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1,557,416
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Does Your Gas Detection Program Need a Health Check?

Three things every safety professional should know about their portable gas detectors, data management and their safety culture.

By: Dave Wagner, Director of Product Knowledge, Industrial Scientific Corporation

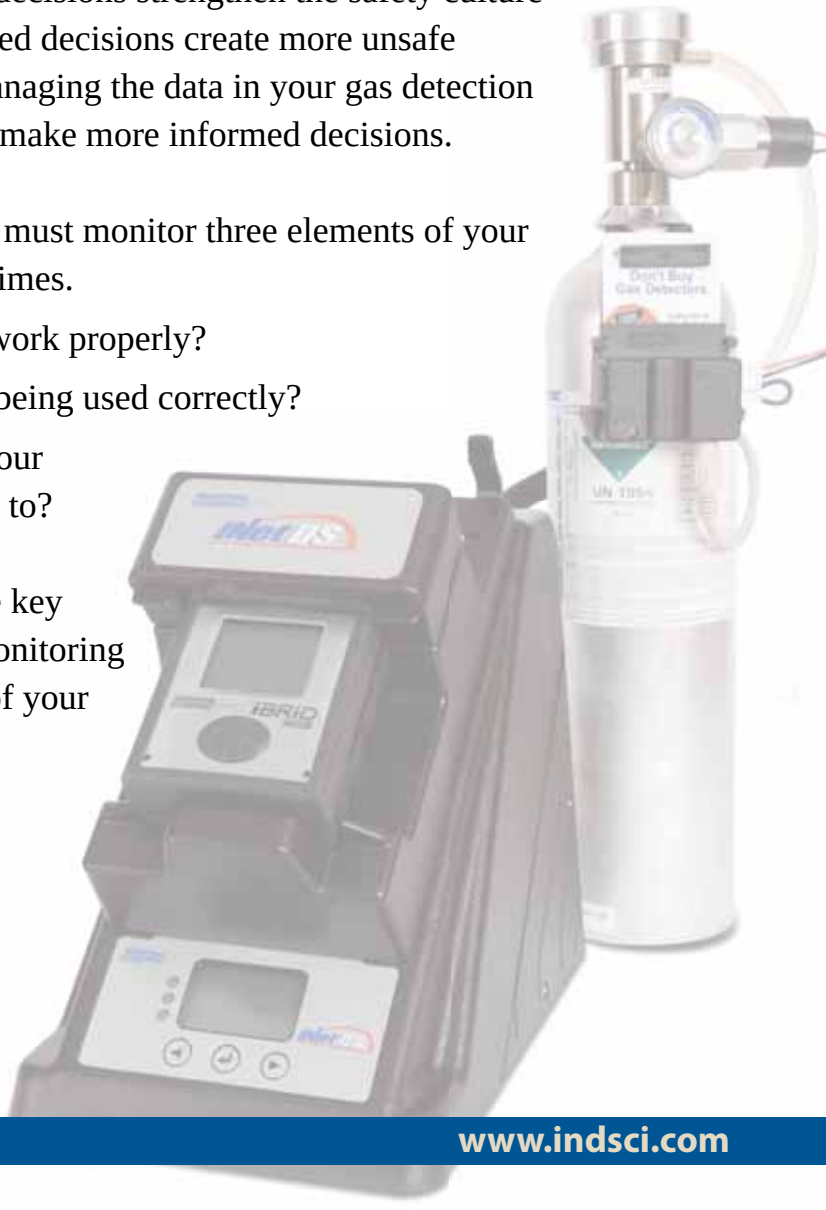
Ninety-six percent of all on-the-job injuries are caused by at-risk acts, according to DuPont Safety Resources. The other four percent of injuries are caused by at-risk conditions in the workplace. When at-risk acts and at-risk conditions converge, well…

From this paper, you will learn how the essential safety data stored within your gas detectors will help you make decisions that increase the safety of your workplace and build a stronger safety culture in your organization. Informed decisions strengthen the safety culture and will save lives; uninformed decisions create more unsafe behaviors and conditions. Managing the data in your gas detection program will position you to make more informed decisions.

As a safety professional, you must monitor three elements of your gas detection program at all times.

1. Do your gas detectors work properly?
2. Are your gas detectors being used correctly?
3. What gas hazards are your team members exposed to?

Data pertaining to these three key areas held within your gas monitoring instruments paints a picture of your gas detection program and safety culture.



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1. Do your gas detectors work properly?

A portable gas detector is a critical piece of equipment meant to save your life. If you are going to use it with confidence, you must know that it is in proper working condition. The most important elements of gas detector maintenance are function ("bump") testing and calibration. The processes are often thought to be too costly and too burdensome to perform on a regular basis. However, there are systems available that fully automate and document these functions, reducing the cost to your team. These systems also provide the data which is critical to assessing the overall health of the program.

A brief exposure to a gas concentration greater than the instrument alarm set points applied during a bump test confirms that the sensors and alarms function properly.

Bump testing

The only way to be certain that a portable gas detector will respond properly when it encounters a life threatening gas condition is to test it with a known concentration of the target gas before you use it. A gas monitor is a complex system that includes a sensor surrounded by sensitive electronics, alarms, a battery and a display. When you turn the instrument on, you can easily see that the battery and display are working properly. But what about the rest of the instrument? Do the sensors and alarms work at all? What if the instrument was dropped causing the sensor to break internally? Did the sensor and alarm openings become obstructed when it fell in the mud? How do you know? A brief exposure to a gas concentration greater than the instrument alarm set points applied during a bump test confirms that the sensors and alarms function properly.

Calibration

While bump testing verifies that an instrument and its sensors are functional, it does not do anything to confirm the accuracy of its readings. This is done through routine calibration.

