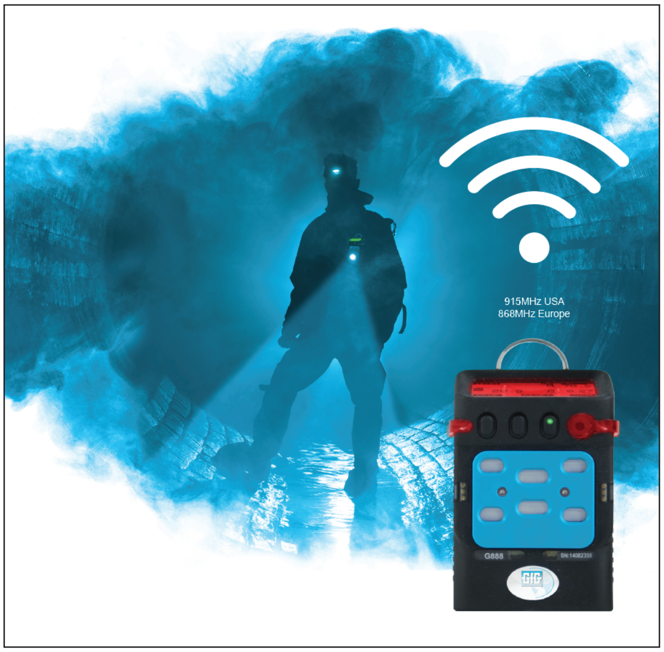
AP 1023:
Using Wireless Technology to Integrate Gas Detection and Worker Safety



Communication is vital when dealing with atmospheric hazards. It's not enough to measure the hazards; procedures need to communicate the results in real time to affected workers, managers and emergency responders.

The methods used to communicate monitoring results are a central part of any atmospheric monitoring program. After all, the accidental release or accumulation of toxic or combustible vapors is one of the most significant threats to worker safety. The faster the existence of a dangerous condition is discovered and communicated to workers, supervisors and emergency responders, the less likelihood there is for property damage, injury or loss of life. When the location of the gas detector is distant from the emergency responders, timely communication of this information is even more critical.

The methods for acquiring and disseminating this information are changing very rapidly. In the past, emergency conditions were communicated by means of a separate hand held radio, telephone, pager, siren or horn.

Advances in wireless technology are making it possible to transmit information in real time between individual workers, supervisors and emergency response team members. This is particularly important for solo workers, workers in confined spaces, and workers performing other risk associated tasks. Supervisors are never out of contact, even when workers are out of sight. Besides being able to see readings in real time, wireless connection allows two way communication between supervisors and instrument users. The central idea is to make the monitoring results immediately available to whoever needs the information exactly where it is needed. Results can be displayed locally on a tablet, laptop, cell phone, or personal computer, transmitted to a standby rescue team, or redundantly displayed on a PLC as part of the site's environmental health and safety system. Alternatively, multiple instruments can be linked into self-contained networks controlled and integrated by means of a mobile wireless host.

In the past, the most common method for real-time communication of readings and / or alarm state information has been by means of hard-wired connection between the gas detector and a controller or PLC located in a central safety office, guard shack or control room. This approach is still commonly used with permanently installed "fixed" gas detection systems. Using a cable to connect portable instruments to a nearby controller is more challenging. Some designs allow multiple instruments to be connected by means of cables to form a multi-monitor system. This approach has several potential drawbacks. The length of the connector cable is often limited, the sensors provide readings for the general area as opposed to readings from the breathing zone of individual workers, using multiple instruments linked by connector cables can be cumbersome, and as requirements have become more rigorous, the certifications carried by these products are often not be as desirable as the certifications carried by non-cable connected portable instruments.

Connecting instruments with a remote host or terminal by means of wireless or Radio Frequency (RF) links has long been an attractive alternative. However, licensing issues, limitations on the number of transmitters able to share the available frequencies, and concerns about the dependability and robustness of the wireless link left many site managers unwilling to take a chance on this otherwise attractive technology. Over the last few years, however, changes in RF transmission technology have made wireless integration of monitoring systems increasingly commonplace.

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Figure 2: The Micro Link is a dedicated wireless server used to integrate information from up to 10 portable instruments. If there an interruption in communication, the status indicator for the affected instrument turns from green to red, and the alarms in the Micro Link are activated.

