Improving Safety & Health Performance: Identifying & Measuring Leading Indicators

By JACK TOELLNER

Many safety practitioners in industry spend a fair amount of time attempting to measure safety performance. While some of this time may ultimately improve safety performance, one must ask how much of it is truly value-added to the extent that it is clearly linked to preventing people from being injured/becoming ill.

This article shares lessons learned by ExxonMobil Development Co. with respect to measuring safety. It is hoped that sharing such experiences will help validate existing concepts and serve as an impetus for new concepts. It is also hoped that this article will increase the profession's body of knowledge and, as a result, help practitioners better protect workers.

WHY MEASURE SAFETY?

When discussing safety with other professionals and workers, one must stress that safety is not about numbers; it is about people and protecting them from injury. So, why should a company measure safety performance? To understand whether its safety efforts actually prevent accidents and illnesses. Ultimately, the numbers indicate whether these efforts are effective. As Ingalls summarizes, "Measuring performance 1) enables reasoned decisions and assessments, 2) allows comparison with previous (or others') performance and 3) compares actual performance with planned performance" (23-28).

Safety professionals should strive to help management and workers reduce the numbers of injuries and illnesses to zero (or as close to that level as realistically possible). Recognizing that an organization will not likely achieve zero injuries overnight, its performance is typically reported as a downward-trending curve over time (Figure 1). Given this simplest of curves, it is then reasonable to assume that its primary goal is to use given resources and knowledge to continuously drive the curve downward.

TYPES OF SAFETY METRICS

Safety metrics fall into two basic categories: 1) leading indicators, which are measurements linked to preventive actions; and 2) trailing (or lagging) indicators, which are linked to the outcome of an accident.

Suppose an employee slips and falls. Actions that could have been taken to prevent the slip—be it improved housekeeping, use of slip-resistant soles or training—can be defined as leading indicators. Measurements linked to an outcome—be it type of injuries, OSHA recordability or near-hit reporting—are examples of trailing indicators.

Trailing Indicators: What's Wrong With Them

The most-common trailing indicators (e.g., total recordable index, lost-time index and number of days restricted) used by U.S. industry are largely driven by OSHA recordkeeping requirements. However, due to variations in interpretation and application of these guidelines, these indicators may not consistently reflect performance over time or between competing work areas. Trailing indicators have an inherently low level of confidence because of the large numbers of variables (e.g., people impacting the decision to record or not record an incident) and associated negative connotations of reporting an incident.

One primary concern with these indicators is that they are inherently linked to bad news (an injury/illness). Who wants to be the bearer of misfortune? This is especially true if one is responsible for the operation where the injury/illness occurred. Managers are rarely eager to communicate less-than-positive news up the management chain (which makes one wonder how often some injuries/illnesses are not reported—particularly if performance evaluations, pay or bonuses are linked to trailing indicators).

The level of confidence in trailing indicators is further reduced by the confusion associated with the definition of recordability. While OSHA advises, "If in doubt, record it," many in industry assume the opposite position, "Don't record it unless we absolutely have to." And, despite the agency's new recordkeeping guidelines which are designed to eliminate some of this gray area, recordability will likely continue to be a matter of debate.

Accident management also impacts the confidence level in trailing indicators. For

