Testimony of
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House Science, Space, and Technology Subcommittee on Energy and Environment Hearing

Supporting American Jobs and the Economy through Expanded Energy Production: Challenges and Opportunities of Unconventional Resources Technology

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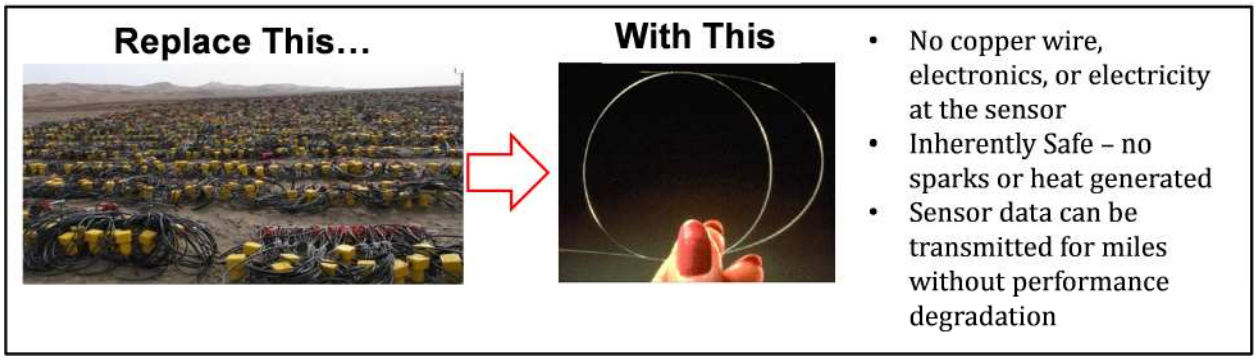
Introduction:

Chairman Harris, Ranking Member Miller, and other members of the Subcommittee, I am Jim Andersen, President and CEO of US Seismic Systems, Inc. (USSI). Thank you for this opportunity to testify today.

US Seismic Systems, Inc., (USSI) an Acorn Energy portfolio company (ACFN:NASDAQ) is a Delaware corporation headquartered in Chatsworth, California whose primary focus is to develop and manufacture sensor systems for the Oil & Gas sector based upon proprietary fiber optic technology. These sensors, which are powered only by light, are designed to replace the 50-year old copper wire-based sensor technology that is currently in widespread use within the oil Exploration and Production (E&P) industry. The existing 50 year-old sensor technology is too costly and unreliable to support the new oil and gas recovery techniques needed to meet the world's increasing demand. USSI's fiber optic sensor systems are designed to replace these legacy systems, with more reliable, more precise, less expensive, and inherently safe systems.

The USSI fiber optic sensor technology is revolutionary, with three patents issued, and ten patents pending. USSI's all-optical sensors represent a radical departure from today's electronic-based sensing systems; they function with no in-situ electronics, copper conductors, or electrical power. The USSI system eliminates the need for electronics, electrical connectors, batteries, and heavy copper cables in the field.



USSI's new fiber optic sensing systems provide users with a huge competitive advantage over those relying on electronic sensor technology. They will enable users to improve efficiency, increase output, and enhance safety, all at a lower cost. USSI has a world-class business and technical team, internationally recognized for their expertise in fiber optic sensors and related technology.

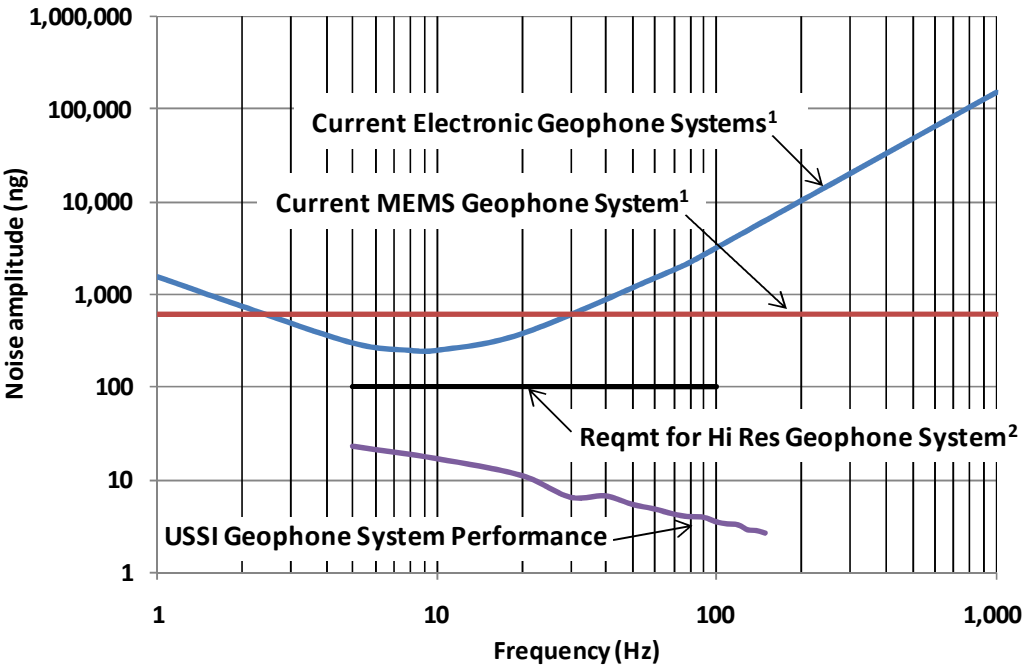
Environmental issues/concerns with the unconventional energy production process are threatening to derail the current revolution in the US energy market. USSI believes that we all must recognize that despite following all the best practices, problems can and do still occur, i.e., fractures can occur outside of the intended zones, and well casings do sometimes leak.