This trend continues to gain momentum, as more and more monitoring and control systems offer safety managers the option to "go wireless". In addition, the nature of the transmitted information has become increasingly sophisticated. Readings, alarms, time history exposure calculations, "man down" alarms, communication link status and strength, and two way communication between the instruments and the server are all now available in real-time via wireless link.

As monitoring programs become more dependent on telemetered information to verify worker safety, the integrity of the real-time communication link becomes increasingly important. The emergence of new types of digital radio communication methods, greater flexibility in positioning system elements to maintain communication in complicated monitoring environments, and the ability of the system itself to constantly assess the status and communication linkage between system elements, have significantly increased the reliability and feasibility of using wirelessly transmitted information in health and safety monitoring programs.

Methods for Wirelessly Communicating Gas Detection System Information

There are two basic approaches currently being utilized for wirelessly transmitting information between portable gas detectors, and a remotely located base station or information processing point. The first is interfacing the instrument with an add-on wireless communication module. One method is to use a Bluetooth® transceiver built into the instrument to provide a wireless link over a limited distance between the instrument and a "smart" cellular telephone, laptop or tablet. The smart phone or tablet is used to communicate via cellular telephone or WIFI Internet connection with the information processing point or terminal. One of the limitations of this approach is that when the instrument is being used in a hazardous location, such as a confined space, the device used to send the information onwards must be certified for use in the same hazardous location as the instrument. Intrinsically safe cell phones and tablets are available, but can be very expensive!

Another problem is that cellular telephone and WIFI connections do not work very well in confined spaces and other industrial environments where walls, heavy structures and equipment block the transmission.

A variation of this approach is to embed the cellular communication module within the instrument. This avoids the issue of needing a secondary cellular communication device, but does not solve the problem structures or conditions that block the transmission. The work-around for this limitation is to add repeaters which rebroadcast the information, usually at greater intensity, over a greater distance, or through the intervening structure. The second approach is to include an integral RF (radio frequency) modem inside the instrument.

Several related technological trends and advances have made using real-time RF data transmission increasingly attractive. A major factor is the availability of “ISM” (industrial / scientific / medical) radio transmission frequencies that in many jurisdictions do not require a user license for transmission. Although local or national regulations vary, in many parts of the world users can simply purchase instruments that include integral ISM band RF transmitters, and put them into service without the need to obtain a radio license. In other jurisdictions, a license is required, just as a license is required for other types of hand held RF communication devices and radios.

Another factor is the increasingly sophisticated methods used for radio transmission and signal processing that make it possible to maintain a solid communication link between the instrument and the remotely located base controller. Encrypted, frequency hopping digital transmitters are now routinely used to protect the real-time digital RF data stream signal from interference from other RF sources. This technology additionally helps ensure that the communication link is secure and robust enough to be dependable for use in safety monitoring programs.

Spread-spectrum, frequency hopping radio transmitters send a short, high-speed stream of digital packets of information at one frequency, then “hop” to another frequency to transmit the next stream of data packets. Part of the information encoded in the string of packets is the frequency where the receiver (or transceiver) should look for the next string. Because of heavy redundancies in the information transmitted in the digital strings, as well as multiple fallback frequencies encoded in the string in case of a failure to receive the next stream of information at the expected frequency, it is possible to maintain seamless communication between the base controller and remotely located detectors, even when there is significant loss of individual strings of information.

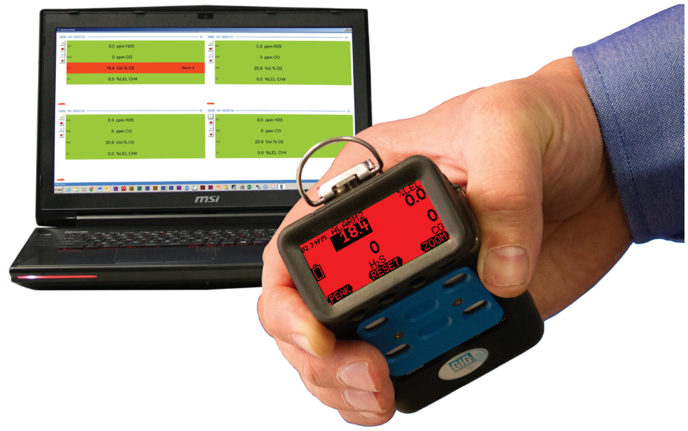

Figure 3: The RF transceiver and visual software can be installed on a laptop, tablet or personal computer. The transceiver plugs into any available USB port. The monitoring information is displayed directly on the computer screen or LCD. Transmitted information includes readings, gas alarms and “man down” alarms in the event that a worker falls or stops moving.

