personnel may be present only intermittently, including pump or compressor stations, meter stations, valve stations, and other facilities, such as launcher and receiver sites. Depending on the release rate from a leak and the local conditions, personnel entering one of these facilities, whether they are enclosed spaces or not, may unknowingly enter a hazardous situation due to the accumulation of released product. In addition to personnel safety, leaks at facilities, including pump or compressor stations, meter stations, valve stations, and other facilities, such as launcher and receiver sites, constitute a large volume of released product. As these sites may or may not be occupied by personnel, releases can continue for days or weeks before they are identified and corrected, resulting in a variety of potential environmental harms from the products released.

The use of fixed vapor detection and alarm systems at all pump stations, compressor stations, meter stations, and valve stations, to include launching and receiving facilities, is a necessary step to ensure worker and community safety. As with all mechanical and electrical equipment, proper operation, maintenance, and testing of fixed vapor detection and alarm systems is critical to ensure the systems will function as designed. The absence of, or non-compliance with, written procedures for pipeline personnel to operate a fixed vapor detection and alarm system and procedures to respond to local or remote (e.g., from a control room) alarm indications could nullify the public safety and environmental benefits from installation of such a system. Lack of maintenance and failure to thoroughly test for the proper operation of such a system could result in false alarms, or more worryingly, failure to detect a hazardous condition or properly alarm. Failure of a fixed vapor detection and alarm system to operate properly could cause harm to operator personnel entering the area, who might not otherwise be informed of the hazardous condition. Likewise, the lack of detection could result in an extended period of time before identification of the release, causing increased loss of product and potential additional harm to the environment. False alarms from improperly maintained and/or untested equipment also present costs, including diverting attention from legitimate alarms and the use of manpower and time.

35. Adopting Section 2178.6 Land movement
Section 2178.6 focuses on geologic hazards such as land subsidence on or adjacent to pipeline rights of way. When these hazards are identified, the operator must perform additional inspections and evaluations to determine the extent of the geologic hazards and take remedial action through API RP 1187 and 49 CFR § 195.401(b) as necessary. Geologic hazards are not unique to California but pose threats to pipeline integrity that, if not properly addressed, lead to unseen stresses on pipelines and forces that can lead to pipeline rupture.

Geologic hazards (also known as geological hazards, geophysical hazards, geo-technical hazards, or geohazards) are geological processes and/or phenomena that occur when geologic conditions have the potential to damage a pipeline or right-of-way or impact the safe operation of a pipeline. Geologic hazards include earthquakes, landslides, sinkholes, erosion, and ground subsidence, among others. Geologic hazards also include soil movement caused by man-made events (i.e., construction activities that cause soil instability and ground movement on a nearby slope). These hazards are independent of the product transported.

Potential warning signs of an impending landslide movement, a type of geologic hazard, may include collapsed pavement or cracking of paved areas, bulging ground at the base of a slope, or leaning or tilted trees. These warning signs may not be visible on a right-of-way, but could be readily apparent in the adjacent area; landslides and other geologic hazards are capable of moving large volumes of earth significant distances from their originating location. Regular inspections of pipeline rights-of-way and adjacent areas over time can also alert operators to worsening conditions that may indicate a geologic hazard presents an impending risk to the pipeline.

Numerous recent failures across the United States on hazardous liquid and carbon dioxide pipelines have resulted from the lack of identification and/or timely remediation of geologic hazards. PHMSA accident investigation revealed that the cause of the 2020 Satartia accident was axial strain on the pipeline from a landslide, which originated at a roadside embankment. This issue was also raised by PHMSA advisory bulletin ADB-2022-01.

Observing and inspecting pipelines for geologic hazards are necessary preventative safety measures.

36. Adopting Section 2178.7 Depth-of-cover survey
Section 2178.7(a) directs operators to conduct a depth of cover survey at least once every 5 years to confirm that the depth of cover over a pipeline complies with section 2175.4. Areas identified as having instances of washout, flood, or other geologic conditions that lend themselves to the removal of the cover of pipelines must be inspected at least every 3 years. Cover on top of a pipeline can erode over time or after significant weather events. A specified time frame for conducting these inspections is imperative, as personnel change and activities that are conducted over and around pipelines may not be passed on to successive personnel. Or those activities that lead to loss of coverage are simply missed. These surveys allow operators to ensure proper coverage and are a necessary safety measure to ensure accidental pipeline strikes and safety conditions do not occur.