FIGURE 1

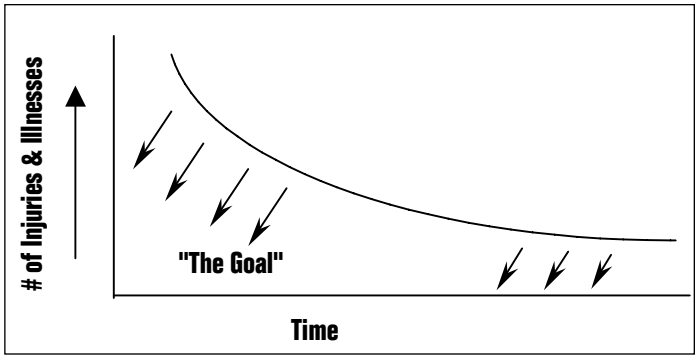


FIGURE 2 Severity Index

SEVERITY SCALE	DESCRIPTION
Level 0 (0 Points)	First-aid only, no restricted duty (RD).
Level 1 (1 Point)	RD ≤ 2 days, prescription medication, "minor pain" injuries, minor rashes (e.g., typical OSHA recordable).
Level 2 (2 Points)	RD ≤ 10 days, serious bruises or abrasions, "real pain" i.e., cuts that require stitches.
Level 3 (4 Points)	RD ≤ 30 days, fractures, other "significant pain" injuries requiring surgery or hospitalization (e.g., typical days away from work OSHA recordable).
Level 4 (8 Points)	RD > 30 days, multiple serious injuries, amputations, life-threatening injuries or partial long-term disability.
Level 5 (16 Points)	Complete disability (e.g., unable to return to work) or fatality.

FIGURE 3 Analysis of Severity Data

SEVERITY	1992	1993	1994	1995	1996	CALCULATION METHODS
Level 1 (Least)	42	35	28	25	15	Each L1 = 1 point
Level 2	27	15	16	15	14	Each L2 = 2 points
Level 3	16	20	11	14	14	Each L3 = 4 points
Level 4	16	6	5	2	8	Each L4 = 8 points
Level 5 (Most)	3	3	3	0	0	Each L5 = 16 points
Total Count	104	79	63	56	51	Sum L1 to L5
Weighted Score	336	241	192	127	163	(#L1*1) + (#L2*2)... (#L5*16)
Average Score	3.2	3.1	3.1	2.3	3.2	Total Count / Weighted Score
% Level 4 or 5	18	11	13	4	16	(#L4s + #L5s) / Total Count

example, suppose an employee slips, falls and breaks his arm while in work area A. The area manager is relatively inexperienced in the process of accident management and allows the doctor to keep the employee home for two weeks despite the fact that he is able (and willing) to perform restricted duty. Had this employee been working in Area B (which has an experienced/aggressive manager), he likely would have received a restricted-duty assignment. As a result, the incident would not have been recorded as a days-away-from-work accident, and Area B would appear to have a better safety record.

In this example, the outcome was influenced by the area manager's accident management skills. It could also have been impacted by the employee's cooperation (or lack of cooperation). One can certainly cite cases in which an injured person did not want to report the injury because s/he did not want to ruin the group's safety record.

Trailing Indicators: Making the Best of the Data

O'Brien suggests that trailing indicators, such as the OSHA recordable rate, may not accurately reflect a company's safety performance and therefore may be misleading (41-44). Despite this fact, safety professionals should recognize that such indicators will not simply go away. Managers often view trailing indicators as the ultimate final measure of performance and expect the safety organization to monitor and manage such data.

Given that fact, the best strategy is to maximize these data. When evaluating injuries and illnesses, safety professionals should consider performing two additional analyses: 1) a severity analysis and 2) an "if not but for luck" analysis.

A severity analysis is based primarily on an incident's severity and excludes the variability introduced by interpretation of OSHA recordkeeping guidelines (which are broad in some cases). To perform this analysis, one must reference a severity index with classification levels linked to the level of pain/discomfort and lower productivity. Figure 2 offers an index developed by several safety coordinators within ExxonMobil; any firm can create a similar site-specific index.

To perform this analysis, one assigns a severity rating for each injury/illness that occurs, then analyzes performance and trends based on severity rather than OSHA recordability (Figure 3). This eliminates the noted variability associated with OSHA definitions as well as that linked to accident management skills. Consequently, one can better compare statistics over time and between other operations. Reducing the overall variability of the numbers increases the overall level of confidence in the analysis. The key is to not manipulate the numbers to look better; they must accurately represent what occurred rather than desired results.

A severity index can also be used in conjunction with an "if not but for luck analysis." The latter is best defined as an assessment that considers an event's potential outcome rather than its actual outcome. Each accident that occurs has an actual outcome and, unless the worst thing that could happen actually does happen, an "if not but for luck" outcome.

