March 23, 2018

Hon. Howard R. Elliott
Administrator
Pipeline and Hazardous Materials Safety Administration
U.S. Department of Transportation
West Building Ground Floor, Room W12-140
Docket #PHMSA-2016-0136
1200 New Jersey Avenue, SE
Washington, DC 20590-0001

Re: Pipeline Hazardous Materials Safety Administration (PHMSA), Department of Transportation; Comments of the Fiber Optic Sensing Association to the PHMSA Gas Pipeline Advisory Committee, Docket #PHMSA-2016-0136

Dear Administrator:

The Fiber Optic Sensing Association ("FOSA") appreciates the opportunity to submit comments to the Gas Pipeline Advisory Committee ("GPAC") meeting March 26-28, 2018.[1]

FOSA is a non-profit organization created in Washington D.C. in 2017 with the mission of educating industry, government and the public on the benefits of distributed fiber optic sensing (DFOS). FOSA members include Adelos, AFL, AP Sensing, Asymmetric Technologies, Corning, Ditch Witch, Dura-Line, Fotech Solutions, Frauscher Sensor Technology USA Inc., Hifi Engineering, NKT Photonics, OFS, Omnisens, OptaSense, OZ Optics, and Prysmian.

Through webinars, videos, white papers, public presentations and public policy advocacy, the organization provides information on the use of fiber optic sensing to secure critical facilities, enhance public safety and protect the environment.

[1] The Gas Pipeline Advisory Committee is established in accordance with the Federal Advisory Committee Act (5 U.S.C. App. 2, as amended) and 49 U.S.C. 60115.

<u>Relevance to this Proceeding</u>

Information concerning distributed fiber optic sensing is relevant to this proceeding because DFOS can help mitigate a number of the risks which the proposed rule seeks to address, including:

- **3rd Party Damage**. As numerous commenters have stated, excavation and other intrusive activity is the leading cause of pipeline accidents. DFOS is uniquely qualified to help avoid such damage because, on a 24-7 basis, it can alert pipeline operators of driving, walking and digging activity near the pipeline and pinpoint the location of such activity, providing early warning prior to pipeline strikes. This application of DFOS is widely deployed around the world as a key tool for damage prevention;

- **Seismic activity**. As Stanford University researchers recently established, fiber optic sensing can provide early warning of seismic activity[2] and enable pre- and post-event analysis;

- **In line inspection**. Fiber optic sensing is complementary to ILI. Specifically, DFOS can track pig movement through the pipe in real-time, to provide high accuracy location and speed tracking;

- **Data collection, risk evaluation.** Fiber optic sensing generates large amounts of data which can help operators assess the effectiveness of their integrity management programs over time, providing long-term environmental pattern of life and operations data which optimizes pipeline operation while improving risk models;

- **Shut-off and remote control valves.** Fiber optic sensing facilitates timely closing of valves by quickly identifying problems with a higher location accuracy (30-100ft) than traditional approaches. Importantly, this provides operators with faster reactions times and better location accuracy for pipeline shut-off, which is a key safety action during a pipeline incident scenario.

In this submission, and consistent with GPAC's mission, FOSA will:

- Provide a brief description of DFOS technologies used for pipeline intrusion and leak detection;
- Reference FOSA information designed to assist pipeline operators in utilizing DFOS technology, including,
    - FOSA's recently-released primer, *Installation Considerations for Pipelines* www.fiberopticsensing.org/page/installation-considerations, and

[2] "Stanford researchers build a "billion sensors" earthquake observatory with optical fibers,"Stanford News Service, Oct. 19, 2017, https://news.stanford.edu/press-releases/2017/10/19/building-billionr-optical-fibers/

  - FOSA's webinar *Advancing Pipeline Safety with Fiber Optic Sensing* www.fiberopticsensing.org/p/cm/ld/fid=734&tid=310&sid=2387 , and
- Provide recommendations to the GPAC.

A. Fiber Optic Sensing

1. Optical Sensing Technology

Optical fiber is used in many sensing technologies. The unique characteristics of optical fiber makes it extremely well suited to detect minute changes in conditions such as strain, vibration (sound) and temperature, over great distances and with yard-scale spatial resolution.

In the pipeline sector, optical fiber can be used both to detect and avoid leaks. Regarding detection, distributed fiber optic sensing provides an alert within minutes – sometimes within seconds - and determines location with great accuracy, facilitating quick action that can minimize leak size. Perhaps even more importantly, distributed optical fiber sensing allows constant monitoring for intrusion and other problematic conditions such as ground movement, which can help avoid leaks altogether.

Two North American pipeline operators – SoCalGas and Husky Midstream -- have recently indicated plans to install DFOS on new pipeline deployments,[3] and multiple other North American installs and trials are occurring. In other regions of the world, pipeline operators have begun to routinely include DFOS as part of new construction.[4]

A DFOS system is comprised of optical fiber cable, detection electronics and software. The glass fiber is the sensor, detecting events over its entire length. A laser pulse interrogates the fiber and a detector measures back reflections from every pulse. Based on the unique properties inherent to the fiber and the scattering of light, software determines whether an incident (acoustic, temperature or strain) is occurring and alerts operators to the problem, the severity of the problem, and the exact location. It is even possible to classify events.