USSI believes it is better to install systems that can detect the occurrence of these potential problems, such that they can be corrected before significant damage occurs.

Overview of USSI Fiber Optic Technology

By way of overview, US Seismic Systems Inc. (USSI) has developed an Ultra-High Sensitivity (UHS) fiber optic seismic sensing system designed to replace the expensive, unreliable, bulky electronic geophones and equipment used in existing oilfield seismic monitoring systems with a high sensitivity, low cost, ultra-reliable fiber optic geophone system. The USSI system eliminates all in-situ electronics and electrical power cables, while providing superior signal to noise performance as compared to legacy systems.

For over 50 years, it has been generally accepted within the oil & gas industry that geophones represent the most effective and reliable approach for monitoring subsurface seismic activity. Conventional geophones consist of a magnet mounted inside a wire coil. Relative motion between the magnet and the wire coil produces an output that is proportional to the level of seismic activity. These geophones systems have performance that is marginal for today's new unconventional oilfield recovery methods and they are simply too costly. Since the USSI fiber optic geophone relies on a completely different technology than the magnet/coil geophone (laser light and optical fiber vs. electricity and copper wire), it is not subject to the same performance limitations. As a result, USSI is able to design and build fiber optic geophones with detection sensitivities more than 100 times higher than the conventional electronic geophones***. As a matter of fact, the performance of the USSI fiber optic geophone is superior to the performance of the traditional geophones in every key category: sensitivity, noise floor, distortion, bandwidth, and dynamic range, and all at a lower cost.*** The major advantage fiber optic sensors have over conventional electronic-based sensors is the ability to separate the electronics (preamplifiers, filters, ADC, multiplexing electronics, etc.) from the sensor, taking the electronics out of the hostile sensing environment (downhole, ocean bottom, buried, etc.), allowing the electronics to reside in a benign controlled environment, where they are always accessible for repairs or upgrades.

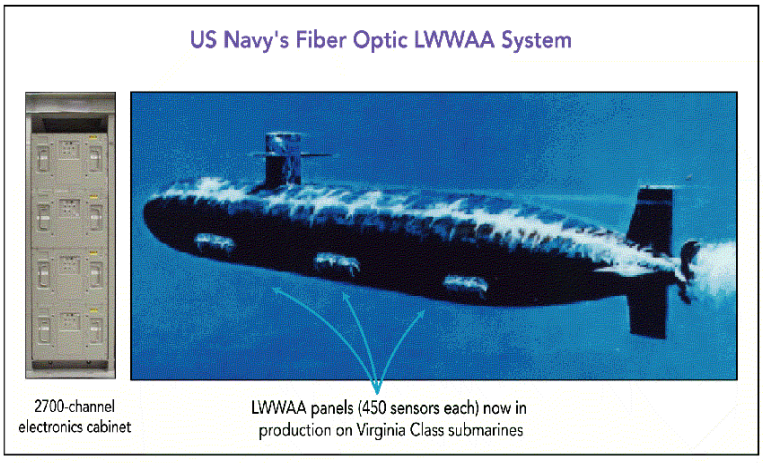


USSI Geophone System has the Lowest Noise Floor vs. all Competing Systems

1. **Geophone and MEMS Accelerometer Comparison at Spring Coulee, Alberta**, Canadian Society of Petroleum Geologists (CSPG), Canadian Society of Exploration Geophysicists (CSEG) and the Canadian Well Logging Society (CWLS) *Convention*, Calgary, Alberta 2009
2. **Characterization of a High Resolution Acquisition System For Marine Geophysical Applications**, Instrumentation and Measurement Technology Conference, Sorrento, Italy 24-27 April 2006