This fact significantly improves the overall robustness of the wireless link between the base controller and other gas detection system elements. Structures or equipment that may block the signal at one frequency, often have no effect on the signal at the next transmission frequency. This fact allows spread-spectrum RF transmission to work well in many areas where a traditional, single-frequency transmitter or radio would not be able to function.

This type of technology also makes it much easier for many users to share the same frequency range. Because it is extremely unlikely that two different RF system transmitters would hop at exactly the same instant between the same two frequencies, it is nearly impossible for one system’s transmitter to “step on” or block another system’s signal. Because of this fact, it is possible for as large number of digital RF systems to coexist in the same geographic area, without interfering with each other’s signals. This is what makes non-license required, ISM band radio based systems possible.

There are two basic approaches as well to the configuration of the remote server or host used to display and process information. The RF transceiver and software can be installed or plugged into a laptop, tablet or personal computer, in which case the monitoring information is displayed directly on the computer screen or LCD.

Use of a laptop or tablet allows the full display of readings, status and alarm state information. The computer or tablet can also function as a communication hub, with digital communication outputs that allow information to be redistributed to additional remote locations.

Another approach is to use a dedicated wireless host to integrate the monitoring results from multiple instruments. Portable, wireless gas detection system servers are certified for use in hazardous locations, and designed to handle environmentally harsh conditions. The wireless host replaces the laptop or tablet used to integrate the system. The wireless host is designed for simplified operation. It includes a display as well as audible and visual alarms, and indicators that show the communication status of the instruments being included in the system.

Sometimes the wireless server is located immediately outside the monitored area, where it can be used to help maintain better communication between workers in the hazardous location and supervisors or emergency responders standing by outside the area. Sometimes the information is transmitted to a more remote location, for instance, the office of the safety manager, or to a third-party rescue provider. Sometimes the information is transmitted redundantly to several remote locations. Wireless technology allows real-time communication on a worldwide basis. Once the monitoring results exist as a digital information stream, the results can easily be sent onward within seconds via RF, cellular telephone, hard-wired landline, or over the Internet, literally anywhere in the world.

Portable wireless systems are scalable and capable of handling anywhere from one or two portable instruments, to 10 or 20 or more gas detectors simultaneously. An important architectural issue is whether multiple systems can be blended “on the fly” into larger systems or information arrays. For instance, a company might own several small, wirelessly integrated multi-instrument systems normally used one-at-a-time. In the event a particular job requires deployment of a single, larger system, or in the event of an emergency, it might be very important for additional monitors to be added very quickly to the smaller systems used during routine operations. The important thing is for the system to be capable of the flexibility required by the nature of the environment being monitored, and the work being performed.

Flexibility in the display of readings and alarm state information is also very important. The primary location for the display of the monitored results might be on the supervisor’s laptop, but the real-time monitoring information might also need to be redundantly displayed in the office of a third party rescue team.

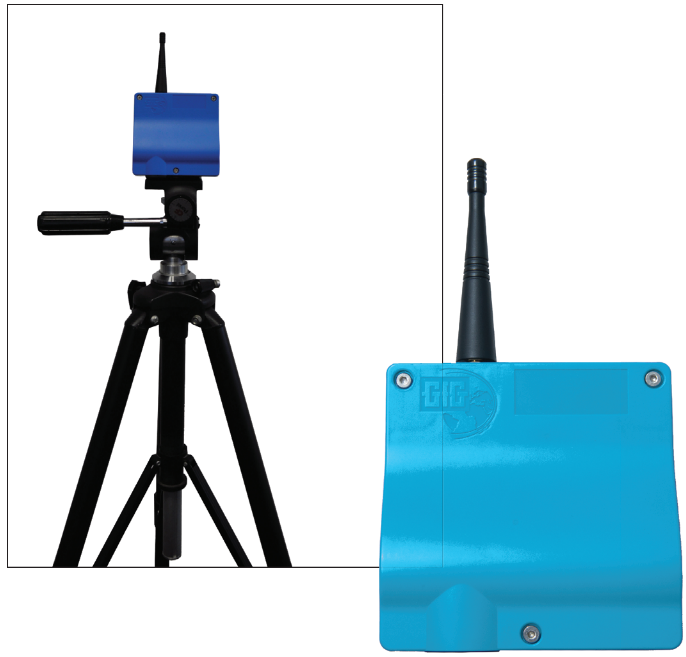

Figure 4: Repeater units can be used to acquire and retransmit the RF signal to get around corners or intervening obstructions. Adding multiple repeaters can be used to extend the transmission distance to as many miles as needed.

