Blast-Zone Safety
Using Wireless Gas-Detection Monitoring

Rae Systems, Inc.

Overview

Area monitoring for toxic and flammable gases using wireless detection systems keeps workers and assets safe by providing a cost-effective early warning system for unseen threats such as hydrogen sulfide and methane during oil and gas exploration operations. Oil and gas exploration often involves the controlled use of explosives to facilitate extraction. Traditionally, wireless devices have been shut off to ensure detonators are not inadvertently triggered by a radio frequency (RF) signal. Turning off wireless gas-detection equipment, however, leaves workers exposed if the atmosphere becomes bad – that is, until now.

For decades, blast-area security prohibited the use of wireless devices at any location where blasting caps or other explosives are present to prevent a wireless signal from inadvertently detonating explosives. If a radio frequency (RF) signal is powerful enough, the wires of a commercial electric detonator can serve as an antenna and pick up the electromagnetic signal, potentially firing the detonator and setting off explosives prematurely. To eliminate such risk, wireless devices such as cell phones and two-way radios – as well as radio-based gas-detection systems – need to be shut off in and around active blast-zone areas.

Shutting off wireless gas detectors – which can be placed near potentially hazardous areas such as a drill wellhead – leaves workers at the job site potentially exposed to unseen toxic gases and vapors without an early warning system to alert them to contaminated air.

While non-wireless portable or personal monitors that cover a workers' breathing zone are recommended at blast sites, they only alarm at the time of exposure and do not provide early detection to dangerous or potentially explosive gas. Wireless systems with remote gas detectors can be quickly deployed around a perimeter of a project or in other fixed areas to enhance personal and handheld monitoring by providing continuous, real-time monitoring to detect toxic gases, such as hydrogen sulfide (H_2S) and flammable vapors, such as methane (CH_4), before they pose a danger to workers or others in the area.

Independent, third-party tests from an established testing company verify the wireless MeshGuard Gas-Detection System from RAE Systems is safe to use in blast-zone areas without posing a risk of premature or unexpected detonation of explosives. According to the report, the MeshGuard sends a low-voltage signal in a small fraction of a second equivalent to about 0.07 milliwatts that is "imperceptible" by even the most sensitive commercial electric detonators.

Blast Zone Test Methodology

The blast zone safety study was commissioned by RAE Systems – and conducted by a reputable independent third-party company – to confirm the MeshGuard system, which uses a small radio transmitter to send data wirelessly, is safe for use in close proximity to the lead wires and explosive charges of commercial electric detonation systems.

According to the report, any RF transmitter can induce electric currents to flow in nearby electric wires, whereby the wires act like an antenna. If the RF transmitter is near the lead wires of an electric detonator, then current will flow through the bridge wire of the detonator. The goal was to determine if enough current would flow to heat the bridge wire, and subsequently cause the detonator to fire. Because any type of commercial electric detonator might be used around the MeshGuard detection system, a worst-case approach was assumed by testing for the "lowest safe power level of any type of commercial electric detonators." The no-fire level of the detonator was set at 40 milliwatts because most commercial electric detonators operate at a higher no-fire power level.

The tests utilized a recently calibrated volt-ohm meter (VOM) meter to measure signal strength; a vacuum thermocouple (VTC) simulated the blasting cap; insulated hookup wire (AWG 22) was used to simulate the lead wires of an electric detonator; and a #2 incandescent light bulb simulated the detonator. During startup of the MeshGuard monitor, the signal-strength meter went full scale, indicating the unit was indeed emitting electromagnetic radiation.

About one-foot of wire was connected to the ends of the lead wires of the #2 light bulb to create a dipole antenna. If the antenna picks up enough RF power to fire an electric detonator, the light bulb will glow brightly. When this assembly was placed near the MeshGuard, which was then turned on, the bulb did not glow. Various orientations of the pickup antenna were attempted, including connecting the wire ends together to form a loop antenna. All of these efforts failed to make the bulb glow, indicating the RF power pickup was less than the power level required to fire an electric detonator.

The detector was then tested using the simulated electric detonator. By connecting about two feet (60cm) of the lead wires to the VTC, which is a very sensitive RF detector, a dipole antenna was formed. This assembly is similar to an electric detonator with its lead wires stretched out. It was tested with the MeshGuard many times while re-orienting the antenna in relation to the MeshGuard detector. The vacuum thermocouple registered voltage output of only 1.50 volts, a negligible indication of RF power pickup. This corresponds to about 0.07 milliwatts, which is "i[illegible]" by even the most sensitive commercial electric detonators.

In a final extreme worst-case test, the ends of the lead wires were twisted together to make a loop and placed on top of the MeshGuard antenna. This compares with putting an electric detonator with short-circuited leads directly on top of the MeshGuard. The simulated electric detonator (that is, the VTC) did not register any RF power pickup in this scenario.

