Fiber Optic Sensing Association
Connect and Protect

February 25, 2018

U.S. Department of Transportation
West Building Ground Floor, Room W12-140
Docket #PHMSA-2016-0128
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 for the Docket #PHMSA-2016-0128

Dear Administrator:

The Fiber Optic Sensing Association ("FOSA") appreciates the opportunity to submit comments to the Voluntary Information-Sharing System Working Group.[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., LIOS Technology (NKT Photonics,) OFS, Omnisens, OptaSense, OZ Optics, and Prysmian.[2]

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.[3]

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[1] Voluntary Information-Sharing System Working Group, created in accordance with Section 10 of the Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2016 (Pub. L. 114-183), the Federal Advisory Committee Act of 1972 (5 U.S.C., App. 2, as amended), and 41 CFR 102-3.50(a).
[2] For further information, please visit fiberopticsensing.org
[3] FOSA's Technology Committee produced and made public a non-company branded webinar "Advancing Pipeline Safety with Fiber Optic Sensing"
see https://www.fiberopticsensing.org/p/cm/ld/fid=734&tid=310&sid=2387

In this submission, and consistent with the Working Group's charter, FOSA will:

- Highlight the potential that DFOS has for pipeline leak detection; and
- Propose for the Working Group's consideration potential recommendations that improve the identification and adoption of enhanced leak detection technologies.

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.

In the pipeline sector, optical fiber can be used both to detect and avoid leaks. Regarding detection, distributed fiber optic sensing immediately determines severity and location with great accuracy, facilitating quick action that may reduce injury and damage. Perhaps even more importantly, DFOS allows constant monitoring for integrity, intrusion and problematic conditions, thereby helping to avoid leaks altogether. Two North American pipeline operators – SoCalGas and Husky Midstream -- have recently indicated plans to install DFOS on new pipeline deployments,[4] and multiple North American trials are occurring. In other regions of the world, pipeline operators have begun to routinely include DFOS as part of new construction.

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

[4] 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; 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/

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 fibers can be utilized.

Generally, three categories of distributed fiber optic sensing technology are utilized for pipeline leak detection and intrusion 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 Datacom 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 Recommendations

1. PHMSA Sanctioned Leak Detection Testing Facilities.

FOSA recommends that the Voluntary Information-Sharing System Working Group advise PHMSA that to properly assess the efficacy of various 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.

2. PHMSA Performance Based Leak Detection Standards

FOSA recommends that the Voluntary Information-Sharing System Working Group provide advice to PHMSA to expedite the adoption of performance-based standards for leak detection technology. Fulfilling the statutory mandate of the Pipeline Safety, Regulatory Certainty and Job Creation Act of 2011[5] would provide regulatory clarity to the pipeline industry and related industries. 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 Voluntary Information-Sharing System Working Group 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 Should Include Fiber Optic Sensing in its Leak Detection Guidance

PHMSA guidance to stakeholders regarding leak detection technologies should include DFOS as reasonable options. 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. To assist pipeline operators in

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

deploying optimal leak detection technology, PHMSA should provide broader information in its publications and guidance.[6]

C. Conclusion

FOSA appreciates the opportunity to offer input to the Voluntary Information-Sharing System Working Group. The Association believes that modem 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

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[6] See https://primis.phmsa.dot.gov/comm/factsheets/fsleakdetectionsystems.htm Accessed on February 21, 2018.