McGraw Hill Science and Technology Encyclopedia defines calibration as "the process of determining the performance parameters of an instrument by comparing it with measurement standards." Calibration assures that a device will produce results which meet or exceed some defined criteria with a specified degree of confidence.

Along with establishing a point of measurement accuracy, calibration provides insight into the condition of the sensors in the instrument. Gas sensors are consumable components with a finite life. Some sensors naturally last longer than others and the rate of consumption of some sensors more than others correlates directly to the amount of gas they are exposed to. Nevertheless, most, if not all gas sensors are consumable and their sensitivity and response to gas will degrade over time. The typical life span of various sensor types is shown below.

Oxygen Sensors	1.5 – 2.0 years
Catalytic bead combustible gas sensors	3 – 5 years
Electrochemical toxic gas sensors	1 – 4 years (depending on type)
Infrared gas sensors	5 – 10 years
Photoionization gas sensors	2 – 4 years

Even in a sterile environment, all gas sensors will lose sensitivity over time. In the field, sensitivity loss occurs more rapidly. Effects of environmental conditions such as temperature, humidity, dust, dirt and rough handling all contribute to premature sensor degradation. Calibration adjusts the readings to account for changes due to these factors. It also allows you to monitor changes in the condition of the sensors and keep your fleet in proper working order by replacing these components at the appropriate times.

Although bump testing and calibration are distinctly different functions, executing both

correctly ensures that your gas detection equipment is working properly. Any time an instrument fails to respond properly during a bump test, a full calibration should be completed successfully before using the instrument again.

2. Are your gas detectors being used properly?

Despite all the advancements in gas detection technology, industrial workers still die from exposure to toxic or explosive gases. Gas detector manufacturers can produce the most reliable instruments available, but if they are not used properly, the likelihood of people being injured and killed will remain very high.

In an organization with a weak safety culture or poor processes, team members might not use their gas detectors correctly. They might not use them at all. Even with the highest skill levels, years of experience and the best of intentions, team members will be at risk if they are not supported by safety-conscious management working to improve the culture.

Usage indicators that will help you spot behaviors that have a negative impact on the safety of your team members can be seen in the data from your gas detection program. Here are some examples of at-risk behaviors that you should look for to know whether or not your gas detectors are being used properly.

Using gas detectors without a bump test

You should know if your team tested their gas detectors before the start of each shift. In a previous white paper, "Why Bump Testing Saves Lives: New data reveals the correlation between bump test frequency and gas detector failures," we discussed how data collected from more than 27,000 gas detectors shows that three in every 1,000 instruments used on a daily basis are likely to fail a bump test and subsequently fail to respond properly to gas if it is encountered during use. This study was originally conducted in 2009 by Dr. Raghu Arunachalam, Ph.D., who is the Director of Emerging Technologies at Industrial Scientific Corporation. Since then, this likelihood has been confirmed in data collected over a period of eight years from nearly 47,000 gas detectors. As clear as this evidence is, workers still continue to use instruments without bump testing them first. Why?

The only way that you can be assured that a portable gas monitoring instrument will respond properly when it encounters a life threatening concentration of gas is to test it with a known concentration of gas.

You probably wouldn't feel safe flying in an airplane if you knew that the pilot had not performed the pre-flight inspection of the aircraft. And the captain wouldn't fly the plane himself if he knew the check list hadn't been completed properly. If you are going to be certain that the instrument you send out to the field will work if and when it is called upon to do so, you must make sure the bump test is performed each and every time. It is certainly worth repeating. **The only way that you can be assured that a portable gas monitoring instrument will respond properly when it encounters a life threatening concentration of gas is to test it with a known concentration of gas.**

Weak Safety Culture	Strong Safety Culture
• Instruments used without bump testing	• Instruments bump tested daily
• Instrument used very infrequently	• High utilization of instrument fleet
• Long-lasting alarm events	• Fast response to alarm events
• Instruments turned off during alarm events	• Alarm conditions quickly verified to be cleared
• High alarm events occur frequently	• High alarm events rarely occur
• Alarm events not reported	• All alarm events investigated to determine root cause

Using gas detectors that are overdue for calibration

A gas detector that is overdue for calibration is less likely to give accurate readings. It is also less likely to alarm at the appropriate time. Keeping the instrument calibration up to date provides confidence in its readings and its overall performance. Your team members are more likely to believe the readings and react appropriately to the warnings that the gas monitors provide rather than simply discount them as "false alarms".

Ignoring alarm events

You might wonder why someone would ignore an alarm from their gas monitor. Once again, a poor safety culture can lead to this unsafe behavior. Team members have a drive to succeed and simply want to get the job done. Unfortunately, that drive, along with a false sense of security because similar conditions have been encountered before without any negative or catastrophic consequences, will eventually bring the at-risk acts and the at-risk conditions to the point of convergence.

> Too often, team members do not use their gas detectors at all.

Dr. Arunachalam's gas detector study uncovered how often this occurs. On average, gas detectors go into high alarm once every 10 days. In 0.26 percent of those alarm incidents, the users turn the gas detector off while it is still in the alarming condition. This means that in a fleet of 50 instruments, users turn the unit off during a high alarm event 4.7 times over the course of a year. In other instances, users simply continue to work through the dangerous condition while the unit is alarming. The graph in Figure 1 shows how a worker continued to work through an alarming condition while the gas concentration exceeded the alarm point of 5 PPM (parts per million). When the gas concentration increased beyond 5 PPM the second time, the worker simply turned the detector off. If you see this happening on your team, you might want to find out if this is a part of a serious safety culture problem.

