Improving Safety Through Behavior and Gas Exposure Tracking

David D. Wagner, Director, Portable Products, Industrial Scientific Corporation,
1001 Oakdale Road, Oakdale, PA 15071, USA. Phone: 412-788-4353, Fax: 412-788-8353, Email: info@indsci.com, Web: www.indsci.com

The writing of this article follows on the heels of a meeting between the author and the Chief Deputy Attorney General of the Commonwealth of Pennsylvania. The purpose of that meeting was to investigate and discuss the circumstances of a fatal Pennsylvania mining accident. The Attorney General's office was desperately trying to determine an answer to the question of why the portable gas monitor, that was carried by the victim and designed to detect the methane gas that was inadvertently ignited into the fatal explosion that took his life, was turned off at the time of the accident.

Industrial Scientific Corporation has designed and manufactured portable gas monitoring instruments for more than more than twenty years. There are countless testimonials to how these instruments have saved lives and improved the level of safety in the workplace. Yet accidents like the one described above still occur and workers are still injured and killed in gas related accidents. This has led to one very clear realization. Manufacturers can design and produce the most reliable and best performing gas monitors possible. They could be maintained and cared for with the highest level of integrity. But if they are not used properly or not used at all, they cannot perform the function for which they were intended – saving lives.

It becomes clear how tracking behavior patterns surrounding the use of gas monitoring instruments and analyzing exposure data collected from these instruments can be used as leading indicators of potential workplace safety problems.

Behavior and Safety

The term behavior can be defined as an 'observable action or activity."[1] Carrying this definition through with regard to safety it can be said that behavior is an observable action or series of actions or activities that result in patterns that affect the safety of an individual or a group of workers.

Individual behaviors are repeatable. If you have done it once, you will likely do it again. Whether it has been done consciously or subconsciously, we have all trained ourselves to perform in certain ways. When unsafe behaviors start to occur with increasing frequency, the likelihood of accidents and injuries occurring become greater.

Safety behaviors can be viewed similarly to the illustrious safety fire triangle. When fuel and oxygen are present in the correct proportions along with a source of ignition, explosion occurs. When unsafe behaviors (sources of ignition) occur in the presence of significant hazards (fuel and oxygen), accidents and injuries do occur.

Now, back to the definition; behaviors are observable and are seen by others. As such, they are recordable. Since they are recordable, behaviors are leading indicators that can be analyzed and subsequently corrected to prevent accidents and injuries.

Gas Monitors and Datalogging

Datalogging is a feature that has been available in portable gas monitoring instruments since the early nineties. However it is a feature that historically has been used very infrequently. Through the first decade of availability, less than 10 percent of the portable gas monitors that were sold were equipped with datalogging functionality. Datalogging was considered a premium function and provided as an add-on at a premium price. The data recording capability was generally limited to storing average or peak gas readings and did not encompass storing values for other parameters. These "advanced" features were primarily used by industrial hygienists for performing air quality surveys or for monitoring gas levels in a variety of process applications where personnel gas exposures were not at issue.

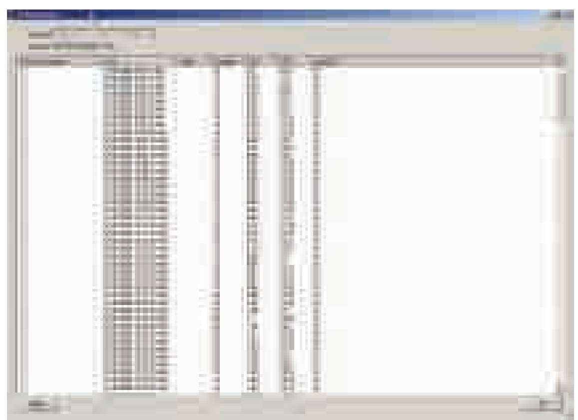

Figure 1. A datalog file recorded on a typical gas monitoring instrument.

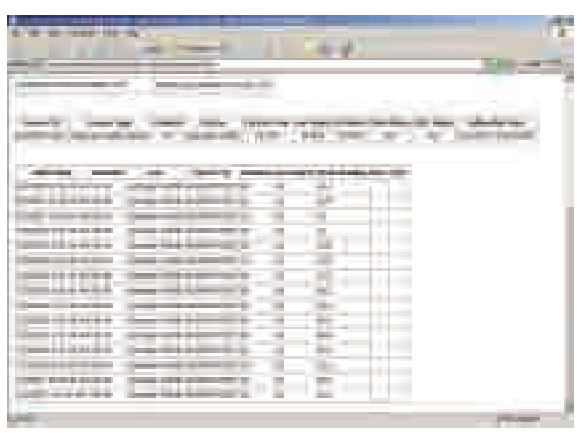

Figure 2. An Alarm event data file example recorded on a typical gas monitoring instrument.

Today's portable gas monitors generally have datalogging functionality as standard equipment. Dataloggers are capable of utilizing flexible recording intervals and having periods of data storage up to one year or more. Beyond storing gas levels, instruments also store a number of other parameters such as calibration dates, temperature readings, on/off times, minutes of operation and user identification and location information. *Figure 1* is provided as an example of a typical datalog file from a portable gas monitor. Although many of the instruments available today have these features activated all of the time and record this information continuously, the data is rarely used for anything beyond after-the-fact investigations following a safety related incident. What is largely missed is that all of these parameters are useful for not only establishing what has occurred in the past (lagging indicators), but provide indicators for what potentially may occur in the future (leading indicators).