The end result shows the MeshGuard system can be safely used in blast zones to protect workers from toxic and flammable gases without risk of an unexpected firing of nearby electric detonators. For those who already own a MeshGuard system, it can now be used safely in blast zones without implementing any setting changes or upgrades.

Key Applications in Oil and Gas

In the upstream oil and gas industry, one of the requirements for maximizing production of new or existing wells relies on a process known as "perforation." It involves generating holes in the production casing to get access to a formation or reservoir. One typical method requires the use of a perforating gun that electrically fires charges that put holes into the wellbore casing or liner. Its key advantage includes improved control of the well by providing precision in connecting to formations and the ability to seal perforations that are no longer productive.

While blasting is a key part of the process, it can lead to dangerous emissions of deadly or combustible gasses and vapors, including leaks from the wellbore. Wireless detectors can be deployed in and around the wellbore for early detection of any gas or vapor leaks. Data trailer personnel can monitor the readings in real time and the data gets logged for later retrieval. Area wide alarms can be sounded if leaks threaten personnel, allowing teams to avoid direct contact with dangerous gases that can have both short-term and long-term health consequences. Workers are often also equipped with non-wireless personal gas detection monitors.

Natural gas continues to play a key role in the global energy market. Technological advances in horizontal drilling and hydraulic fracturing, or fracking, have enabled greater access to shale formations, providing a commercially viable and vast source of natural gas reserves.[i]

Modern-day fracking begins with traditional vertical drilling to reach deep underground shale formations and then turns horizontal as the drill moves through the shale thousands of feet below the surface. Perforation blasts are then used to punch holes in the casing and shale that creates small fissures through which hydrocarbons flow into the well stream. Fracturing fluid, consisting primarily of water and sand, along with chemicals to improve flow, are then pumped into the well to fracture the underground fissures. The water is removed, but the sand remains to hold the fractures open, which permits gas to flow to the surface. While the drilling process can take about 2 to 3 months to complete, fracking can be completed in days and can provide up to 20 to 40 years of well production.[ii]

Fracking sites are typically large areas that bring many workers into the site to operate trucks bringing in source materials and trucks removing spent materials. This makes one of the key applications in fracking perimeter monitoring, which provides safety for workers and any communities or other work sites that may be nearby. At the same time, separate monitors can be deployed near the wellbore and other process equipment to ensure any unrecovered gasses can be identified and appropriate safety actions can be taken.

Coalbed methane is a form of natural gas extracted from coal beds. The methane is stored inside the coal, but open fractures, or cleats, allow the gas to escape. Because of the methane content, gas-detection monitoring is critical. While methane is non-toxic, it is extremely flammable and can form explosive mixtures with air. The MeshGuard system monitors LEL and is rugged enough to operate dependably in these harsh monitoring environments.

MeshGuard Has Been Determined Safe to Use in Blast Zones

Testing shows the wireless MeshGuard Gas-Detection System is safe to use in blast zones without posing a risk of unexpected detonations. RAE Systems' wireless MeshGuard Gas-Detection System has been tested and verified by an industry-established third-party testing firm for safe use in blast zones without risk of unexpectedly firing even the most sensitive commercial electric detonators at close range. This application note highlights safety factors related to underground blasting in the oil and gas industry, the test methodology used to verify the safe use of the MeshGuard system in such environments, and key wireless monitoring applications in the upstream oil and gas industry.

The wireless MeshGuard Gas-Detection System provides simple and rapid deployments in a wide range of industrial-safety and remote-monitoring applications. It combines gas-detection and advanced wireless technology to provide real-time control of area-wide gas and vapor threats, while eliminating the need for lengthy and costly cable-installation projects. It delivers the ideal solution for oil and gas drilling and exploration applications – which include areas where blasting caps and explosives are frequently used.

Hassle-Free Wireless Monitoring

The MeshGuard connected gas-detection system – rapidly deployable in industrial and remote-monitoring applications – delivers all the reliability of a fixed-detection network, but without any of the hassles. Its powerful wireless sensors can be easily and rapidly deployed in any environment, eliminating the need for lengthy and costly installation projects.

- Cost savings and productivity increases help the system to quickly pay for itself, with no more trenching and cable runs.
- Rapid deployment means installation and monitoring in hours – not days or weeks.
- All system components certified to Class 1, Division I and Zone 0 to comply with all required international, federal and state regulations for safety monitoring of toxic gases and intrinsic safety.
- Self-forming and self-healing technology provides automated turn-on and keeps the network online even if a sensor is removed or relocated, or if transmission is interrupted.
- Real-time information helps safety managers make the best on-the-spot decisions.

