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Tristan Brown
Deputy Administrator
Pipeline and Hazardous Materials Safety Administration
Docket Management System
U.S. Department of Transportation
1200 New Jersey Avenue, SE
West Building Ground Floor
Room W12–140
Washington, DC 20590–0001

Re: Pipeline Hazardous Materials Safety Administration (PHMSA), Department of Transportation; Notice of Proposed Rulemaking, Pipeline Safety: Gas Pipeline Leak Detection and Repair, Comments of the Fiber Optic Sensing Association.[i]

Dear Administrator:

The Fiber Optic Sensing Association ("FOSA") appreciates the opportunity to submit comments to the Pipeline and Hazardous Materials Safety Administration (PHMSA) regarding the Notice of Proposed Rulemaking (NPRM) Pipeline Safety: Gas Pipeline Leak Detection and Repair Docket No. PHMSA–2021–0039, 49 CFR Parts 191, 192, and 193, Federal Register Number: 2023- 31890, (May 18, 2023).

The Fiber Optic Sensing Association (FOSA) was founded in 2017 as a non-profit organization to educate industry, government, and the public on the benefits of fiber optic sensing technologies that enhance public safety, promote the security of critical facilities and infrastructure and protect the environment. Our members include organizations that manufacture, install, test, evaluate, support, and/or use fiber optic sensing systems and equipment.[ii]

I. Technical Discussion - Distributed Fiber Optic Sensing (DFOS)

Distributed and quasi-distributed fiber optic sensors connect optoelectronic interrogators to a fiber within an optical fiber or cable, converting the fiber to an array of distributed sensors. The fiber becomes the sensor as the interrogator injects pulsed laser energy into the fiber to detect events along the fiber. This technology can continuously monitor vehicle movement, foot traffic, digging activity, tampering, seismic activity, temperatures, structural integrity, liquid or gas leaks, and many other conditions and activities. It is used worldwide to monitor pipelines, power stations, telecom networks, railways, roads, bridges, international borders, critical infrastructure, terrestrial or subsea power cables or pipelines, and downhole applications in oil, gas, and enhanced geothermal electricity generation.

DFOS systems perform exceptionally for intrusion, gas and liquid leak, and geotechnical movement detection along pipelines. Features include:

- Continuous coverage along the length of the pipeline over long distances;
- 24x7 operation, without disruption to pipeline operations or flow;
- Extremely accurate detection, location determination, and reporting in real-time;
- Up to 99 percent efficacy of external leak detection;
- Classification of disruption, e.g., leaks, automobile, person, , digging, ultralight aircraft, subsidence, and other acoustic and temperature events;
- Discernment of local natural temperature variation vs. temperature variation due to an incident;
- Much earlier event detection than incumbent technologies, potentially preventing catastrophic failure; and
- Immediate detection and geolocation of tampering by covert (undetectable) underground installations.

Because the entire length of the optical fiber serves as the sensor, DFOS can replace thousands of traditional single-point sensors, simplifying installation and management. DFOS technology has proven to be an effective, continuous means of accurately detecting small temperature and strain shifts.

Fiber optic sensing is not constrained by line of sight or remote power access. Depending on system configuration, it can be deployed in continuous lengths exceeding 30 miles with detection at everywhere along its path, with resolution down to ~3 feet over the entire span. Sensing systems can be concatenated over thousands of miles. Competing technologies cannot match the cost per sensing point over great distances. Often existing fiber optic cables are used or sensing-optimized cables may be deployed. Fiber optic sensing measures changes in naturally occurring "backscattering" of light in an optical fiber. Measurable change is observed when the fiber encounters vibration, strain or temperature change. The fiber is a sensor over its entire length, delivering real-time information on physical surroundings and security. Furthermore, the data instantaneously pinpoint events and conditions occurring at or near the sensor cable.