Behavior and Gas Monitoring Instruments

There are typically two types of behaviors associated with gas monitoring instruments. The first involves patterns of how the instruments are maintained and the condition in which they are kept. The second relates to patterns of behavior surrounding how the instruments are actually used. The Industrial Scientific iNet™ database provides insight into both types of gas monitoring behaviors.

iNet is a patented system in which Industrial Scientific Corporation collects data from customers using portable gas monitoring instruments in a variety of industries. The data is retrieved from the instruments via a system of instrument Docking Stations™ and is uploaded to the iNet database via the internet. The data includes information on patterns of bump testing, calibration and diagnostic testing as well as gas exposure data. Although the primary purpose for collecting this data is to provide proactive instrument maintenance services, the data can also be used to provide insight into the behaviors surrounding the instruments. iNet customers can be provided reports indicating the behaviors surrounding the calibration and maintenance of their instruments as well as reports that summarize instrument and employee exposures to gas hazards and instrument alarming conditions.

Portable gas monitoring instruments should be tested and calibrated on a routine basis. Manufacturer and industry best practices recommend that portable gas monitors are bump tested daily or prior to each use. The bump test is a critical act, providing direct feedback to the user regarding the operational integrity of the instrument and is the only method of ensuring that the instrument is functioning properly and safely.

Data collected from 95 customers using 2300 portable gas monitors reveals that the instruments are bump tested on frequency intervals from 2 to 651 days. The data shows that the instruments are tested on average every 51 days while they are being used on average every 3 days. Clearly this data reveals a pattern of unsafe behavior that is likely to lead to a negative outcome. Examining the data more closely will uncover what individuals or groups, or what specific functional areas neglect the recommendations or requirements to perform the regular instrument bump testing leaving them vulnerable to future accidents.

Gas exposure data recovered from approximately 10,000 instruments used by approximately 120 customers revealed more than 45,000 toxic and combustible gas alarm conditions where exposures exceeded recommended safety guidelines over the two-month period of September and October, 2007. Add conditions on low oxygen exposures to this data and an additional 2400 dangerous conditions were encountered. Without individual analysis of each of these encounters it is difficult to determine whether or not these exposures resulted in any significant accident or injury. However, it can certainly be deduced that these instances could indicate behaviors that bring the hazardous conditions and individual workers much too close together.

Many of the alarm conditions revealed in the data clearly show behaviors of repeated exposures to dangerous conditions. In the example shown in *Figure 2*, a worker was repeatedly exposed to elevated conditions of hydrogen sulfide that were as much as eight times higher than the recommended safety limits. The worker claimed contrary to the medical evidence that no exposure occurred. However, post incident review of the available data revealed that the worker initially retreated from the dangerous condition, only to repeatedly return for several minute periods before retreating again from concentrations that were continually increasing each time the area was entered.

In another example revealed from recorded data, a multi-gas instrument was being used for atmospheric testing in confined space entry applications. The company procedures required that atmospheric testing be performed continuously during the period of entry. Data collected from this instrument uncovered that the instrument was being used for three to five minute intervals for pre-entry testing and was then turned off until it was used again for the next entry.

Summary Actions

In each of the examples cited, individual behaviors led to or could have led to serious exposures to dangerous conditions. Without the use of datalogging and subsequent analysis of the data, employers and safety professionals would typically be unaware that the conditions or behaviors existed. In the limited data set studied, 47,000 alarm conditions would likely have gone unrevealed in just a two month period.

These recorded observations are all leading indicators to potentially catastrophic situations. With early and routine analysis of the data, the catastrophic consequences of the behaviors can be avoided. Data can reveal the need and opportunities for training. Repeated exposures will occur when workers are not properly trained to recognize the presence of gas hazards and how to respond to them. Workers must have an understanding of the situations that they may encounter in order to respond to them in a comfortable, confident and positive manner. These situations can and will be revealed through a careful analysis of past data.

A long look into leading indicators in recorded data may also reveal the need for changes in processes that will enhance worker safety. Repeated data patterns in particular applications may indicate that a process change is necessary or potentially has the ability to mitigate exposure to hazardous conditions. Repeated exposures in particular applications or in particular locations may also indicate that maintenance or other corrective action is necessary to eliminate potential hazard exposure.

Finally, safety can only be ensured if the tools used to provide safety to workers are in good functional condition. Continuously reviewing data related to the maintenance of safety equipment such as portable gas monitoring instruments will aid in ensuring that best practices are being followed and that workers are not needlessly being exposed to hazardous conditions because the tools designed to protect them are not being kept in proper working order.

The gas monitor carried by the victim of explosion described in the introduction to this paper had no datalogging capability. There was no opportunity to analyze data and or see a pattern of behavior that may have been a leading indicator that could have predicted the potential for, and subsequently prevented that tragic explosion. Nevertheless, it is unlikely that the day of the explosion was the first time that the victim had carried the monitor in the off position.

Do not waste the opportunity to use recorded information that reveal patterns of behavior and offer opportunities to prevent catastrophic incidents before they occur.

References

[1] *Definition of Behavior, accessed March 5, 2007 from www.rotc.monroe.army.mil/helpdesk/definitions-1/terms.htm*