Let's return to the employee who slipped and broke his arm. The outcome of such an incident could range from a

FIGURE 4 Examples of Incidents & Assigned Severity

	DESCRIPTION	ACTUAL SEVERITY	"IF NOT BUT FOR LUCK" SEVERITY
#1	While backing out a joint of drill pipe, a contractor was struck in the chest by the breakout tongs and knocked backwards through the V door.	2	5
#2	After cleaning the upper deck, a deck hand complained of eye pain. Upon examination by a doctor, it was determined that the deck hand had a very small piece of rust in his eye.	2	3
#3	While tightening a bolt, the fitter's hand slipped and struck the valve. The resulting injury required two stitches to close.	2	2
#4	An explosion occurred in a mud logging house. The mud logger suffered bruises and cuts, and was placed on restricted duty for approximately 15 days.	3	5

FIGURE 5 Data Plot on Actual and "If Not But for Luck" Severity

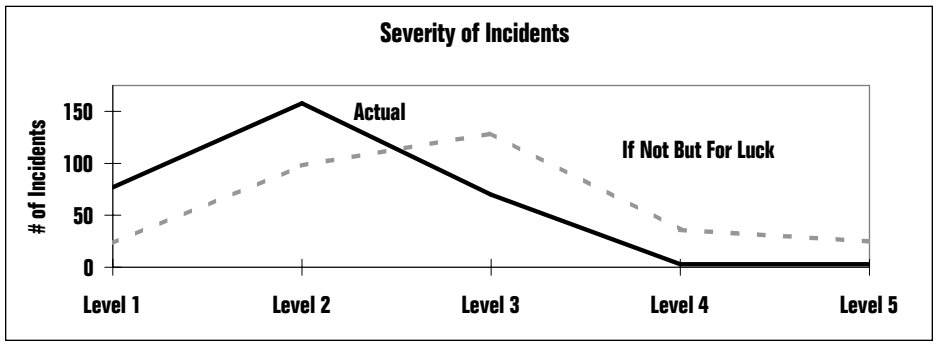
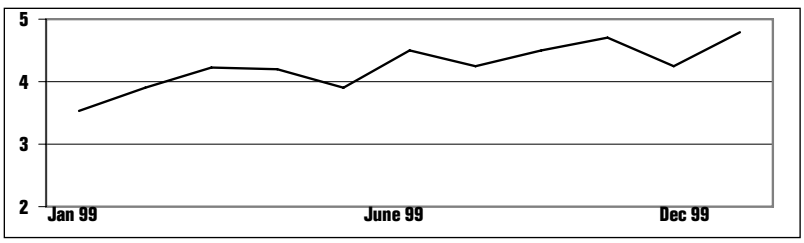


FIGURE 6 Relative Quality of Morning Safety Meetings



bruised ego to a broken arm to a significant disability. Figure 4 shows several accidents that occurred; using the severity index (Figure 2) both an actual outcome and an "if not but for luck" outcome are assigned. Notice in the third incident that the actual and "luck" outcomes are identical. For any given event, the worst-possible outcome does occur in some cases (and it may not involve a fatality or disability).

When conducting this analysis, one must take care to not overstate the potential outcome. While true that a slight statistical chance does exist that every time an employee slips s/he may potentially die, it is not reasonable to make this assumption in the analysis. It is reasonable, however, to state that if an employee slips and hits his/her head, s/he may potentially die. Remember, someone may be looking for any reason to invalidate the analysis. If potential results are overstated, the audience will likely discount the analysis and question the analyst's professional credibility.

The primary purpose of this analysis is to motivate management and workers to eliminate "luck" from the equation. How is this accomplished? By placing additional emphasis on system issues and/or safe behaviors (e.g., hazard elimination, safer designs, engineering controls, worker training, better PPE).

Figure 5 highlights performance differences between actual and potential severity. Such plots highlight the number of serious disability and fatality cases that could have occurred. This image can be a real eye-opener for both management and employees. As with typical trailing indicators, severity data can be plotted versus time to show performance trends.

Leading Indicators: An Opportunity to Maximize Performance

Leading indicators are simply those metrics associated with measurable system or individual behaviors linked to accident prevention. These indicators focus on maximizing safety performance by measuring, reporting and managing positive safe behaviors. As noted, the primary goal of the safety profession is to reduce the total number of injuries over time by driving the injuries versus time curve (Figure 1) down and to the left.

To achieve this goal, safety resources must target accident prevention processes rather than accident management processes. The underlying principle is fairly basic: The more accidents prevented, the fewer accidents that must be managed; this leaves management more time to focus existing resources on accident prevention.