The main uses for DFOS in pipeline monitoring are:

- Detecting unauthorized or unexpected third-party interference near the pipeline;

- Detecting excessive strain being applied to the pipeline due to shifts in the soil caused by subsidence, landslides or other geotechnical reasons;
- Detecting soil erosion and water ingress as means of very early warning and prevention;
- Detecting pipeline leaks, ruptures or valve operation, whether liquid, gas or a combination of liquid and gas;
- Detecting negative pressure waves traveling inside pipelines; and
- Tracking the position of instrumentation and cleaning PIGs (Pipeline Inspection Gauges/Gadgets).

DFOS methods provide significant advantages for pipeline operators, complementing traditional Computational Pipeline Monitoring Leak Detection Systems (CPM LDS) by adding prevention through very early detection. Additionally, DFOS instantaneously pinpoints sudden operating changes at all points along the asset and issues alerts/alarms to hasten responses and mitigate harm.

Distributed Acoustic Sensing (DAS) can monitor the vibration characteristics of the pipeline and quickly detect unauthorized or unexpected third-party interference or intrusion by monitoring the vicinity of the pipeline. DAS can go as far as to determine the potential cause of the vibrations and therefore alert the pipeline operator of potential threats to the pipeline. DAS can also be used to detect leaks and associated events by sensing multiple effects on the fiber, among them:

- Changes in temperature;
- Subtle vibrations in proximity to the pipeline that result from product escaping under pressure into the surrounding soil, or into the air if an above-ground pipeline;
- Direct commodity release detection using changes in strain, thermal, and acoustic noise from the leak orifice; and
- Indirect sensing of the leak by observing the resultant negative pressure waves caused by the onset of the leak, as described in API RP 1130.[iii]

Distributed Temperature Sensing (DTS) is deployed to monitor the subtle temperature variations that occur on or around pipelines. From effects due to product escaping the pipeline to subtle changes to terrain in the vicinity of the pipeline, DTS is suitable to report absolute temperatures that help characterize events, pinpoint areas of concern, and track subtle changes occurring with time – providing alerts and alarms as appropriate.

- Escaping gas lowers temperature at the leak point, DTS pinpoints and characterizes this.
- Escaping oil increases temperature at the leak point, DTS pinpoints and characterizes this.
- Right-of-way erosion due to water ingress near pipelines creates a temperature profile that DTS can pinpoint, remotely monitoring magnitude and associated changes.

Distributed Strain Sensing (DSS) is deployed along or on pipelines to monitor changes in the strain that might be caused by shifts in the soil in the vicinity of the pipeline. If the strain from these soil shifts grows large enough, it can cause the pipeline to shift, buckle and even rupture, allowing product to escape. DSS is an ideal tool for use in prevention of the catastrophic events that are known to occur with aging pipelines.

- DSS supports preventative maintenance, reporting subtle changes in strain and compression on pipelines to which they are coupled.
- DSS is effective as it detects the very small changes that occur over weeks, months and years.
- DSS can also be used in the vicinity of the pipeline to monitor soil stability and the small changes in the supporting earthworks that, with change, can threaten the pipeline itself.
- DSS characterizes the nature of the threat, its location or expanse, and its magnitude.

II. Regulatory Discussion

FOSA Recommendations Regarding Pipeline Leak Detection

FOSA supports the public policy intent of the Protecting our Infrastructure of Pipelines and Enhancing Safety (PIPES) Act of 2020 (P.L. 116-260), Section 113, mandating the adoption of performance standards for operators of new and existing gas transmission and distribution pipeline facilities to conduct leak detection and repair programs. In support of this objective, FOSA makes three broad sets of recommendations.

1. Adopt Leak Detection Performance Standards

As noted above, Section 113 of the PIPES Act of 2020 requires PHMSA to issue minimum performance standards for operator leak detection and repair programs reflecting the capabilities of commercially available advanced leak detection technologies and practices. PHMSA's proposed new § 192.763 requires operators to establish written Advanced Leak Detection Programs (ALDPs) and performance standards that appropriately implement the statutory mandate.