In addition to geologic hazard identification, a proper inspection of the right-of-way can identify exposed pipelines or areas of reduced depth of cover from the original pipeline burial depth. The threat of reduced depth of cover (up to and including pipeline exposure) can occur in parallel with threats presented by geologic hazards, such as landslides exposing pipelines due to soil or pipe movement. This threat can also present in tandem with other threats, such as increased construction or agricultural activity, severe weather events such as flooding, and regular scouring at water crossings, or as a separate threat altogether, unrelated to any other threats present on the pipeline system.

Numerous resources are available to pipeline operators on the use of depth of cover as an important preventative and mitigative measure for certain threats. ASME RP 1133, Guideline for Onshore Hydrocarbon Pipelines Affecting High Consequence Floodplains, notes that "depth should be maintained to eliminate impacts from the future migration" of water channels in crossings and that the depth of burial must be below the level of scour. ASME RP 1160, Managing System Integrity for Hazardous Liquid Pipelines, includes "performing a depth of cover survey and proactively lowering shallow pipe in actively tilled land or areas where significant construction activity is occurring, planned, or expected" as an option for the prevention or mitigation of the threat of mechanical damage. ASME RP 1160 states that data from right-of-way condition surveys and depth-of-burial surveys, among numerous other data types, "should be collected and integrated in support of an integrity management program," and if this "data is missing or incomplete, the operator should attempt to collect this data."

ASME B31.8S notes that increasing depth of cover can be an effective method to prevent incidents of third-party damage, as Appendix A7 of ASME B31.8S notes that "agricultural lands with shallow depth of cover may be more susceptible to third-party damage." Appendix A9 of B31.8S includes the depth of frost line in the list of minimum data that should be collected to assess the risk from the threat of weather or other outside force damage; if a pipe is buried below the frost line, the threat of frost heave is seriously reduced, directly tying the pipeline's current depth of cover to the reduction of that threat. Accordingly, Appendix A9 of ASME B31.8S recommends that if "a pipeline falls within the listed susceptibilities [for weather related and outside force threats], line patrolling should be used to perform surface assessments."

Section 2178.7(b) provides that when deficiencies are identified, remedial action must take place within 1 year of completing inspections. Once a condition is identified, taking the proper and prompt steps to resolve those issues is not only prudent, but it will ensure an additional safety measure in preventing pipeline incidents and accidents.

37. Adopting Section 2179 Internal Corrosion Control

Section 2179(a) requires operators to establish a monitoring and mitigation program to address corrosive effects on internal portions of pipelines and implement technologies to mitigate those corrosive effects. This includes the limitation of water and hydrogen sulfide within the product stream, among others. These identified constituents can lead to thinning of pipeline walls and make them susceptible to failure. It is imperative that operators establish a monitoring and mitigation program to identify where corrosion causing constituents are entering the pipeline system and what their quantity is. Operators must use a process to mitigate those constituents through product sampling, inhibitor injections, in-line cleaning, pigging, separators, or other technologies. Operators must limit water to 50 ppm and hydrogen sulfide to 20 ppm. These standards are set to eliminate the possible deleterious effects of those compounds to the maximum extent possible. Evaluation should be conducted at least 4 times per year, not to exceed 4 ½ months, due to the highly corrosive nature of those and other constituents, should they make their way into a pipeline system. In addition, operators must evaluate their monitoring and mitigation program once a year, not to exceed 15 months. These standards are set because of how quickly corrosion and accompanying safety concerns can progress even under an aggressive monitoring program. Knowing what is happening on the inside of the pipeline is key to ensuring failures do not occur.