Figure 1 – Gas Exposure Above Alarm

Not using gas detectors

Too often, team members do not use their gas detectors at all. The database used in Dr. Arunachalam's study shows that the average utilization rate of multi-gas detectors on a daily basis is approximately 15 percent. This may seem surprisingly low. However, investigators of gas-related fatal accidents have often found no gas detectors at the accident scene, a gas detector attached to the victim in the off position, or most unfortunately, the gas detector was found left behind in the victim's truck. These findings support the data which suggests that gas detectors are not used as frequently as they should be.

3. What gas hazards are your team members exposed to?

The primary function of a gas detector is to detect hazardous gas concentrations and measure exposure levels. High alarm events on instruments indicate areas where at-risk conditions exist. Dr. Arunachalam's database has recorded more than 7 million gas detector alarm events. How many of these alarm events have been investigated to determine the root cause of the problem? How many of these events have even been reported? Every safety professional should know how often these at-risk conditions occur and which team members are being exposed to them. Knowledge of these conditions gives you the opportunity to take corrective action and mitigate the hazards before a catastrophic event or an injury to one of your team members occurs.

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Identifying at-risk acts and conditions

Now that you understand which at-risk acts and at-risk conditions you should be looking for, the question is how do you find them? You could have your team members manually record gas exposures and alarm events and also have them document all of their maintenance activities. However, the gas detectors and automated systems built to maintain them hold all of the data necessary to allow you to see if your detectors are working properly, if they are being used properly, and what gas hazards your team members are being exposed to with little or no manual intervention.

Bump test and calibration records will show you if your gas detectors are being maintained properly. As we have already discussed, gas detectors should be bump tested prior to each day's use or each work shift. Calibration should be performed at regular intervals according to the manufacturer's recommendations. Many manufacturers and industry groups such as the Industrial Safety Equipment Association (ISEA) support calibration of portable gas monitors at monthly intervals. Your documentation should show that these intervals are being adhered to regularly.

Detail on the condition of the sensors in your detectors will also come from keeping good calibration records. Recording the sensor's output at each calibration will allow you to track and trend the sensor's response over its lifespan. A recording and history of the sensor serial numbers will also give you evidence that the sensors are being replaced in a timely manner and that the instruments are being maintained properly.

Bump test and calibration records are also key pieces of evidence that point to whether or not your gas detectors are being used properly. Correlating bump test and calibration times with instrument use data shows that instruments are being properly tested before use. The simple fact that you can see that the tests are taking place on schedule is also evidence of this behavior.

Correlating data periods with times that team members are known to be performing field operations reveals whether or not your gas detectors are actually being used when they are supposed to be. Of all the at-risk behaviors, your team not using gas detectors when they should is probably the most dangerous. A lack of correlating data is clear evidence of a lack of use.

Improvements to your safety culture will only occur if you use the data that you have available to you.

Other at-risk acts can be found by reviewing instrument alarm event and exposure data. Alarm events that last more than just a few minutes are indications that your teams are ignoring warnings from their instruments and working through at-risk conditions. Periods where no exposure data exists that begin suddenly during the course of an alarm event show that detectors are being turned off when alarm events occur. These events will only be found with careful analysis of the data.
All gas reading data should be used to identify the at-risk conditions and hazards that your teams are exposed to. Alarm events and high exposure levels are clear evidence that your team may be in danger. But, prolonged gas exposures just below the alarm thresholds point to at-risk conditions just as clearly as the alarm events, and recurring instances of elevated readings from the same areas show where particular operations may lead to problems.

Using the data

Improvements to your safety culture will only occur if you use the data that you have available to you. Too often, data that is collected from a fleet of gas detectors is just stored in a file folder or database and never looked at again. Or worse yet, it is not looked at until some catastrophic event forces a postmortem investigation of the numbers. If your data is not going to be used for monitoring conditions and making improvements to your processes and environments, then why collect it in the first place? Doing something productive with all of the numbers has to be part of your plan to enhance the health of your gas detector program.

Data should not make you do more work. It should work for you. There isn't a question about the value of having more data. To realize that value however, you must have a more efficient system accessing the data. You should have a system that organizes and presents it so that the health of your gas detection program can be seen at a glance. The system should alert you when there are problems and allow you to quickly drill down into the data to identify the root cause of any issue or at least show you where to look for it.

Future systems will be able to predict incidents before they occur so that you make decisions quickly and take action to prevent them.

Data management systems are evolving rapidly. As more data is collected, more opportunities arise for innovative ways to use it. Today, there are systems using advanced predictive analytics to identify the source of problems. Future systems will be able to predict incidents before they occur so that you make decisions quickly and take action to prevent them. But until then, there are many options for automating gas detection data management.

What to look for in a gas detection data management system

A good gas detector data management system will give you full insight into the following data points.

- **Do your gas detectors work properly?**
  Being able to see the condition of your equipment at a glance will let you know whether or not your team's monitors are in good working order and ready to keep them safe. You should be able to see:
  - Bump test schedules and results
  - Calibration schedules and results
  - Instruments passed due for bump tests
  - Instruments passed due for calibration
  - Marginal or failed sensors
  - Low, empty or expired calibration gas cylinders

- **Are your gas detectors used properly?**
  You want the comfort of knowing that your gas monitoring instruments are being used in the way they were intended to be used, and that your team is working to avoid at-risk acts. Your system should tell you:
  - If gas detectors were used without a bump test
  - If gas detectors were used without completing the scheduled calibration
  - If a gas detector was turned off during an alarm event
  - If gas detector alarm values are set properly

- **What gas hazards are your team members exposed to?**
  Alarm events tell you when your team is exposed to at-risk conditions and how they respond to them. Your data management system should show you:
  - When alarm events happen
  - Where alarm events happen
  - Which gas detectors were in alarm
  - Who was using the gas detector in alarm
  - Type of gas that caused each alarm
  - Concentration of gas during the alarm event
  - Duration of the alarm event