The adoption of API RP 1175 "Pipeline Leak Detection – Program Management" in April 2022 reflects the advances in industry best practices.[iv] Developed under API's American National Standards Institute (ANSI) accredited process, API standards are appropriately recognized not only for their technical rigor but also their third-party accreditation, which facilitates acceptance by state, federal, and increasingly international regulators.

Within the 1175 Recommended Practice, Annex D-2 "Example of Performance Metrics & Targets" anticipates explicitly, for example, the use of external method leak detection systems "with a sensitivity that can locate a leak of 0.5 bbl within 15 minutes with a location accuracy of plus or minus 5 meters (~ 16 feet). This "external method" reflects an improvement over CPM LDSs offering a 100 bbl detection threshold.

Average Alarm Threshold	CPM LDS[v]	External Method LDS[vi]
• Distance	+/- 5 miles	+/- 5 meters (~16 feet)
• Release	100 bbl	0.5 bbl
• Time	30 minutes	15 minutes

Including metrics associated with Distributed Fiber Optic Sensing in the latest revisions of the API RPs is a testimony to the technology's contribution to leak detection.

FOSA notes that API 1175's Annex D-2 incorporates a geographically more precise standard than "20–50 linear feet" rupture estimate that the NPRM references at 31916.[vii]

2. Performance-Based Methane Leak Detection Standards

As previously noted, Section 113 of the PIPES Act mandates adopting performance standards for leak detection.[viii] Despite this statutory mandate, the language used in "192.763 Advanced Leak Detection Program" might be construed as a technology mandate for "handheld leak detection equipment."

As an alternative, PHMSA should prioritize the adoption of a Continuous Methane Monitoring Framework instead of a more episodic approach to monitoring provided by a handheld device that, at best, may pass by specific locations a few times per year. Continuous methane monitoring vastly differs from the low-frequency, handheld analyzers and cameras historically relied on by industry and regulators alike.

Consequently, comparisons should focus on the total emission reduction results achieved among technologies, i.e., a performance-based comparison rather than a comparison based on the supposed similarities of these different approaches.

Continuous monitoring can provide a rapid, cost-competitive, and autonomous alert system to notify operators of potentially anomalous, unplanned, or fugitive emissions events. As an alert system, continuous monitors can trigger additional action to assess conditions and determine the appropriate course of action, including deployment of personnel for further investigation and repair.

A continuous monitor for methane is akin to a household smoke alarm. When a smoke alarm triggers in a home, the fire department is not immediately called, nor do the people in the house instantly use the fire extinguisher. Typically, the first step is to assess the situation for additional information and then determine the appropriate course of action. Continuous monitors have the potential to provide this type of high-frequency alarm and, thus, as in the smoke detector analogy, must be paired with an appropriate protocol to help operators interpret and determine how to respond to these alarms.

FOSA notes the ongoing and active research into continuous methane monitoring. For example, National Energy Technology Laboratory (NETL) researchers have been developing better ways to ensure the pipeline network's safety and mitigate methane leaks using fiber optic sensor technologies and surface acoustic wave sensors. According to NETL, their pipeline sensor team "recently completed successful field tests of an extensive new collection of fiber optic sensor and surface acoustic wave sensor technologies for natural gas pipeline monitoring that can help ensure safer and more secure natural gas pipeline delivery and mitigate greenhouse gas (GHG) methane emissions."[ix]

FOSA encourages PHMSA to lead by example by more accurately reflecting the progress of advanced technology in enhancing leak detection. PHMSA guidance to stakeholders regarding leak detection technologies should include fiber optic sensing. For example, PHMSA's "Fact Sheet on Leak Detection Systems" currently contains no reference to or information about fiber optic sensing or any other external leak detection technology. This document was evidently last revised in 2011, thus failing to reflect over a decade of technological progress. To assist pipeline operators in deploying optimal leak detection technology and to share timely information with state and local authorities, PHMSA should provide broader information in its publications and guidance. [x] Similarly, PHMSA should reframe from adopting "handheld methane detectors" as its preferred technology benchmark.