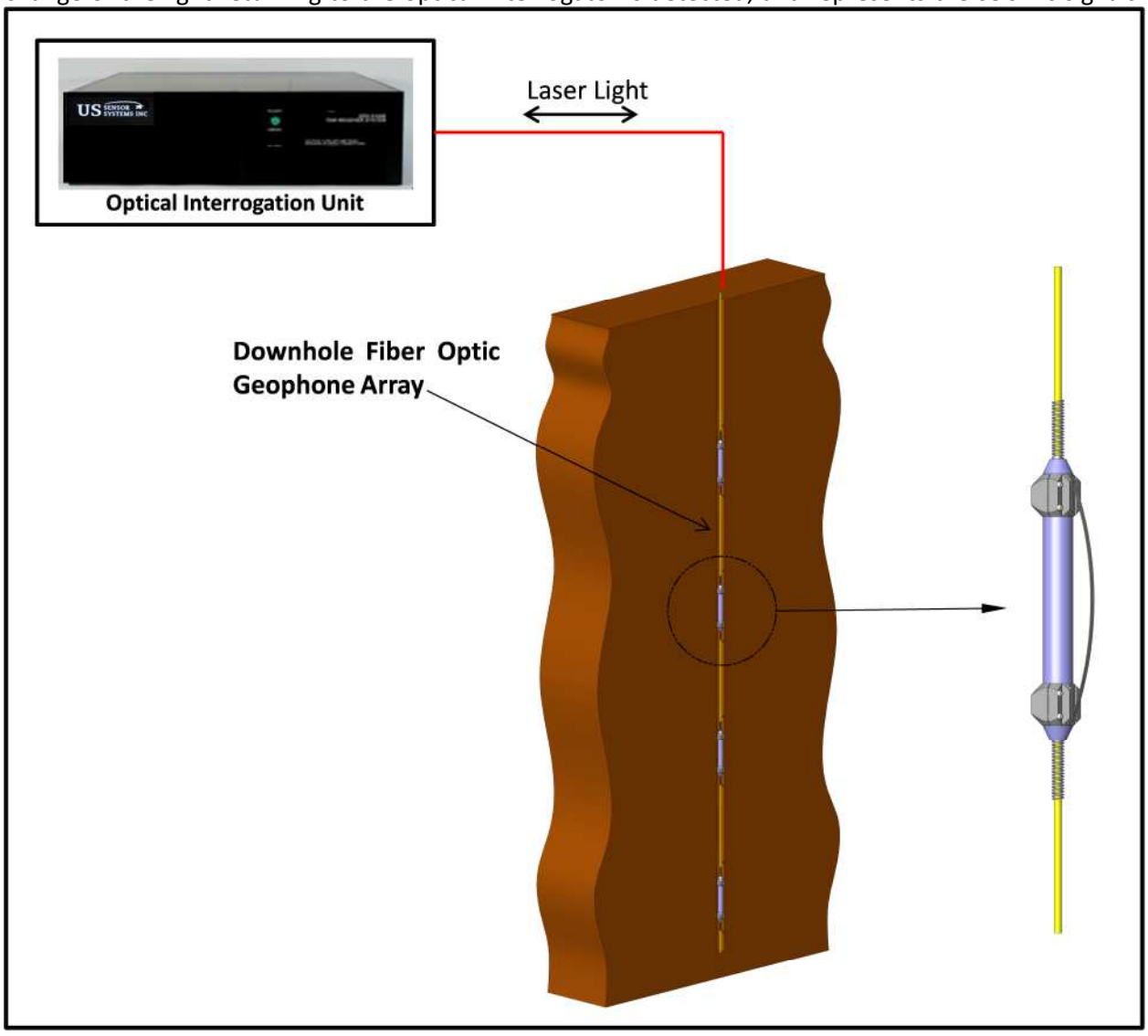
The chart above shows how the performance of the USSI fiber optic geophone compares with other oilfield geophone sensor technologies and with industry requirements. As can be seen in the chart, the USSI system has the lowest noise floor of all microseismic systems on the market. This translates into the ability to detect much quieter signals.