The latest data management technology

Industrial Scientific's solution for managing your gas monitoring program is a hosted software platform called iNet Control. When coupled with an iNet DS Docking Station, iNet Control gives you complete visibility into your fleet of gas monitors and the effectiveness of your gas monitoring program. iNet Control's browser-based user interface allows you to schedule bump tests to take place daily, twice daily or anytime the detectors are docked. You can schedule calibrations to take place at the intervals you want and when you want them to occur. Gas exposure and alarm

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event data will be downloaded from the detectors automatically on the schedule that you establish. Best of all, you can set these schedules, trigger events such as bump tests and calibrations to occur on demand and view your data from anywhere at any time. Whether you are on the factory floor, in your office, at home, or grabbing a quick lunch on the road, you can access your fleet information in iNet Control from any PC with Internet access 24 hours a day, seven days a week from anywhere in the world.

iNet Control will provide you with alerts when at-risks acts have taken place such as using an instrument without it being bump tested or turning an instrument off while it is in alarm. At-risk conditions will be revealed as you see each and every alarm event along with the level and duration of the exposure. iNet Control also allows you to make sure that your equipment is up to date with automatic downloads of all instrument and docking station updates and firmware enhancements. iNet Control is the only gas detection data management solution that provides you with:

- Performance indicators and trend tracking
- Performance comparisons to industry averages
- Exposure trends to help identify potential problems
- Data and report customization
- Reports and alerts that are automatically emailed to you
- Automatic shipment of instruments, parts or calibration gas when problems with your equipment are detected or about to occur

The iNet database comprises the largest bank of gas detection data in the world.

The iNet database comprises the largest bank of gas detection data in the world. As of April 2011, iNet Control has access to more than 26 billion gas readings and more than 7 million alarm events downloaded from more than 47,000 instruments used on more than 2,500 customer sites in 19 countries around the world. iNet Control uses this data to measure an organization's performance against industry wide trends and estimate its risk profile. Today, iNet Control will give you complete visibility into the health of your gas detection program so that you make informed decisions and manage safety more effectively. In the future, iNet Control will merge your data with all of the other data points collected to predict and therefore prevent accidents and injuries before they occur.

To find out more about how iNet Control can help you manage the health of your gas monitoring program, contact Industrial Scientific for a free evaluation of your program today.

About the author

Dave Wagner, Director of Product Knowledge for Industrial Scientific has more than 20 years experience in the development and application of portable gas monitoring instruments and systems. He is a unique source of gas detection information. His formal training and broad experience give him insight that few others have in this industry. He excels at simplifying technical topics so that the average person can understand them.

Dave joined the company in 1986 as an Electrical Engineer. Since then, he has served in several positions within many departments, including:
- Chief Electrical Engineer
- General Product Manager
- Manager of Customer and Product Services
- General Manager of Service Operations
- Director, Portable Products
- Director of Engineering

Dave graduated from Penn State University with a bachelor's degree in Electrical Engineering. He also holds an MBA in Management and Technology from Carlow University.

Dave has authored many training/technical manuals along with multiple gas detection related articles for inclusion in leading safety publications. In addition, he has delivered numerous presentations for leading safety organizations such as ASSE, AIHce and FDIC.

Recently Published Articles:

"Gas Detection in 2011: Have the rules changed?"
ISHN, May 2011
www.ishn.com

"Does Your Gas Monitor Do What You Think It Does?"
Occupational Health and Safety, October 2010
www.ohsonline.com

"What's All This TLV Stuff About Anyhow?"
EHS Today, May 2010
www.EHSToday.com

"A week in the life of a portable gas monitor"
Occupational Health and Safety, May 2009
www.ohsonline.com

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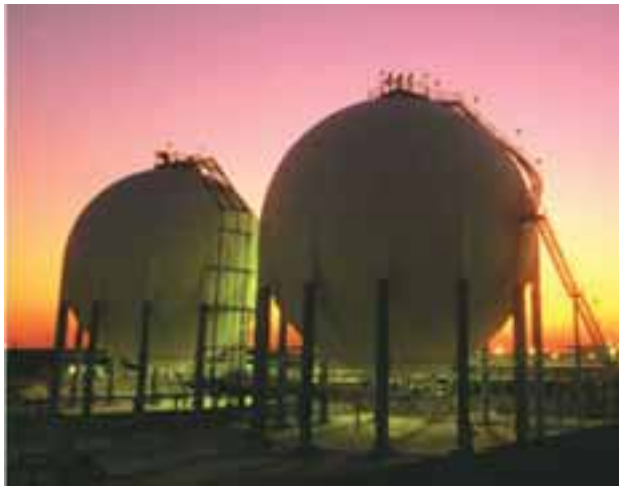
Leading Refinery Optimizes its Gas Detection Program with iNet®

This refinery produces a wide variety of refined petroleum products including gasoline, jet fuel, diesel, asphalt, carbon black oil, sulfur, sulfuric acid and liquefied petroleum gas (LPG).

Challenge

Safety has long been a priority of this energy company, integrating it into every facet of its operations. When a fleet of six gas detectors became mechanically unreliable at one of its petroleum refineries, it was clear that in order to maintain personal safety, the instruments would need to be replaced. In addition to the lacking reliability of the monitors, between five and six hours per week were being spent maintaining them, leading to increased costs and decreased efficiency.