This technology can be deployed to continuously monitor vehicle movement, foot traffic, digging activity, seismic activity, temperature changes, structural integrity, liquid and gas leaks, and many other conditions and activities. It is used around the world to monitor power stations, telecom networks, railways, roads, bridges, international borders, critical

[3] "SoCalGas Breaks Ground on Innovative Fiber Optic Installation to Monitor Pipelines in Real-Time," PRNewswire, December 13, 2017, https://www.prnewswire.com/news-releases/socalgas-breaks-ground-on-innovative-fiber-optic-installation-to-monitor-pipelines-in-real-time-300571157.html; Jaremko, Deborah, "Husky Midstream to use fiber optic sensing as standard for new pipelines in active heavy oil region," JWN Energy, January 15, 2018, http://www.jwnenergy.com/article/2018/1/husky-midstream-use-fiber-optic-sensing-new-pipeline-standard-active-heavy-oil-region/.

[4] See "Distributed Fiber Optic Installations of FOSA Members, November 2017 Survey," https://www.fiberopticsensing.org/page/map

infrastructure, terrestrial and subsea power and pipelines, and downhole applications in oil, gas and enhanced geothermal electricity generation.

DFOS is not constrained by line of sight or remote power access and, depending on system configuration, can be deployed in continuous lengths exceeding 30 miles with detection every few feet along its path from a single interrogator unit, and interrogator units can be networked together to extend coverage hundreds of miles. Cost per sensing point over great distances cannot be matched by competing technologies and often previously deployed communications fibers can be utilized.

Generally, three categories of distributed fiber optic sensing technology are utilized for pipeline intrusion and leak detection. They can be employed in tandem or separately:

- Distributed Acoustic Sensing (DAS)
- Distributed Temperature Sensing (DTS)
- Distributed Strain and Temperature Sensing (DSTS, also known as DTSS)

1. Distributed Acoustic Sensing (DAS)

Distributed Acoustic Sensing (DAS) is a sensing technology that delivers real time spatially resolved acoustic and vibration output from virtually unlimited points along a fiber optic cable. The technology effectively turns common optical fiber into a series of thousands of sensitive virtual microphones or vibration sensing devices. DAS produces thousands of channels of acoustic output from these virtual microphones – in real time.

The DAS unit sends a short pulse of laser light down an optical fiber where tiny changes of refractive index, frozen at the time of manufacture, cause a small amount of light to be returned towards the origin by Rayleigh backscatter. The backscatter is modulated by any sound waves or vibration propagating through the glass – causing the pattern to change at that point. These changes can then be processed for vibrational content or simply listened to individually.

DAS can be used on linear assets such as pipelines, roads, tracks, borders or fences. Using specially developed algorithms it is possible to listen to, track and detect various activities and events along such assets, including vehicle and foot traffic, digging or tunneling. It can also be used for asset condition monitoring by detecting events such as pipeline leaks or broken rails, and much more. Several companies offer design, planning, installation and service of DAS systems to a number if industries, including the pipeline sector. Over 10,000 miles of buried transmission pipeline is being continuously monitored worldwide using DAS.

DAS is easy to install during pipeline construction, requires little to no power in the field, and dramatically simplifies sensing systems when compared to traditional point-sensing methods. In many cases, it is possible to use available “dark” fibers alongside existing networks close to the asset. New fiber optic cables can be deployed at relatively low cost, and unused fibers can be used for other purposes such as asset communications or rural broadband delivery.

2. Distributed Temperature Sensing (DTS)

Distributed Temperature Sensing delivers spatially resolved measurements of changes to temperature at any point along the length of a fiber optic cable. This allows a single optical fiber to replace thousands of individual temperature sensors.

The DTS device sends laser light into an optical fiber. Part of the light is backscattered to the device, where it is analyzed. The Raman backscattered light changes with the temperature applied to the fiber. By accurately measuring the changes in Stokes and Anti-Stokes elements of the backscattered light, the temperature change can be calculated. To monitor temperature, the sensing cable must be designed and installed so that the temperature of the asset being monitored is transferred to the fiber. DTS can be implemented using multimode communication fibers in cabled form.

DTS is commonly used for monitoring lengthy structures, where changes in temperature may be indicative of an impending danger or system failure. In addition to pipelines, other structures like tunnels, oil wells, and power lines are all structures that can benefit from DTS monitoring. Similarly, industrial process monitoring, heat trace monitoring, as well as fire detection in large buildings or tunnels, can benefit from DTS.

3. Distributed Strain and Temperature Sensing (DSTS, also known as DTSS)

Distributed Strain and Temperature Sensing delivers spatially resolved measurements of changes to both strain and temperature at any point along the length of a fiber optic cable. This allows a single optical fiber to replace thousands of individual strain or temperature sensors.