Acronyms and Terminology

Blasting caps	A small primary explosive typically used to detonate larger, more powerful secondary explosives.
Bridge wire	A relatively thin resistance wire used as a pyrotechnic initiator. Electric current heats the wire to set off a chemical reaction that melts the wire and opens the circuit.
Dipole antenna	A common radio wave antenna created by wire or metal rods set in a parallel and collinear fashion whereby voltage is applied at the center between the two conductors.
Fracking	Fracking is short for induced hydraulic fracturing, or hydrofracking. It is a process where highly pressurized fluids are used to create underground fractures to increase the release of petroleum, natural gas and other resources trapped in shale and rock.
H_2S	Hydrogen sulfide (H_2S) is a very poisonous chemical compound that is colorless and flammable with the foul odor of rotten eggs. It is often produced by the bacterial breakdown of organic matter in the absence of oxygen.
LEL	The lower explosive limit, or LEL, is a flammability limit based on the lowest concentration of gas or vapor in air capable of combustion if it finds an ignition source, such as an electrical arc or flame.
MeshGuard system	The wireless MeshGuard Gas-Detection System provides rapid deployment in a wide range of industrial- safety and remote-monitoring applications. It combines gas-detection and advanced wireless technology to provide real-time control and eliminate the need for lengthy and costly cable- installation projects.
Perforation	Perforation refers to blasting holes in the casing or liner of an oil well to access petroleum or gas reservoirs trapped in porous or fractured rock formations.
ProRAE Guardian	RAE Systems' ProRAE Guardian is an advanced virtual command center for real-time monitoring of wireless sensor. A variety of RAE Systems monitors and third-party products can communicate directly or through gateway products with ProRAE Guardian using one of several communication networks, such as AreaRAE or the MeshGuard system.
RF signal	A radio-frequency, or RF signal is electric current with distinct properties over direct or alternating currents that makes it capable of radiating off a conductor into space in the form of electromagnetic waves, commonly referred to as radio waves.
Self-forming/self-healing network	A feature of robust wireless mesh-network technology that automatically configures the network and re-routes signals on the network if one or more nodes fail, enabling the network to continue to function without a fixed infrastructure.
Vacuum thermocouple	A vacuum thermocouple, or VTC, is a common instrument for measuring high-frequency current and voltage. It is a sensitive device that can make a quantitative measurement of power pickup from an RF signal.
VOC	Volatile organic compounds are organic chemicals with a high vapor pressure at ordinary, temperate conditions.
VOM	A volt-ohm meter (VOM), or multimeter is an electronic measuring instrument that combines several measurement functions into a single unit, including measuring electrical properties such as voltage, current and resistance.
Wellbore	A hole drilled to explore or extract natural resources such as water, oil or gas.

Learn More: Additional Useful Information, Videos, Reference Data and Links

1. Register for a free Facility-wide Wireless Gas Detection Assessment and demonstration **HERE** (http://www.raesystems.com/support/request-information)
2. Watch a video on MeshGuard deployment and use in Oil & Gas and Industrial settings HERE (http://www.youtube.com/watch?v=7dvFXzsatHY)
3. Learn more, and see videos on wireless gas detection including how to obtain remote access to real-time gas, radiation, and biometric data to enhance safety HERE (http://www.raesystems.com/emergency-responder/)
4. Learn more about Oil & Gas wireless detection **HERE** (http://www.raesystems.com/industry/oil-and-gas)

About RAE Systems Inc.

RAE Systems is a global sensor and wireless-system innovator that designs and manufactures a full line of fixed, portable, handheld and personal chemical- and radiation-detection instruments. The company's life- and health-saving detectors are used in 120 countries by many of the world's leading industrial organizations, emergency responders and government agencies.

RAE Systems offers a variety of rapidly deployable and custom-configurable sensor solutions for radiation monitoring. RAE Systems delivers cohesive, wirelessly connected threat-detection solutions that create a layered defense against gas and VOC threats and other gas and combustible risks. RAE Systems' solutions for Oil & Gas monitoring and protection are:

- **Versatile**: RAE Systems' easily deployable fixed and portable monitors placed in sensitive areas transmit sensor information in real-time to a central location for quick interpretation, analysis and action.
- **Wireless**: Wireless atmospheric monitoring that utilizes cost-effective equipment that is easy to install and operate can assist plant managers and operations commanders and first responders with real-time information on potential hazards.
- **Proven**: With more than 15 years of experience, RAE Systems' innovative solutions have a verified track record.

RAE Systems offers a wide range of rugged, yet easy-to-use monitors that enable continuous, real-time safety- and security-threat detection in nearly every environment, along with wirelessly connected solutions that lead the industry in performance and reliability. RAE Systems' intrinsically safe and globally certified monitors help elevate safety for workers, responders and the public at large; reduce project downtime; and maintain regulation compliance.

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[i] EPA (U.S. Environmental Protection Agency) website: Natural Gas Extraction – Hydraulic Fracturing. http://www.epa.gov/hydraulicfracture (Retrieved 12 Sept 2012).
[ii] IBID.