USSI's systems are based upon proven fiber optic technology originally developed for the US Navy's Virginia Class nuclear submarine LWWAA program. LWWAA is the largest fiber optic sensor system in production, valued at over $450M. While I am now USSI's CEO, I previously started and led Litton's (now NG) Fiber Optic Strategic Business Unit that designed and manufactured the LWWAA system. Key members of the LWWAA team are now at USSI. USSI has commercialized the technology for improved reliability and lower cost.



How does the USSI Fiber Optic Sensor Work?

The sensor in the USSI system is simply optical fiber. The optical fiber also serves as the transmission path to and from the fiber optic sensors. Engineers at USSI have developed proprietary techniques to package the optical fiber in ways that enhance its sensitivity to seismic signals. The system works as follows: Laser light from the Interrogator is launched down the optical fiber to the geophone array. Seismic disturbances cause the phase of the light going through the geophones to change. The phase change of the light returning to the optical Interrogator is detected, and represents the seismic signals.



The optical interrogator electronics includes a laser source with a phase modulator which imparts a high frequency carrier (modulation signal) onto the light launched down the fiber, as well as the receiver electronics for demodulating the reflected signals and translating them into a digital electronic signal. The fiber optic telemetry cable provides the data path to and from the individual sensors, and incorporates optical connection units that serve as the connection point for the individual geophones. The optical geophone converts the ground motion into an optical phase shift which is demodulated in

the interrogator. The remotely deployed fiber sensor/telemetry cable contains no electronics. All of the electronics resides in the interrogator.

Hydraulic Fracturing for Unconventional Resource Development Defined

Hydraulic fracturing is a well stimulation process used to release oil, natural gas, geothermal energy, and even water from "tight" underground formations to maximize the extraction of these resources. Hydraulic fracturing is used by the oil and gas industry to fracture low permeability, resource-bearing subsurface rock to allow oil or natural gas to move more freely from the rock pores to production wells that bring the oil or gas to the surface.

During hydraulic fracturing, frac fluid, consisting primarily of water with chemical additives, is pumped into a geologic formation at pressures up to 15,000 psi. The high pressure of the fluid, which is designed to exceed the rock strength, opens or enlarges fractures that can extend several hundred feet away from the well. After the fractures are created, proppants in the fluid are pumped into the fractures to keep them from closing when the pumping pressure is released. After the fracturing is completed, the downhole pressure of the geologic formation causes the injected fracturing fluids to rise to the surface where it is typically stored in tanks or pits prior to disposal or recycling. Since the flowback fluid may contain numerous contaminants, proper handling/disposal of the flowback fluid is required.

Importance of USSI's Fiber Optic Systems for Unconventional Energy Production

Currently, less than about 3 per cent of 20,000+ frac jobs performed annually in the United States are monitored. This monitoring process, called microseismic monitoring combines subsurface sensors with powerful data collection and analysis software, to record the myriad of tiny microseisms (or microearthquakes) that occur as fluid is pumped into a well bore, splitting or fracturing the subsurface rock formation holding the natural gas or oil. The individual locations of these microseismic events are then mapped to create an image of the fracture locations. As the name microseismic implies, these are small events, thus the need for the much higher detection sensitivity of USSI's fiber optic geophones.

Many leading producers will readily admit that increased monitoring will lead to reduced environmental impact and improvements in efficiency, however, based upon today's electronic sensor technology, it is simply unaffordable. The problem is that using today's electronic sensor technology, the cost of a system to provide the monitoring is approximately $5M, which is comparable to the cost of completing the well. This is cost prohibitive, especially at today's low gas prices. And, this cost does not include the drilling of instrumentation wells for the sensor arrays, or their installation. Fortunately, USSI's fiber optic sensor systems for microseismic monitoring are based upon proprietary fiber optic technology that is substantially less expensive. In full production we currently estimate, that USSI's microseismic systems will sell for approximately 10% of the cost of today's electronic systems. USSI is in discussions with the companies responsible for over 75% of the frac jobs performed annually in the US.

As is usually the case with the introduction of a new technology, a few forward looking companies looking to become industry leaders in the responsible and efficient development of our country's shale gas resources become the early adopters. Such is the case with FTS International www.ftsi.com (previously Frac Tech Services), a leading independent provider of well stimulation (hydrofracking) services for the oil and gas industry in the United States with a focus on environmentally friendly ways to do business - developing vital assets and promoting energy independence, while protecting natural resources. FTS International, one of this country's largest multi-stage, unconventional completion services companies, intends to work with USSI to develop a custom fiber optic microseismic monitoring

solution that will eventually enable FTSI to be the first to offer cost-effective monitoring of 100% of their frac jobs.