One pipeline industry colleague observed in Congressional testimony during the PIPES Act consideration: "Harnessing technology to advance pipeline safety is a theme we are pursuing across industry and recommend Congress adopt as well. For example, hi-tech tools can now scan pipelines like an MRI or ultrasound at the doctor's office. Pipeline operators have the opportunity to find issues early, perform maintenance and keep pipelines operating safely. The problem is federal regulations can't keep pace with fast-moving technology innovations. In fact, outdated PHMSA regulations sometimes conflict with the latest knowledge and techniques."[xi]

3. U.S. Pipeline Safety Testing Facility

Advancing the development of effective leak detection systems is critical to improving pipeline safety and preventing methane releases. Toward this objective, FOSA strongly supports a PHMSA pipeline safety and test facility.

FOSA first proposed such a facility in 2018 in our report, the *Need for a U.S. Pipeline Safety Test Facility*. The report stated, "FOSA believes there is a significant need for a pipeline safety test facility in the United States, and that such a facility would provide clear benefits. It would help validate existing safety technologies and accelerate the advancement of new technologies. With better technology, operators would reduce incidents and mitigate costs, fines, and negative public relations. Regulators would gain greater knowledge of the capabilities offered by new technologies, assisting in their ability to help the industry operate more safely. And - most importantly - the public would face fewer and less severe pipeline incidents. Pipelines are statistically proven to be the safest mode of hydrocarbon transportation and are increasingly targeted for carbon capture, utilization, and storage (CCUS), yet when incidents occur they can be catastrophic to the public and the environment. An opportunity to improve the safety and efficiency of such a vital piece of American infrastructure should be seized."[xii]

Our report contained the results of a questionnaire with a number of influential pipeline industry representatives. Our threshold question was, “Would you use it?” The response was overwhelmingly positive: 83% of respondents indicated they were likely or highly likely to use such a facility if it existed, while 13% said they didn’t know. No respondents indicated they were unlikely to use it.[xiii]

As we noted, "There is ample precedent within the U.S. transportation industry for such a facility: the Federal Transit Administration, Federal Aviation Administration, Federal Rail Administration, Federal Highway Administration, and National Highway Traffic Safety Administration each supports at least one test center aimed at improving safety in specific sectors." A national facility of this nature would serve multiple purposes, including lowering pipeline operators' cost of testing new technologies, facilitating certification of technology performance standards, and facilitating PHMSA's information-gathering mandate. And as PHMSA increases its attention to preventing methane releases, a dedicated facility would help identify and expedite the adoption of more effective methods for meeting this goal.

FOSA was encouraged that PHMSA indicated in 2020 that it would be moving forward with preliminary work toward such a facility. As the agency said at the time, "The proposed Research, Development, and Testing Facility will enable PHMSA to go from being a back-seat R&D supporter to a leader and active innovation collaborator. This initiative will enable PHMSA to initiate cooperative research with academic and private sector partners to further pipeline safety technology development and implementation. "[xiv] [xv]

III. Conclusion

FOSA believes systems meeting the proposed standards suggested above are technically, operationally, and economically feasible. Such standards support critical public safety and environmental protection policy interests. Moreover, establishing such clear performance standards will assist pipeline operators by clarifying expectations.