Most companies establish goals and measure those areas that are truly important—such as cost, quality, schedule and production. If safety is truly important, should industry not also measure actions taken to prevent accidents? If not, how can companies understand whether those actions are meeting expectations? If key behaviors associated with preventing accidents are not measured, one cannot truly control them in an effective manner.

GETTING STARTED WITH LEADING INDICATORS

To monitor leading indicators, one must take three steps:

1) understand accident causes;

2) determine key steps to preventing those accidents;

3) convert those key steps into measurable processes.

Analysis of ExxonMobil technical data demonstrates that multiple unsafe behaviors are linked to more than 90 percent of accidents. These include lack of ability to recognize hazards; blurring of consequences and/or priorities; inadequate tools; poor work practices/processes; and failure to manage change.

In Exxon's case, since most accidents are linked to unsafe behaviors, the key to prevention is to focus on promoting safe behaviors. This entails teaching employees how to identify hazards; providing them

FIGURE 7 Average Housekeeping Score

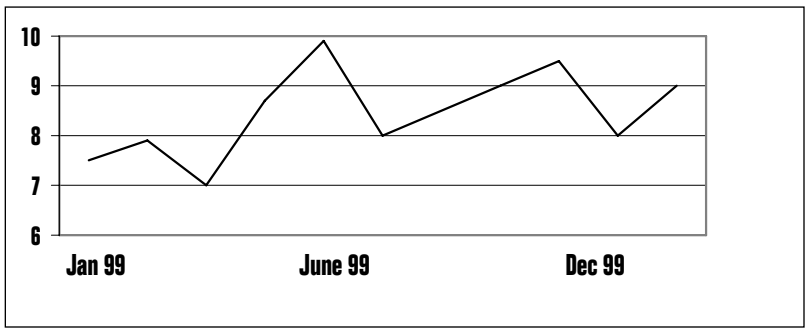


FIGURE 8 Number of Closed Down Areas

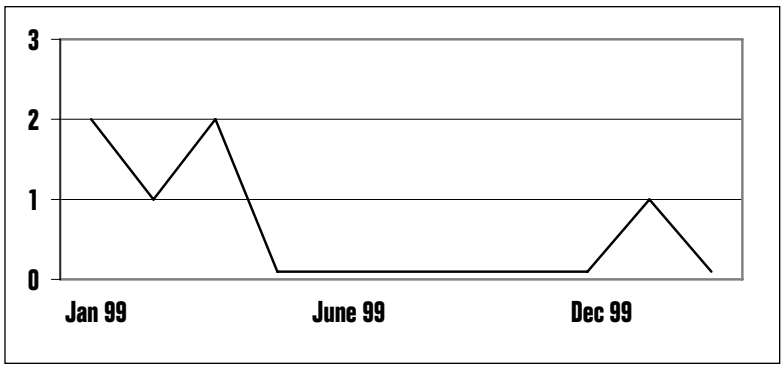
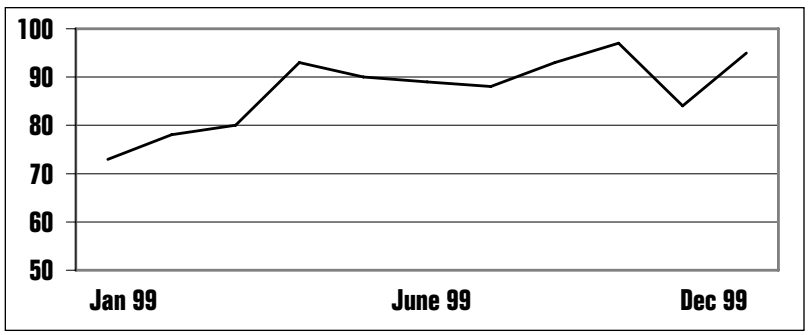


FIGURE 9 Effective Score of Barricade Performance



with appropriate tools and resources; demonstrating management commitment; involving employees; and implementing accident prevention processes.

The next step is to convert key steps linked to accident prevention into measurable processes. This can also be stated in terms of defining the measurable basis for the work location's current success, or determining measurable actions needed to improve performance. When developing leading indicators for a construction site, five questions serve as a starting point.