Operators of carbon dioxide pipelines would be required to choose from technology used to mitigate the corrosion-affecting constituents, including product sampling, inhibitor injections, in-line cleaning, pigging, separators, or other technology that mitigates the potentially corrosive effects of constituents in a carbon dioxide product stream. More specifically, the technology to mitigate corrosion-effecting constituents should be capable of allowing no free water and otherwise limit water to 50 ppm by volume in any phase. This specification for water content would enable a pipeline to transport sufficiently dry carbon dioxide to mitigate, or otherwise make negligible, the influence of other impurities that often accelerate the mechanisms of internal corrosion. This water content specification is more stringent than specifications provided in relevant literature and used by current carbon dioxide pipeline operators; however, given that no consensus has been reached on an acceptable, industry-wide water content specification for carbon dioxide pipeline transportation, the OSFM proposes the more conservative specification.

Technology to mitigate corrosion-effecting constituents must also be capable of limiting hydrogen sulfide to 20 ppm by volume of total product in any phase. PHMSA has seen support in relevant literature for a range of allowable hydrogen sulfide concentrations, with some limits as low as 20 ppm; these limits also have the benefit of greatly reducing the possibility of sour cracking. With regard to the safety of the public and the environment, OSHA and NIOSH have established that the IDLH level of hydrogen sulfide is 100 ppm, and the regulation language incorporates that limit, with a factor of safety. The limit to the concentration of hydrogen sulfide that can be transported in a carbon dioxide stream acts as a measure to protect the public and the environment.

Operators must include a process to evaluate whether corrosion affecting constituents are effectively monitored and mitigated by their monitoring and mitigation programs at least four times per calendar year, at intervals not to exceed 4 ½ months. Additionally, operators must evaluate and review their monitoring and mitigation programs (basing these evaluations and reviews on the results of the program) at least once each calendar year, at intervals not to exceed 15 months. Based on the evaluation and review of the results of the programs, operators would then update their monitoring and mitigation programs and implement adjustments, as necessary.

Section 2179(b) requires operators using inhibitors to mitigate internal corrosion to use the inhibitor in sufficient quantity to protect the pipeline system, use coupons or other monitoring equipment to determine their effectiveness, examine the coupons twice a year but not to exceed 7 ½ months, and review their program annually but not to exceed 15 months. These methods will provide real world corrosion numbers and see what is happening on the interior of the pipeline. The time frames will also allow operators to address their corrosion concerns quickly with relevant data from coupons and their inhibitor program. This section also allows operators flexibility, ensuring their monitoring and mitigation programs are working to prevent potentially unsafe wall loss on their pipeline.

38. Adopting Section 2180 Notifications and Submissions
    This section directs operators to a monitored email address for required notifications that have been identified throughout the regulation language. These notifications are necessary for the OSFM to conduct and schedule inspections to ensure safety and compliance with these regulations.

39. Adopting Section 2180.1 New construction, replacement, or relocation
    This section specifies the form that must be filled out and filed with the OSFM prior to construction, replacement, or relocation of a pipeline. The required form acts to inform the OSFM what activities operators are undertaking. Those activities are often subject to inspection for compliance with a host of pipeline safety laws, in addition to those specifically identified in the carbon dioxide regulations. This form and notice are necessary for our office to ensure pipelines are designed and constructed in a safe manner.

40. Adopting Section 2180.2 Notification of Rupture or Potential Rupture
    This section describes what instances of a rupture or potential rupture require notification to the OSFM and what process to follow when making those notifications. The definition of rupture is also provided from existing

statute in Government Code Section 51018(c). The prompt notification of a rupture is often the first step in pipeline emergency response. The sooner our office is notified, the sooner we can respond and provide support until the emergency is over. This same standard applies to any emergency response agency that falls under the Office of Emergency Services. An early response is necessary to take action to mitigate the hazards of a pipeline emergency. This section is necessary because actions taken after the Satartia, Mississippi incident revealed that the operator did not notify local emergency responders of a potential failure. Before the accident, the operator had neither adequately coordinated with local emergency response officials on potential response efforts in the event of a release, nor developed and implemented an adequate continuing public education program.