Solution

Implementation of the new Industrial Scientific portable gas detectors soon began in the safety department, and then was later expanded to plant operations. Those monitors implemented were several multi-gas detectors, including (3) MX6 iBrid™, (21) MX4 iQuad™ and (36) iTX. More than 550 GasBadge® Plus instruments were also employed for single-gas monitoring. Lastly, 81 DS2 Docking Stations™ were put to use for consistent and automated calibration, record keeping, battery charging and diagnostics readings of the refinery's new gas detector fleet.

Shortly following the delivery of each of the instruments, iNet® was implemented for easier management of the gas monitors. iNet, Industrial Scientific's Gas Detection as a Service solution, seamlessly solved the refinery's maintenance and reliability challenges. Costly and time-consuming maintenance tasks became automated, ensuring that well-maintained, iNet-ready gas detectors were prepared for each day's use.

Results

Since subscribing to iNet, Gas Detection as a Service has quickly become invaluable to the facility. The refinery's employees are now more productive as there is virtually no instrument downtime by having an optimized fleet. It also provides cost savings by eliminating unnecessary ownership, maintenance and labor costs. Management now spends less than two hours per week maintaining their even larger fleet of gas detectors. Also with iNet, subscription pricing eliminates the need to buy gas detectors, contributing to further cost savings.

Most importantly, iNet has greatly contributed to a safer workplace within the refinery. Employees have peace of mind in knowing that their lives are protected by superior, reliable gas detectors every day. The refinery looks forward to using more instruments on iNet in the future, and hopes to explore other ways in which Industrial Scientific can help to keep employees safe.

> *"If you have more than 10 instruments, you cannot live without iNet."*
>
> – Health & Safety Specialist

To learn more about iNet from Industrial Scientific, visit www.dontbuygasdetectors.com.

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Predictive Analytics in Workplace Safety:

Four 'Safety Truths' that Reduce Workplace Injuries

A Predictive Solutions White Paper

Predictive SOLUTIONS
An Industrial Scientific Company

Many industries and business functions are taking advantage of their "big data" sets by performing advanced analytics to make predictions about the future. When applied correctly, predictive analytics allows leaders to gain deep insight into their business and deploy their scarce resources in an optimal way. Advanced and predictive analytics have revolutionized many industries, from biotechnology and mapping of the genome to banking and market research, and is the foundation of Internet search engines such as Google search.

Predictive analytics is now also available to safety professionals to predict and prevent workplace injuries. This white paper reviews recent results from pioneering research in the development of these powerful safety prediction models.

It also outlines the safety inspection data used to fuel the predictive models (leading indicators), and why this type of data is preferred over other safety data (lagging indicators). Finally, this paper describes the actionable insights identified through this research, distilled down to four truths about safety, or "Safety Truths," that drive the predictive models and form the basis of injury prevention activities.

The results of this research, applied to workplace safety, brings us one step closer to the vision many of us share of sending every employee home safe, every day. After all, if workplace injuries can be predicted, they can be prevented.

Can workplace injuries really be predicted?

The researchers developed a number of predictive models with accuracy levels between 80 and 97% in predicting injuries at actual worksites.

The simple answer is yes, workplace injuries and safety incidents[1] can be predicted before they happen. This has been confirmed by research conducted by teams from Predictive Solutions Corporation and Carnegie Mellon University (CMU) – the same CMU team that helped develop the Watson supercomputer that originally gained fame by beating the top "Jeopardy" champions and has since been applied to helping doctors diagnose rare and complicated diseases[2]. Using a subset of Predictive Solutions' data set of over 112 million safety observations and their associated safety incidents recorded from over 15,000 individual worksites[3], the researchers proved that workplace incidents can indeed be predicted before they happen with high levels of accuracy. They also found that the safety inspection and observation data from these worksites was a strong predictor of future incidents. The researchers developed a number of predictive models with accuracy levels between 80 and 97% in predicting injuries at actual worksites. The research also found a high degree of correlation – r-squared as high as 0.75[4] – between predicted and actual

1 The terms "workplace incident" and "workplace injury" will be used interchangeably throughout this paper. As will terms like "safety inspection," "safety audit," and "safety observation."

2 http://money.cnn.com/2011/09/12/technology/ibm_watson_health_care/index.htm

3 Predictive Solutions' data set is compiled directly by its customers in numerous industries through standard safety inspections, safety audits, safety observations, and other leading indicator and hazard analysis data collection programs including Job Safety Analysis (JSA) audits and safety risk assessments conducted BEFORE safety incidents and injuries occur. This data is collected in both Behavior-Based Safety (BBS) as, well as conditions or compliance-based safety and risk assessment programs. The specific studies referenced in this paper included data from 250 worksites across a four-year period.

4 For more information on the use of r-squared values, visit this website http://en.wikipedia.org/wiki/Coefficient_of_determination

incidents. As an example, Figure 1 shows the comparison of the actual incidents that occurred at one of the worksites with the predictions made by a model developed in the study.