1) What is the safe behavioral basis (system or individual) for the site's success?

2) Is it measurable?

3) If the site does more of it (or improves quality), will safety improve?

4) If the site management team does not manage safe behaviors, is the rate of such behaviors likely to drop?

5) If the rate drops, will safety performance decline?

Considering these questions in more detail, a safety professional working with site management should be able to recommend multiple leading indicators. The author's experience has shown that effective leading indicators are those metrics linked to safe behaviors (actions taken to prevent accidents). Examples include safety training and communications; level of employee participation in toolbox safety meetings; number of supervisors conducting safety walkthroughs; number of safety audits performed; and number of safe behaviors observed. The metrics selected must be embraced by supervisory and worker safety teams because ownership is essential to success.

Since it is a challenge to control (or manage) factors that cannot be effectively measured, the leading indicator must be measurable on a real-time basis. If an indicator is not measurable, it will be difficult to establish a quantifiable goal and communicate progress toward that goal. Although it can be difficult to measure safety attitudes on a real-time basis, safe behaviors can be measured on a real-time basis, provided the measurements are kept simple.

The leading indicators selected must drive safety performance—that is, if a site does more in these areas (or improves relative quality), overall safety performance will improve. For example, ExxonMobil encourages management participation in safety walkthroughs and recognizes these activities as a key element of safety success at many worksites. If one agrees that this activity is crucial to success, then one should also agree that if the site increases the number of walkthroughs or improves their quality, safety performance will improve. Housekeeping is another example. If the level of housekeeping at a given site is a good barometer of safety at that site, it follows that if housekeeping is improved, safety will also improve.

The indicators selected should reflect areas that the site safety team, managers and workers believe should be measured in order to keep the effort robust. If the rate drops and performance does not diminish, why focus resources on those measures? Since most sites have limited resources, it is best not to waste them on processes that do not drive safety performance toward excellence.

PITFALLS & LESSONS LEARNED

Measures that have negative connotations should be avoided. For example, an organization is unlikely to embrace (for any extended period of time) any reporting process that reflects negatively on either the team or an individual. Indicators (either leading or trailing) with negative connotations typically reward individuals and groups for not reporting incidents. Near-hits are an example of an indicator with negative connotations—and many near-hit reporting programs fail because of the negative connotations associated with them. Over time, it becomes convenient to stop reporting these incidents—in some cases, the site may be rewarded for a reduction in reporting.

In the author's opinion, near-hit reporting is a trailing indicator since the only difference between a near-hit and a fatality is often luck (remember the "if not but for luck" analysis). For example, on any given day, a construction worker may experience a near-hit when individual error and/or system failures occur. Suppose a piece of steel falls off a scaffold