The PHMSA failure investigation report detailed the adverse impact of those omissions on the emergency response activities conducted after the pipeline ruptured at 7:06 p.m. on February 22, 2020. Though the operator was aware of a potential accident at 7:07 p.m. through alarms received at its control center, it did not contact fire, police, or any other local emergency responders. Instead, local emergency responders contacted the operator about 42 minutes after the rupture to notify the operator of the release and gain information on the released product. Local emergency responders were forced to respond to an unknown threat with limited information from calls from the public upon which to base their actions. Operator personnel who informed the National Response Center of the accident (two hours after the rupture) characterized the release as involving only approximately 220 barrels of carbon dioxide. Ultimately, the amount of carbon dioxide released was discovered to be significantly more than originally estimated - 31,405 barrels.

41. Adopting Section 2181 Record Retention
This section explains that records must be maintained for the life of the pipeline that demonstrate compliance with the regulations, as well as basic pipeline information related to construction, design, sensitive receptors, testing, inspections, and review. All records must be transferred to a subsequent owner or operator if the asset is sold or transferred. Historic documents are necessary for any pipeline operator to properly assess the risks and conditions present on a pipeline. Mandating the transfer of these records is necessary to ensure that a new operator has the tools to safely manage a pipeline and is aware of the risks present in the system.

42. Adopting Section 2182 Enforcement
This section identifies where OSFM enforcement authority can be found in relation to process and penalties within the existing statutory authority to regulate pipelines. An enforcement tool is necessary for the OSFM to impose orders, direct repairs, assess penalties, and overall ensure pipelines are operated in a safe manner.

CONSIDERATION OF ALTERNATIVES

Reference: Government Code Section 11346.2(b)(4)

The OSFM was directed in statute to adopt regulations that were, at a minimum, as protective as federal draft regulations. Our office was, therefore, somewhat limited in terms of alternatives that could be considered. However, our office did consider the following possible alternatives to the regulation.

Alternative 1

PHMSA specified in their draft regulations that pipelines could transport carbon dioxide at a lower threshold of 50 percent molecules and could also be transported in the gas phase. The OSFM considered these options as they would open up the possibility of more pipelines being constructed to transport carbon dioxide to sequestration sites.

Ultimately, the office rejected this alternative because, as discussed at great length above, pipelines carrying unknown constituents other than carbon dioxide molecules can lead to corrosion, integrity, and other issues in the event of a release. By way of example, other constituents such as water, oxygen, hydrogen sulfide, carbon monoxide, nitric oxide, nitrous dioxide, methane, amines, and glycol could themselves be corrosive for the pipeline or hazardous to public safety and the environment if released. The presence of these different constituents in the product stream increases the likelihood that internal corrosion will occur because there are more possible chemical mechanisms for internal corrosion, especially when water is present, or there are significant changes in operating pressure (which can, in turn, affect the corrosivity of constituents in the product stream). Certain constituents (such as hydrogen sulfide, carbon monoxide, and methane) can also themselves represent hazards to public safety and the environment.

Allowing pipelines to transport carbon dioxide in a gas or liquid phase was also considered in this alternative. Transportation of carbon dioxide in the gas phase is uneconomical and contrary to the primary purpose of SB 614, carbon sequestration. Furthermore, existing carbon dioxide pipeline transportation in the United States is most commonly in the supercritical phase, as it can be transported more economically and efficiently in that phase due to its higher density and lower viscosity when compared to the transportation of carbon dioxide in other phases. Operators that do transport carbon dioxide in the gas phase typically use the product in Enhanced Oil Recovery (EOR). However, EOR is not allowed in California, and therefore, it would seem counterintuitive to allow for the uneconomic transport of carbon dioxide for a purpose that is not allowed in the State. Additionally, pipeline leak detection systems are more effective at finding leaks in dense phase over gaseous.

The factors discussed above recognize the main purpose of SB 614, to sequester carbon. Allowing operators to transport and potentially sequester carbon that is less than 90 percent molecules further did not make sense. Operators are compensated through

45Q tax credits at the federal level based on tonnage sequestered. Transporting product via pipeline incurs cost, so operators are averse to shipping product that they cannot recover costs on. Also, pore space at sequestration sites is limited. Filling up that pore space with constituents other than carbon dioxide would prematurely fill up storage reservoirs with something industry could not be compensated for. Stakeholders also noted that they could already achieve a 90 percent purity level for carbon dioxide. This is not overly burdensome to direct them to do something that they already achieve.