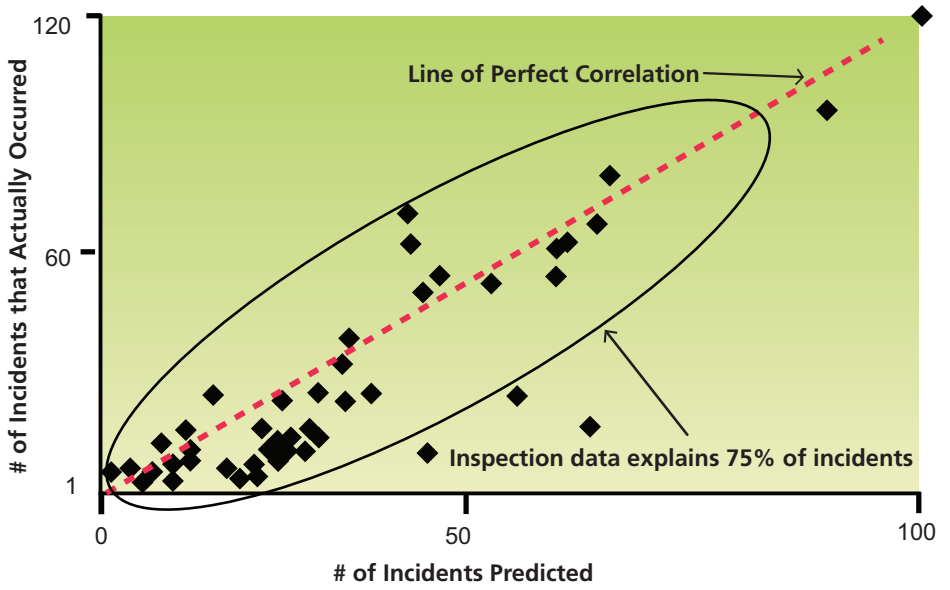

Figure 1 – Correlation of Predicted Versus Actual Incidents at a Worksite

Once it was determined that predictive models could accurately predict workplace incidents, the next step was to identify factors that influence incident levels and what steps organizations can take to optimize their injury prevention programs and ensure employee safety. To answer both of these questions, the researchers turned to the safety inspection data that the predictive models were based on.

Proactive safety inspections are better than reactive incident investigations

Safety inspections are the cornerstone of an effective safety and risk management program. Just as we take measurements of temperature, wind speed, pressure, humidity, etc. over time to arrive at a weather forecast, safety inspections provide the raw data needed to drive the prediction of workplace injuries and safety incidents.

While it is true that historic incident data can also reasonably predict future incident rates, relying on incident data for injury prevention has three major flaws.

First, it is expensive. The Occupational Safety and Health Administration (OSHA) estimates that the direct cost of a recordable incident is $7,000 and a workplace fatality is $910,000[5]. Other industry experts put the indirect costs at three times those amounts[6]. Can companies really afford to rely on such costly occurrences just to get access to data that can help reduce their risk in the future?

5 http://www.osha.gov/SLTC/etools/safetyhealth/mod1_estimating_costs.html

6 http://www.safetymanagementgroup.com/injury-cost-calculator.aspx

Second, waiting for incidents to occur before preventing new ones sends a very chilling message to employees about the company's safety culture. To put it bluntly, leaders are essentially saying, "Joe, I am going to wait until your arm gets severed in our production line before I figure out how to ensure Susan doesn't suffer the same fate. In the meantime, stay safe, and keep that production line moving…we have profit goals to hit!" If leaders are trying to drive both a strong safety culture as well as productivity, this is not an acceptable option.

Finally, and most relevant to those who are experiencing measurable improvements in their injury prevention programs, companies simply run out of incident data points to analyze and learn from. If a company succeeds in driving their incidents down to just a few, or even zero, are they truly safe? How do they know their rates will stay low if they have few or no data points to analyze? There are numerous examples of companies and worksites who one day are celebrating millions of work hours without an incident, but the very next day experience a significant safety incident.[7]

Once a company reduces its incident rate to a low level, they run out of incident data to analyze and have to turn to other data points, like safety inspections and observations, to ensure continued low incident rates. For example, one company in the CMU study lowered its total incidents by 95.3% from 2009 to 2010, resulting in just 20 lagging indicator (incident) data points to analyze. At the same time in 2010, it recorded 8,215 leading indicator (safety inspection) data points to analyze. As they became safer, the lagging data just wasn't sufficient to provide relevant and continuous learning opportunities. This company has now transformed the basis of its injury prevention program from reactive, using lagging indicators such as incidents, to proactive, using leading indicators derived from predictive analytics fueled by a JSA (Job Safety Analysis) inspection checklist program.

Reducing incident rates is always good. However, it does not mean that the work of injury prevention is over – we now need to look more carefully and more widely to prevent a return to high incident rates.

Employing the four Safety Truths

Once it was determined that safety inspection data could drive accurate incident predictions, the researchers went back to the safety inspection data to determine what factors affect incident levels the most. The safety inspection data yielded four key Safety Truths that are not just great predictors of incidents, but also can be deployed toward injury prevention activities once a prediction is made.

◆ Safety Truth #1:

More inspections predict a safer worksite

After detailed analysis of the data, a clear pattern emerged – the higher the volume of inspections, the fewer the number of injuries and incidents. Figure 2 depicts an example of four different worksites and the relationship between number of inspections and recorded incidents over time.

7 http://online.wsj.com/article/SB10001424052748704307804575234471807539054.html

The trend is unmistakable: ***as inspections increase, the reported incidents go down***. In fact, these patterns are very much the norm and repeat themselves over and over in the data.

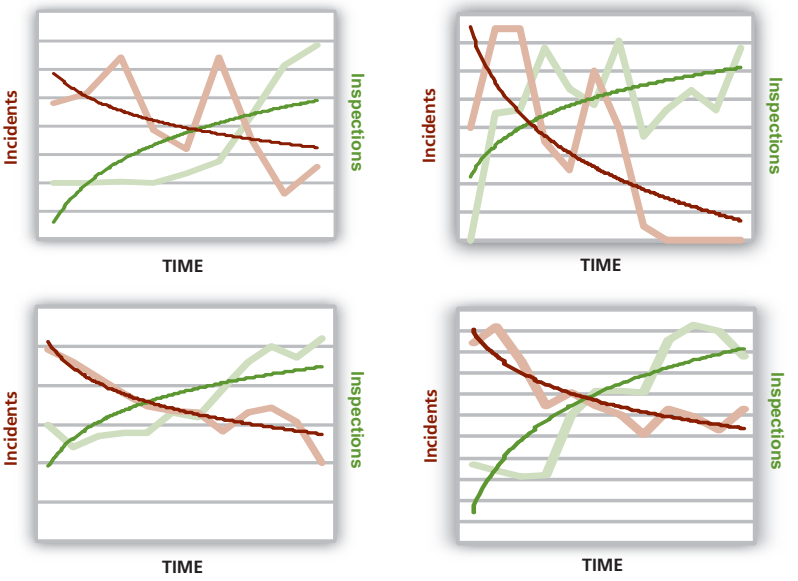

Figure 2 – Incidents Decrease as Inspections Increase

It does not matter what the actual inspections are saying, particularly at the early stages of a safety inspection program, because the greater the number of inspections the better the safety outcome. If your company is experiencing high injury and incident rates, the first step is to simply get onsite with your safety checklist and do more inspections.