FIGURE 10 Participation of Foremen in Safety Walkthroughs

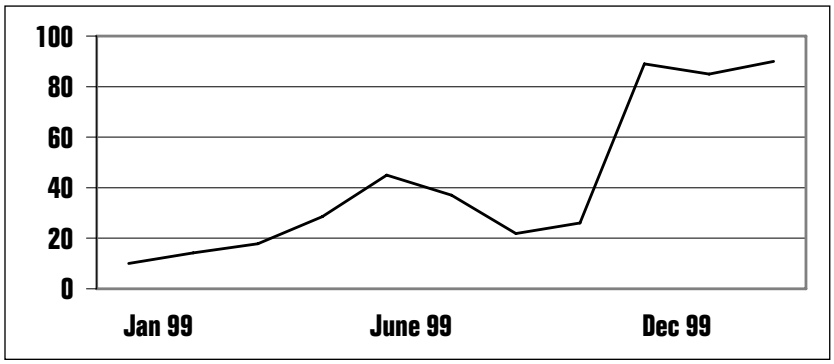


FIGURE 11 Site Management Participation

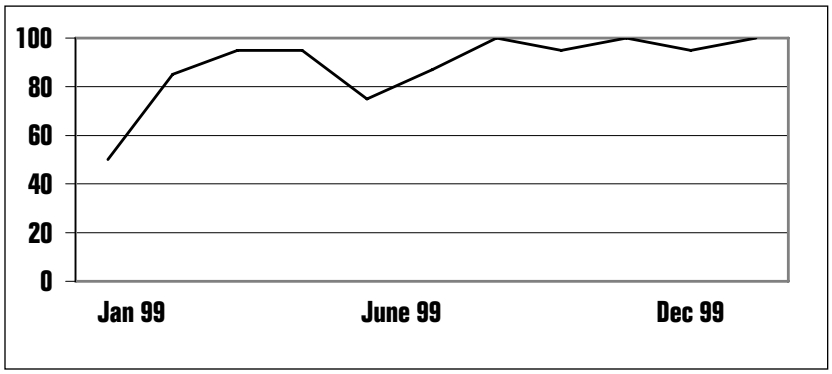
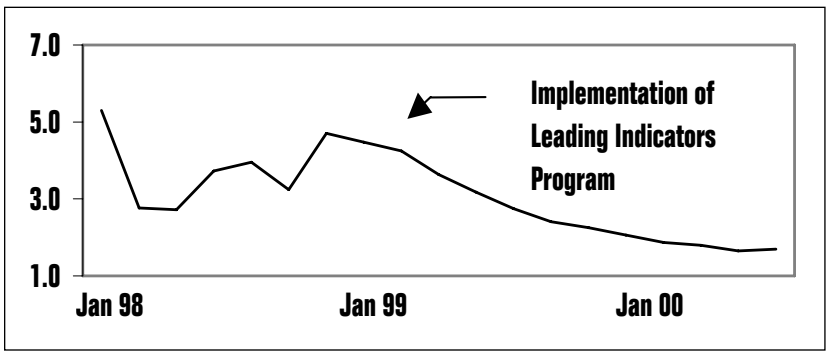


FIGURE 12 Total Recordability Index (Cumulative)



from a height of 30 feet; it hits the ground five feet from a worker. Other than increased anxiety, the worker is not impacted. A few days later, the same behavior or system failure occurs and another piece of steel falls off the scaffold. This time, however, the piece of steel strikes a worker on the head. In the author's opinion, the only difference between the near-hit and actual hit is luck.

Before defining near-hit reporting as a leading indicator, one must ask the following question: If an actual hit (e.g., injury) is considered a trailing indicator, then why define a near-hit differently? Safe behaviors associated with leading indicators have the potential to reduce the number of both near-hits and actual hits.

A site should also avoid selecting too many leading indicators at the outset. In many situations, use of such indicators is new concept; it will take time for the site team to fully understand the process and will likely introduce some new administrative functions (e.g., data compilation). Therefore, it is best to start with no more than four or five indicators—or fewer if resources are tight. In some cases, slow progress can be better if it leads to a higher level of acceptance and long-term success.

It is also best to avoid overly complex indicators and associated measurement processes. In the author's opinion, complexity may increase the chance for error and miscommunication. It should also be noted that some measures may have meaning to the safety and/or management team, yet be meaningless to workers. In addition, implementing indicators that by management dictate, must be used at every site reduces buy-in and ownership of both the local management team and site workers.

The site team must also take steps to prevent a "numbers competition," in which the numbers themselves become more important than the outcome. This can lead to inflation of statistics, which is neither effective nor efficient. The sole purpose of using leading indicators is to improve safety performance.

CASE STUDY: FABRICATION OF DIANA PROJECT TOPSIDES

ExxonMobil recently completed fabrication of two structural steel decks and associated production facilities for an offshore oil and gas platform to be situated in the Gulf of Mexico, some 160 miles from Galveston, TX. The 120′ x 120′ decks were fabricated in Brown & Root's Greens Bayou Fabrication Yard (GBFY) in Houston over an 18-month period during 1998 and 1999. Total weight of the decks and associated piping approached 16,000 tons; during peak construction, more than 1,200 workers were employed on the project.

As a result of management leadership and commitment, worker involvement and a focus on accident prevention processes, GBFY's safety performance greatly improved over the project's first nine months. The Brown & Root management team recognized the benefits of improved safety performance and indicated a desire to implement processes to sustain this performance level. The management team elected to begin using leading indicators. Success factors were analyzed and several indicators recommended.