It would also be counterintuitive to allow transportation of carbon dioxide in a gas state that is uneconomical and requires additional electrical needs to operate. Interestingly, depending on where the electricity comes from (natural gas energy production, for example), additional carbon emissions could result, further reducing the impact of gas carbon sequestration projects. From a safety perspective, requiring pipelines to transport product in a dense phase also means that leak detection systems are more accurate than those placed on gas phase pipelines. Having an effective leak detection system is imperative to safe pipeline operations and early notification in the event of a pipeline leak or failure. Therefore, this alternative was not pursued.

Alternative 2

The office also considered a mandatory requirement to have cathodic protection on a pipeline that was at least -850 millivolts and effective when the pipeline initially began operations. This alternative was not chosen.

All pipelines are required to have cathodic protection under State and federal laws. Cathodic protection acts to prevent corrosion on the external surface of a pipeline. Cathodic protection can be designed in several different ways, but the principle remains the same. Apply an electrical current near the pipeline to draw corrosive properties away from the pipeline and to a sacrificial anode.

After discussion with OSFM internal staff specializing in cathodic protection, we determined that a higher voltage could be detrimental to a pipeline. For example, pipelines that have been subjected to higher currents can induce a process of disbondment of the outer protective coating found on pipelines that is specifically in place to further avoid corrosion. Additionally, too much current can cause hydrogen embrittlement on a pipeline that could then ultimately lead to cracks and pipe failure. Essentially, this requirement, though well intentioned, could ultimately lead to pipe failure from cracking and/or disbondment.

In considering the above alternatives, our office determined that neither option would achieve the statutory requirements placed on the OSFM. Nor would the alternatives be less burdensome and equally effective.

CONSIDERATION OF ALTERNATIVES FOR SMALL BUSINESS

Reference: Government Code Section 11346.2(b)(4)

Alternatives to regulations were rejected because the enabling statute requires the Department to adopt regulations that meet or exceed the standards established in the specified federal draft regulations. Also, please note that only large businesses are expected to own, develop, or operate CO2 capture wells and associated pipelines; California small businesses are not expected to directly bear any costs associated with this proposed rulemaking.

SIGNIFICANT ADVERSE ECONOMIC IMPACT ON BUSINESS

Reference: Government Code Section 11346.2(b)(5)(A)

The Department collected stakeholder comments regarding its preliminary draft regulations. All sections in which the Department received comments that specifically mention potential cost increase were removed in this proposed rulemaking, except that pertaining to the five year depth of cover survey (Section 2178.7). The Department's cost estimate for the study is less than $10,000 every five years. The Department believes that the depth of the cover survey is necessary to help ensure structural integrity and public safety. In addition, the cost is an absorbable business expense.

EFFORTS TO AVOID UNNECESSARY DUPLICATION OR CONFLICTS WITH FEDERAL REGULATIONS

Reference: Government Code Section 11346.2(b)(6)

SB 614 (2025-2026) authorizes the Department to promulgate regulations that meet or exceed the standards established in the specified federal draft regulations. The Department's proposed rulemaking largely mirrors the draft federal regulations, while selectively increasing standards in specified areas in the state's best interest.

AVAILABILITY OF DOCUMENTS ON THE INTERNET

Copies of this ISOR, the Notice of Proposed Regulatory Action (NOPA), the Proposed Regulation Text, and any other materials or documents concerning this rulemaking can be accessed through the Office of the State Fire Marshal's web address at: http://osfm.fire.ca.gov/divisions/code-development-and-analysis/title-19-development/

PLAIN ENGLISH DETERMINATION

The proposed regulations were prepared pursuant to the standard of clarity provided in Government Code Section 11349 and the plain English requirements of Government Code Sections 11342.580 and 11346.2(a)(1). The proposed regulations were written to be easily understood by the parties that will use them.