Our association welcomes the opportunity to work supportively with PHMSA and pipeline operators to identify and test technologies that can achieve the policy objectives expressed by this NPRM. We especially commend the prospect of a PHMSA-sponsored research and safety testing facility as being essential in harnessing the innovation necessary to meet the agency's mission of “advancing the safe transportation of energy and hazardous materials that are essential to our daily lives.”[xvi]

Sincerely,

/s/ Mark Uncapher

Mark Uncapher
Executive Director

Fiber Optic Sensing Association® - 6841 Elm Street, #861, McLean, VA 22101

[i] Federal Register 88, no. 96 (May 18, 2023): 31890.
ii For more information regarding the Fiber Optic Sensing Association, see https://www.fiberopticsensing.org/
[iii] API Recommended Practice (RP) 1130, Computational Pipeline Monitoring for Liquids*, 2nd edition*. The RP addresses the algorithmic monitoring tools used to enhance the ability of a pipeline controller to recognize hydraulic anomalies that could show a pipeline leak; https://www.api.org/products-and-services/standards/important-standards-announcements/rp1130
[iv] API Recommended Practice (RP) 1175 Pipeline Leak Detection—Program Management. The RP establishes a framework for Leak Detection Program (LDP) management for hazardous liquid pipelines that are jurisdictional to the U.S. Department of Transportation (specifically, 49 CFR Part 195); https://www.api.org/products-and-services/standards/important-standards-announcements/rp1175
[v] See PHMSA, Pipeline Safety Stakeholder communications, Fact Sheet: Leak Detection Systems "Computational pipeline monitoring. This leak detection method employs numerous monitored variables, and a sophisticated computer model to identify upsets or potential leaks. Monitored inputs include operating parameters for temperature, pressure, flow and density, and include equipment inputs such as pump start/stop and valve open/close signals. The data from all sensors is compared against a baseline model for values that differ from the modeled case indicating a potential leak. Operational transients such as pump starts, line fills, valve closures, etc., may be modeled as well, so that this automatic leak detection system can continue to work during operational changes that occur in the normal day-to-day operation of the pipeline system." See https://primis.phmsa.dot.gov/comm/factsheets/fsleakdetectionsystems.htm, Accessed August 13, 2023
[vi] External Method LDS include (but are not limited to) fiber optic detection methods. See 8.7.1, API RP 1175.
[vii] NPRM at 31916
[viii] PIPES Act Sec 113
[ix] See, NETL DEMONSTRATES NEW PIPELINE SENSOR TECHNOLOGIES IN A PILOT-SCALE FIELD TEST, https://netl.doe.gov/node/12418, Accessed August 13, 2023
[x] See PHMSA: Stakeholder Communications - Leak Detection https://primis.phmsa.dot.gov/comm/factsheets/fsleakdetectionsystems.htm "Date of Revision**:** 12012011", accessed August 13, 2023; FOSA previously addressed the timeliness of this "Leak Detection Fact Sheet" in February 26, 2018 comment to the agency, see https://www.regulations.gov/comment/PHMSA-2016-0128-0011
[xi] Andy Black – CEO Association of Oil Pipe Lines Testimony - House Transportation & Infrastructure Committee hearing on Pipeline Safety April 2, 2019, https://docs.house.gov/meetings/PW/PW14/20190402/109198/HHRG-116-PW14-Wstate-BlackA-20190402.pdf
[xii] Fiber Optic Sensing Association, The Need for a U.S. Pipeline Safety Test Facility A Technology Study Provided by the Fiber Optic Sensing Association October 15, 2018 https://fiberopticsensing.org/wp-content/uploads/sites/2/2023/07/Pipeline-Test-Facility_Concept-paper_Final_Sep-24-2018.pdf

[xiii] https://fiberopticsensing.org/wp-content/uploads/sites/2/2023/07/Pipeline-Test-Facility_Concept-paper_Final_Sep-24-2018.pdf
[xiv] Remarks of Howard "Skip" Elliott Before NAPSR's Annual Board of Director's Meeting September 15, 2020; https://www.phmsa.dot.gov/news/remarks-howard-skip-elliott-napsrs-annual-board-directors-meeting
[xv] https://www.phmsa.dot.gov/news/phmsa-announces-10-million-award-engineering-services-new-pipeline-research-development-and
[xvi] https://www.phmsa.dot.gov/about-phmsa/phmsas-mission