The DSTS/DTSS device sends laser light into an optical fiber. Part of the light is backscattered to the device, where it is analyzed. The Brillouin frequency of the backscattered light changes with the strain and temperature applied to the fiber. By accurately measuring the changes in the Brillouin frequency (essentially changes in wavelength), the applied strain or temperature change can be calculated. To monitor strain or temperature, the sensing cable must be designed and installed so that the deformation or temperature of the asset being monitored is transferred to the fiber. DSTS/DTSS can be implemented using a combination of telecom fiber (usually a loose jacketed fiber for temperature and a tightly coupled fiber for strain).

DSTS/DTSS is commonly used for monitoring large structures, where changes in strain or temperature may be indicative of an impending failure. In addition to pipelines, other structures like dams, levees, bridges, tunnels, roadways, and power lines are all structures that can benefit from DSTS/DTSS monitoring. Similarly, industrial process monitoring, as well as fire detection in large buildings or tunnels, can benefit from

DSTS/DTSS measurements. Depending on the installation, DSTS/DTSS can be optimized for monitoring strain, temperature, or both.

B. FOSA Information for Pipeline Operators

On March 14, 2018, FOSA released an 11-page primer entitled, *Installation Considerations for Pipelines*, designed to assist pipeline operators, construction companies, technology integrators and others in deploying DFOS systems in the optimal manner. The primer is filed with these comments and is available at www.fiberopticsensing.org/page/installation-considerations.

FOSA also has created a webinar entitled, *Advancing Pipeline Safety with Fiber Optic Sensing* which provides additional insights gained from DFOS pipeline deployments around the world. The webinar is available at www.fiberopticsensing.org/p/cm/ld/fid=734&tid=310&sid=2387

C. FOSA Recommendations

1. Identifying High Consequence Area (HCA) Events in a Timely Manner

FOSA recommends that PHMSA adopt specific performance-based requirements for identifying and reporting significant events, especially those occurring in High Consequence Areas (HCAs). Such a performance standard, consistent with existing available technology, can require that the precise location of an incident should be reported within a specified distance and that such information be received by operators within a minimum specified time.

2. PHMSA Performance Based Leak Detection Standards

Although leak detection is not the subject of this rule, the development of effective leak detection systems is so critical to improving pipeline safety that we feel compelled to raise the topic at every opportunity. We applaud PHMSA's work to encourage improved leak detection technology through its R&D program, which is a serious and important effort to further effective leak detection technology. An essential corollary of the R&D effort is the establishment of performance-based leak detection standards. Having such standards will allow technologists to understand the performance thresholds that are critical for technology development. Moreover, fulfilling this important statutory mandate of the Pipeline Safety, Regulatory Certainty and Job Creation Act of 2011[5] will provide regulatory clarity to the pipeline industry. Therefore, we urge the GPAC to advise PHMSA to expedite the adoption of performance-based standards for leak detection technology. To be clear, we do not recommend mandating specific technologies.

[5] Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011 (P.L. 112- 90)

Indeed, such mandates can inhibit the adoption of alternative combination of technologies that may be both more precise and cost effective. By using performance-based leak detection standards, PHMSA can encourage timely investment in the most cost effective available technologies.

3. Accommodations and Incentives for Operators Adopting Standards-Based Leak Detection Systems.

FOSA recommends that the GPAC urge PHMSA to encourage the deployment of advanced leak detection systems by providing accommodations and incentives to operators adopting such systems. Such accommodations and incentives might include additional time to meet new regulatory requirements, reduced fines or monetary grants to help offset costs.

4. PHMSA Sanctioned Leak Detection Testing Facilities.

FOSA recommends that the GPAC advise PHMSA that, to properly assess the efficacy of various external leak detection technologies, the agency should support the construction and operation of a dedicated leak detection testing facility operated by PHMSA, a quasi-government corporation, or a non-profit organization with expertise in pipeline operations.

Other industries enjoy the support of such federally-supported testing facilities -- e.g., the National Highway Traffic Safety Administration's Vehicle Research and Testing Center (VRTC) and the Federal Railroad Administration's Transportation Technology Center (TTC) -- but the US pipeline sector currently lacks such a dedicated testing center. A national facility of this nature would serve multiple purposes, including to lower pipeline operators' cost of testing new technologies, facilitate certification of technology performance standards, and facilitate PHMSA's information gathering mandate.

5. PHMSA Should Include Fiber Optic Sensing in its Leak Detection Guidance

PHMSA guidance to stakeholders regarding leak detection technologies should include DFOS as an option. For example, PHMSA materials such as "Fact Sheet on Leak Detection Systems" currently contains no reference to or information about DFOS or any other external leak detection technology. [6] To assist pipeline operators in deploying optimal leak detection technology, PHMSA should provide broader information in its publications and guidance.

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[6] See https://primis.phmsa.dot.gov/comm/factsheets/fsleakdetectionsystems.htm, Revised December 1, 2011.

D. Conclusion

FOSA appreciates the opportunity to offer input to the Gas Pipeline Advisory Committee. FOSA believes that modern sensing technology can help meet the important goal of pipeline safety which is shared by the agency, the pipeline industry and the public.

Thank you for your work on this important issue. Please let us know if we may provide you with additional information that might assist in your efforts. I can be reached by phone at 202-423-5344.

Sincerely

Mark Uncapher

Mark Uncapher
Director - FOSA