RF wireless systems are able to maintain good communication over relatively large distances, even in structurally congested industrial environments. However, in some monitoring applications, such as underground or below grade vaults, tunnels or sewers, or when the detector is located in close proximity to vessels or structures made of heavy steel, it may not be possible to establish communication even when the wireless host is located within 20 or 30 meters of the remotely located gas detectors. It may be necessary to add an RF repeater unit that can acquire and retransmit the signal to get around corners or intervening obstructions.

Wirelessly integrated systems that are used for real-time health and safety monitoring must be able to identify and sound an alarm if there is a loss of communication between system elements. Generally, wirelessly integrated systems are based on RF transceivers that are able to both send and receive system information. The base controller transceiver constantly monitors to ensure that all remotely located detectors, remote alarms, and other RF enabled system components are in proper communication with the wireless server.

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Loss of communication between system elements can be detected almost immediately, and used to generate the appropriate local and general alarms. The wireless server does this by regularly polling the instruments in the system. If a remotely located instrument fails to respond when polled, the wireless server is alerted to the existence of a potential communication problem. Similarly, the remotely located instrument expects to be polled by the server. Failure of the remotely located instrument to be polled is also cause for an alarm to be generated, this time by the remotely located gas detector.

Real time wireless communication leads to enhanced worker safety

A very important use of real-time wireless communication technology is in confined space entry and rescue procedures. Wireless technology substantially improves the ability of supervisors to maintain communication with entrants, to alert workers if there is a need to evacuate the area, as well as to coordinate rescue activities. Regulations vary, but in many jurisdictions, certain types of confined space entries are permissibly made on a regular basis without the presence of an on-hand safety attendant. In this case, the inclusion of real-time monitoring data transmitted to a central location is a clear enhancement in the safety of entrants.

Wireless communication provides a particular benefit where, in the event of an emergency, rescue services are to be provided by a "third-party" provider. It goes beyond the scope of this article to debate the circumstances under which it is prudent to rely on rescuers who are not physically present at the site until after an emergency has occurred. The fact remains that many programs rely on exactly this approach to conducting a rescue. One thing is very clear, if this is the approach to conducting a rescue, the timeliness in sounding the alarm and / or activating the response team is crucial to the ability of the team to successfully respond to the incident.

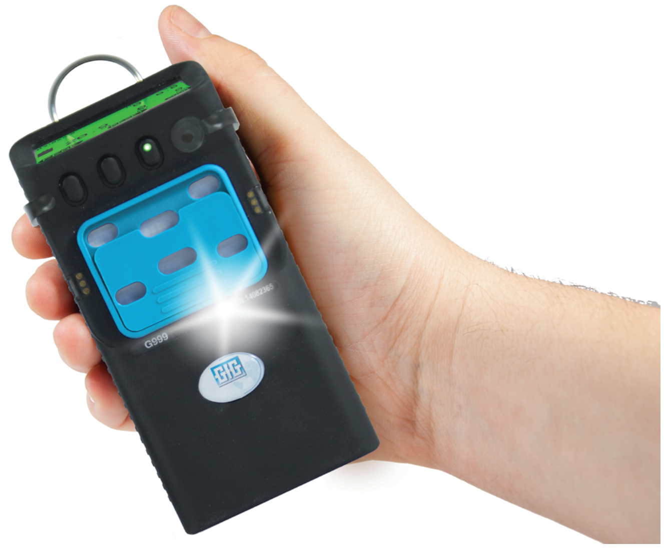

Figure 5: The G999 is a compact, one to six gas atmospheric monitor with internal motorized sample drawing pump and optional wireless communication. The powerful, built-in 868 MHz wireless RF modem has a transmission distance of up to 300 meters.

Having the atmospheric monitoring data and alarm-state information displayed in real-time on a monitor located in the rescue service provider's office is clearly a large step towards improving the ability of the rescue provider to rapidly respond in an emergency.

When it comes to worker safety, it's not enough just to monitor the conditions in the atmosphere. It's what you do with the information that counts. Using wireless technology to distribute information in real time to the people and places where it is needed is transforming workplace safety. The wireless revolution is here to stay.

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