Quality of Morning Safety Meetings

GBFY's construction team begins each shift with a short toolbox safety meeting. These meetings set the stage for the day's safety performance and are a key medium for communicating potential hazards. Meeting quality is a measure of thoroughness and participation. A scoring tool was used to evaluate meeting performance (e.g., quality of communication, attentiveness, worker participation) and the raw score plotted versus time. As Figure 6 shows, relative quality of these meetings increased from a score of 3.5 to almost 5. To achieve this result, meeting leaders were coached on effective planning and presentation skills, and workers were encouraged to participate.

Housekeeping

Housekeeping was recognized as a barometer of safety as well. With as many as 1,200 people working onsite, it was vital to maintain an orderly worksite. A scoring process was developed to evaluate this factor. If the average score dropped below a value of seven, the entire project was shut down and all involved were tasked with getting the site back in order. The project tracked both the number of times the project was shut down and the relative level of

housekeeping. As Figures 7 and 8 illustrate, housekeeping improved over time, while project shutdowns decreased.

Barricade Performance

Fabricating structural steel decks and installing associated equipment required a significant amount of work to be performed in elevated areas. Precautions were taken to prevent items from falling, and redundancy was built into the process by requiring the use of barricades. Initial observation by both the management safety team and the worker safety team revealed that the barricade program was not performing as expected. Subsequently, a measurement process was implemented to improve barricade performance. Weaknesses identified ultimately prompted changes in the process, and additional barricade training was provided. As Figure 9 shows, the end result was improved performance over time.

Safety Walks

It was recognized early on that management leadership and commitment would be a key element of success. One way to demonstrate leadership and commitment is to actively manage by "walking around." Senior management and supervisors were encouraged to participate in site safety walks in order to 1) actively seek out significant hazards; 2) motivate workers and visibly demonstrate that management cares about their safety; and 3) lead by example.

Initially, these walks were viewed as a policing effort, where management documented every hazard observed, then generated an action item list. Over time, management learned to focus in on only the most-significant hazards and spent an equal amount of time talking with workers and soliciting their input on hazards and solutions. Over time, this process of "actively caring" led to significant progress in management participation (Figures 10 and 11) (Geller).

CASE STUDY RESULTS

In this case, use of leading indicators was deemed a success. In addition to a better overall recordable rate, those involved believe this is an excellent process for 1) involving management; 2) increasing worker participation; and 3) focusing safety resources on accident prevention processes. As Figure 12 shows, the injury rate did improve. Approximately 75 fewer injuries were recorded over this 24-month period, during which some 4 million workhours were recorded.

Certainly, one can debate how much of this improvement is directly linked to use of leading indicators. The management team and workers had a desire to improve and likely would have shown improvement without the process.

However, it must be noted that those processes that were measured improved—and those processes were associated with preventing accidents. Management reviewed the processes during management safety steering team meetings and on several occasions made conscious decisions to drive improvement in specific areas.

For example, the percent of management/supervisors participating in safety walks increased as a result of the monthly review process by the management safety steering team. Housekeeping improved because the management team was dissatisfied with conditions and began to measure them during safety walkthroughs. The barricade process improved because it was inspected and measured weekly, and results were used to train workers.

Although one may not be able to prove explicitly that use of leading indicators caused a performance improvement, their use certainly appears to have facilitated improvement. Use of leading indicators provided management a greater opportunity to manage safety performance. It took advantage of that opportunity and excelled. What more could one ask for?

CONCLUSION

Many safety professionals spend a significant amount of time gathering, analyzing and reporting statistics. If these efforts are not directly leading to improved performance, then a site's safety resources are not being maximized.

The safety profession's goal should be to improve both short- and long-term performance. Fewer accidents lead to fewer injuries and illnesses, which means fewer lives disrupted. As frustrating as they may be at times, trailing indicators offer some insight into safety performance. Used correctly, resulting data can help management and workers better understand overall performance trends and the significance of relatively minor events.

Leading indicators are used to focus resources on preventive actions. They:

- allow management to actively demonstrate commitment and leadership;
- enable workers to get involved with measurable processes;
- focus resources on accident prevention processes.

The case study supports the theory that "what gets measured and reported to management gets attention." It also supports the idea that use of leading indicators can facilitate improved performance. ■

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