◆ Safety Truth #2:

More inspectors, specifically more inspectors outside the safety function, predict a safer worksite

Once an organization starts doing more inspections, the next step is to get more people, and specifically more people outside the safety function, involved. Figure 3 shows the link between incidents and the degree of diversity among people involved in performing inspections. It shows that ***the probability of having an incident decreases as the number and diversity of the people performing inspections increases***. Sites that have a high level of participation in the inspection process have a better safety record than sites with a few professional inspectors, even if the total number of inspections performed by the two groups is similar. In other words, having a large number of diverse inspectors doing a few inspections each is better than a few inspectors doing a large number of inspections, even if they are highly trained safety professionals.

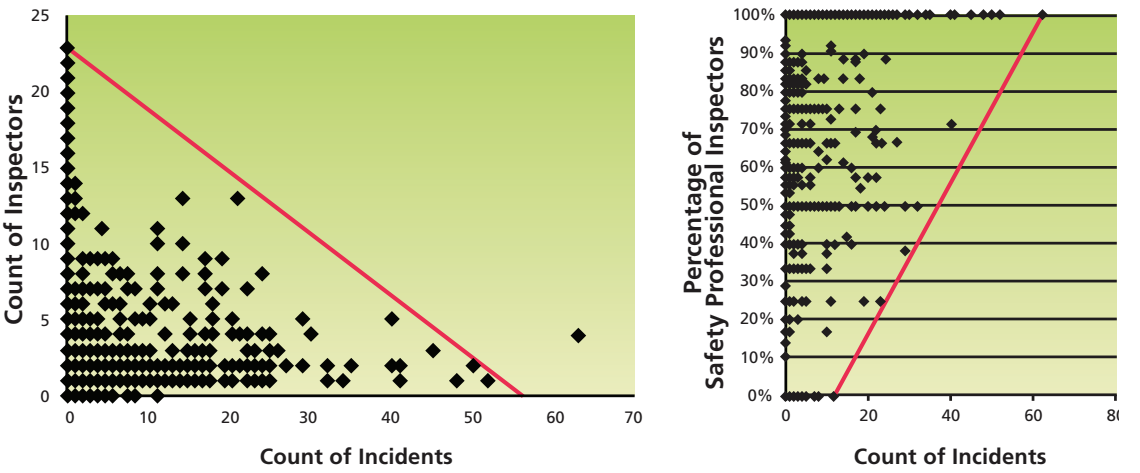

Figure 3 – More Inspectors, and More Diverse Inspectors, Results in Fewer Incidents

If you have increased your number of inspections (Safety Truth #1), but are not seeing improvements in injury prevention, get more people, and people outside of safety, involved in your inspection program.

◆ Safety Truth #3:

Too many "100% safe" inspections predicts an unsafe worksite

If most inspections are returning 100% safe information, your organization may be "flying blind," meaning the worksite is at a higher risk of having an incident, but the inspectors are either not seeing, or reporting, the leading indicator signs of those incidents.

While at first it may seem counterintuitive, a high number of inspections with very few, or no, unsafe or at-risk conditions invariably came from some of the most unsafe worksites in the research conducted by the CMU team. While one could interpret the inspections at their face value and assume that the site is safe given low levels of unsafe conditions, this is rarely the case. It turns out even the safest worksites (e.g. EMR[8] well below 1.0) often have inspections that record a moderate level of unsafe observations.

Intuitively it may seem that as worksites improve their safety performance the number of unsafe conditions reported by safety inspections would fall, but what happens in practice is quite different. The proportion of unsafe conditions found remains fairly steady as organizations continue to improve their safety performance. Generally, as the work environment changes, due to new processes, procedures, equipment, employees, etc., new unsafe observations are found that were not evident in the old environment. Or, what was once considered an acceptable condition or behavior is now deemed unsafe based on new information. Inspectors continually become more critical and discerning of conditions and behaviors in the workplace.

If most inspections are returning 100% safe information, your organization may be "flying blind," meaning the worksite is at a higher risk of having an incident, but the inspectors are either not seeing, or reporting, the leading indicator signs of those incidents. Research shows that the safest worksites continually find a certain level of unsafe conditions and behaviors, and then fix them before they

8 Experience Modifier Rate – see this website for more information on EMR http://en.wikipedia.org/wiki/Experience_modifier

become actual incidents. Figure 4 shows the evolution from the higher risk, or "flying blind," stage (stage #1, in light green) to the lower risk, or "find and resolve," stage (stage #2, in green).