Why Increased Monitoring will Address the Major Environmental Concerns

Several of the major areas of environmental concern can be minimized via increased monitoring during and after the hydrofracking process, these include:

- Chemical contamination of subsurface fresh water aquifers
- Gas Migration
- Induced Seismicity

Chemical contamination of subsurface aquifers can be caused by either fractures/fissures occurring outside of the desired fracture zone, or leakage along the well bore due to a faulty casing/cement job. Both of these adverse events can be detected via low cost, passive downhole fiber optic sensors. Once detected, remediation efforts to correct the problem can be implemented.

Gas migration refers to gas entry into the cemented annulus (area between metal casing strings) creating channels with the potential to provide a gas/fluid flow in the annulus. Migrating gas can affect water supplies, as well as potentially accumulate inside or next to structures such as residences, businesses and farming operations. This could create a risk of a fire or explosion. Gas migration may become a threat to the health, safety and welfare of the public. Properly cementing and casing a well is very important to prevent gas migration. In May of 2011 researchers at Duke University released a study that found high levels of leaked methane in well water collected near shale-gas drilling and hydrofracking sites. The Duke researchers said that the presence of methane likely was due to its escape from faulty drill casings (gas migration). This peer-reviewed study was published in the Proceedings of the National Academy of Sciences.

USSI has developed a well bore leak detection system (patent pending) designed to detect leakage along the well bore surface casing. The system is based upon the USSI PipeSafe™ fiber optic leak detection system for natural gas pipelines.

Induced seismicity refers to earthquake activity that is the result of human activity. Numerous studies have indicated that induced seismicity can be caused by injecting fluid into the subsurface or by extracting fluids at a rate that causes subsidence and/or slippage along planes of weakness in the earth. Lawrence Berkeley National Laboratory is currently conducting extensive research into induced seismicity brought on by hydrofracking operations for both oil and gas extraction and enhanced geothermal activity, and believes that monitoring during the hydrofracking process will allow more precise control thereby minimizing induced seismic events.

Conclusion:

In conclusion, as I have described in my testimony today, USSI has developed revolutionary fiber optic sensing technology that can have a large potential impact on unconventional energy production. USSI acknowledges that even when following the best industry practices, unexpected problems may occur. Fractures can occur outside the desired zone, and documented cases of gas migration have been reported for years, even prior to the revolution in shale gas. Fortunately, the technology now exists to detect these problems such that remediation can be performed prior to the onset of significant environmental damage.

Again, thank you for the opportunity to testify today, and I look forward to answering any questions that you might have.

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About the Author

Jim Andersen is President and CEO US Seismic Systems, a leading producer of fiber optic sensor systems for the Energy and Security markets. Jim started and headed Litton's Strategic Business Unit for Fiber Optic Acoustic Systems, which was recognized as the company's fastest growing business unit from 1995 to 2002. At Litton, he landed the first fiber optic sonar production contract on the new Virginia class submarines, valued at over $400M. Jim began his career as an Engineering Officer on US Navy Nuclear Submarines and went on to hold a variety of engineering and senior management positions in engineering-intensive high-technology companies, including Westinghouse, Whitehall/Hydroscience, Litton Industries and Northrop Grumman. Prior to that, Mr. Andersen held technical and executive positions in companies that developed systems for oil exploration and ocean applications. Mr. Andersen is a member of the Technical Committee of the Marcellus Shale Coalition and a past member of the Board of Directors of the Electro-Optics Alliance, a collaborative group of over 300 US Electro-Optics companies formed to maintain US leadership in Electro-Optics. He has written recent articles for numerous Oil & Gas publications including the **The Oil & Gas Journal**, **Hart's Exploration and Production**, **Offshore Magazine**, **Oil and Gas Reporter**, and **First Break** M**agazine**. He holds a Bachelor of Science in mechanical engineering from the United States Naval Academy and six US patents in sensing systems and optics.

About US Seismic Systems, Inc.

US Seismic Systems, Inc. designs, integrates, manufactures and sells fiber-optic sensing systems and solutions for the energy and defense markets. USSI utilizes all-optical fiber sensing technology for its state-of-the-art sensors. USSI's proprietary optical fiber and electronics combine to form the sensor system. It is designed to replace the legacy electronic-based sensor systems at a lower cost and with improved performance and reliability. For more information visit the USSI website at: www.ussensorsystems.com.