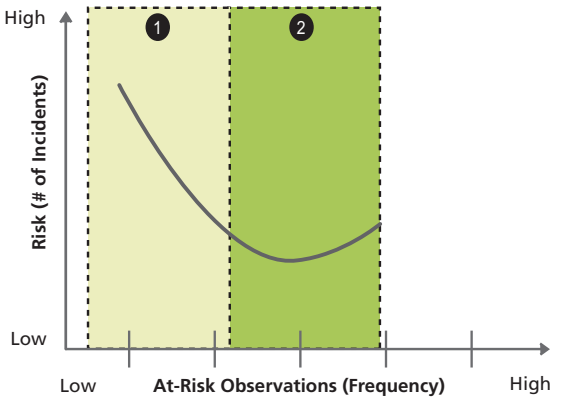

Figure 4 – 100% Safe Inspections Predict an Unsafe Worksite

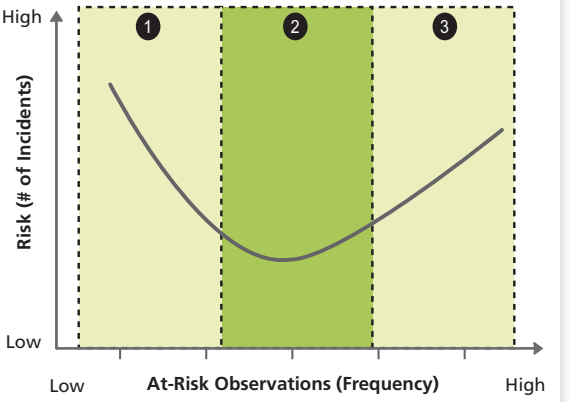

Figure 5 – Too Many Unsafe Observations Predicts an Unsafe Worksite

If you're still having issues with your injury prevention program, make sure your program not only rewards high levels of inspections (Safety Truth #1), by many and non-safety team members (Safety Truth #2), but also trains for and rewards the reporting of unsafe observations from your safety inspections. The more unsafe observations you get, the more you can resolve before they become actual safety incidents.

◆ Safety Truth #4:

Too many unsafe observations predicts an unsafe worksite

To state the obvious, a persistently high level of unsafe conditions is associated with a high level of incidents. Analysis of the data showed that companies in this group have nearly the same level of risk as those that find virtually no unsafe conditions (the "flying blind" stage outlined in Safety Truth #3 and Figure 4). What often occurs is that a lot of inspections are done (properly adhering to Safety Truth #1) by a large and diverse inspection group (properly adhering to Safety Truth #2) and they find a high level of unsafe conditions and behaviors (thus positively avoiding Safety Truth #3). However, the levels of unsafe observations keep increasing because they are not being resolved. **This can be referred to as the "inaction" stage. In this stage, the inspection program is strong, but the resulting injury prevention activities are not.**

In Figure 5, the chart in Figure 4 is expanded to include this "inaction" stage. In order to move away from this inaction stage (stage #3, in light green) and move back to the area of least risk (stage #2, in green), the worksite must commit to resolving its unsafe conditions and behaviors, which the research shows should drive down the level of future unsafe observations to an acceptable level.

It is unconscionable to employ predictive analytics in industries like banking, market research, and Internet search and advertising, and NOT in workplace safety and risk management.

Actual results when the Safety Truths are employed

The research found that worksites that successfully incorporated all four of the Safety Truths had two to three times less incidents. By promoting high levels of inspections, across both safety and non-safety functions, where it was expected that unsafe observations would be continually found and addressed, world-class worksites were able to manage their risk of injuries and stay in stage #2 of Figure 5 – the area of lowest risk.

Conclusion

Workplace safety professionals now have access to cutting-edge advanced and predictive analytics that can predict workplace injuries with high levels of accuracy.

In order to employ predictive analytics in your workplace safety program, you need to fuel the predictive models with data from a robust safety checklist and inspection process, whether it be behavior based or compliance and condition based.

Once the technology predicts where and when injuries will occur, you can use your inspection data to guide your near-term injury prevention activities, and also reduce your risk of future injuries by adhering to the four Safety Truths:

◆ **Safety Truth #1:**
More inspections predict a safer worksite so make sure your program rewards high levels of inspections

◆ **Safety Truth #2:**
More inspectors, specifically more inspectors outside the safety function, predict a safer worksite so include as many people as you can in your safety inspection program and ideally, have more non-safety than safety people in your program

◆ **Safety Truth #3:**
Too many "100% safe" inspections predicts an unsafe worksite so train for and reward the reporting of unsafe observations

◆ **Safety Truth #4:**
Too many unsafe observations predicts an unsafe worksite so commit the time and resources to fixing the unsafe observations before they cause incidents, avoiding persistent high levels of unsafe observations

By employing this methodology, you can reduce your costs, as well as help ensure that every employee goes home safe every day.

It is unconscionable to employ predictive analytics in industries like banking, market research, and Internet search and advertising, and NOT in workplace safety and risk management. Safety professionals, like their peers in these other industries and functions, can now stop being reactive and start being proactive. We can stop investigating incidents, and start predicting and preventing them. It is the right, and smart, thing to do.

Predictive SOLUTIONS
An Industrial Scientific Company

About Predictive Solutions Corporation

Predictive Solutions Corporation, formerly DBO2, saves lives by predicting workplace injuries. Its software solutions help track, trend and analyze safety related data. They also employ proprietary models that predict the likelihood, frequency and location of workplace injuries using its customers' safety observation data. In addition, Predictive Solutions delivers consulting services that drive culture and process change within organizations to create sustainable safety processes that reduce injuries. With more than 100 million observations and nearly 40,000 reported incidents from more than 15,000 worksites around the world, Predictive Solutions has emerged as an industry leader in predicting injuries before they occur. Predictive Solutions, based in Pittsburgh, Pa., was founded in 2001 and became an Industrial Scientific company in 2008. Its employees, along with those of its parent company, are dedicating their careers to ending death on the job in this century. For more information, visit www.predictivesolutions.com.

Our Mission: We save lives, by predicting workplace injuries.

Predictive SOLUTIONS
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