NATIONAL SAFETY COUNCIL®

CAMPBELL INSTITUTE™

# Practical Guide to Leading Indicators:

## Metrics, Case Studies & Strategies

# Executive summary

This report describes the second phase of a research project conducted by the Campbell Institute to advance the state of knowledge and practice regarding the use of leading indicators to improve environmental, health and safety (EHS) performance. The first phase of the project established a broad consensus among EHS leaders at Institute member organizations that sole focus on lagging metrics is not as effective in promoting continuous improvement as using leading indicators to anticipate and prevent injuries and incidents. Additionally, an expert panel of EHS professionals described a set of successful leading indicator characteristics, including being actionable and timely.

The specific aims of the project's second phase were to:

- Collect a list of key leading indicators and metrics to use as a basis for benchmarking;
- Create definitions for each key leading indicator; and
- Qualitatively describe how certain leading indicators are analyzed and put into practice through short case studies.

These research aims were addressed through a series of group discussions and phone interviews with member companies. An initial meeting of industry experts was held to generate a list of leading indicators in each of three categories (systems-, organizations-, and behavior-based indicators). These lists were then discussed separately in three working groups with each group creating definitions and adding specific metrics for the key leading indicators on the list. The work from all three groups was combined to produce one matrix of key leading indicators, their definitions and associated metrics. To provide more context to certain leading indicators, Campbell members contributed narratives detailing the development, implementation and analysis of a leading indicator within their organization.

While a "full set" of leading indicators and metrics is impossible for the Campbell Institute to create due to the changing nature of workplace practices and ever-expanding knowledge of safety science, the matrix offered in this report represents a collaborative benchmarking effort on the part of Institute member organizations to generate a catalog of key or critical leading indicators. The matrix can be used as a guide for companies on their Journey to Safety Excellence, and to help Campbell Institute organizations maintain their world-class status. Additionally, this paper and the information it contains can be used to not only convince senior executive management of leading indicators' importance and predictive power, but also demonstrate through key examples how particular leading indicators have produced positive outcomes in occupational safety.

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*Safety work is today recognized as an economic necessity, and one of the more constructive movements that has ever come into our national life. It is the study of the right way to do things.*

ROBERT W. CAMPBELL 1914

# Introduction

In the first phase of its research on leading indicators (see Campbell Institute white paper, *Transforming EHS Performance Measurement through Leading Indicators*), the Campbell Institute presented a definition of leading indicators as developed by an expert panel of environmental, health, and safety (EHS) executives and described key characteristics of successful leading indicators. A survey of EHS executives in Campbell Institute member organizations identified several key enablers of effective leading indicator implementation and use, including C-suite endorsement of leading indicators and thorough communication of leading indicators' predictive value.

Survey results also identified several common barriers to leading indicator implementation, including difficulty in developing consistently actionable leading indicators, lack of a reliable relationship between leading and lagging indicators, and sporadic non-standardized benchmarking of leading indicators. This second phase of research on leading indicators seeks to address some of these barriers through a collaborative benchmarking project and informative case studies of successful leading indicator implementation from Campbell Institute members and partners. Specifically, Campbell members worked together to produce a list of leading indicators, their definitions and specific metrics for each indicator.

As high-performing organizations, Campbell Institute members rely on benchmarking to maintain and improve their safety performance records. In the first survey, Campbell members expressed a desire for more formal benchmarking opportunities due to the acknowledged importance and benefits of benchmarking. Those who benchmark place themselves in better positions to identify best practices, discover innovative improvements, learn from peers and competitors, and find better performance measurement tools (Camp, 1995; Watson, 1993). The Institute set out to understand the best benchmarking approach to most effectively meet member needs and found several types and approaches to benchmarking as identified by researchers in the past twenty years.

Internal benchmarking usually refers to comparison within an organization, between branches or departments, and allows for an exchange of ideas and practices without the threat of competition (Moriarty & Smallman, 2009; Zairi, 1994). Competitive benchmarking, conversely, takes place when an organization identifies performance gaps in comparison to its direct competitors and seeks to adopt competitor practices to gain market share. This type of benchmarking has been used in research on small- and medium-sized enterprises in the U.S. and abroad (Min & Min, 2013; Min, 2010; Wang & Hong, 2011).

Strategic benchmarking can be similar to competitive benchmarking in that an organization looks to rivals for best practices, but instead of comparing individual procedures, they benchmark strategic initiatives, management of change practices, and other broader, long-term processes (Bogan & English, 1994; Schmidt, 1992). This type of benchmarking has been used recently to improve functionality of websites (Stepchenkova et al., 2010), increase the impact of schools (Green & Davis, 2010), and reduce injury rates among global enterprises (Wynn, 2008). In a study focused on the reduction of incidence rate through benchmarking, researchers found that setting aggressive targets for EHS performance, holding business managers accountable for progress and providing targeted assistance to struggling sites resulted in an average reduction of incidence rates by 77% within 3-12 years (Wynn, 2008).

Collaborative or consortium benchmarking refers to an exchange of information among a consortium of organizations and most commonly involves academics and practitioners working together as co-researchers. Because consortium benchmarking "is a team-based approach focusing on best practices, relevant discussions between academics and practitioners…are likely to emerge and flourish" (Schiele & Krummaker, 2011:1137-1138). This benchmarking approach has been useful in helping to monitor the progress of students (McAllister et al., 2011) and developing curriculum enhancements (Oliver et al., 2011).

After this review of benchmarking types, it appeared that the strategic or collaborative benchmarking approaches were most appropriate for a comparison of leading indicator practices among Campbell Institute organizations given the focus on long-term strategies and the team-based approach between practitioners and researchers. While there is no single set of steps for benchmarking, many of the proposed processes have four basic steps (Camp, 1989; Karlof & Ostblam, 1993; Moriarty, 2009; Schiele & Krummaker, 2011):

1. **Planning:** identifying the process or function to be benchmarked, identifying benchmarking partners
2. **Analysis:** collection of data and analysis of performance gaps
3. **Action:** communicating findings, setting targets, implementing specific actions
4. **Review:** evaluation of benefits, monitoring of improvements

The current phase of this project on leading indicators covers the steps of planning, analysis, and communication of findings. Subsequent phases of this project will most likely track the benchmarking process through the final review and evaluation stages. The outcome for this phase of the project is a matrix of leading indicators, their definitions, and specific metrics for each indicator. This matrix represents a collaborative effort of EHS professionals in top-performing organizations. The information it presents should be relevant not only to those organizations seeking to initiate implementation of leading indicators, but also to more seasoned companies looking for better practices and innovative improvement.

# Methods

## Defining Leading Indicators

The first phase of this research project began with a convening of an expert panel of fifteen EHS professionals. In this moderated discussion, panel members defined leading indicators as proactive, preventive, and predictive measures that monitor and provide current information about the effective performance, activities and processes of an EHS management system that drive the identification and elimination or control of risks in the workplace that can lead to incidents and injuries. Leading indicators measure the events leading up to injuries and fatalities, and also provide information about the current state of an organization's safety management system. Specifically, leading indicators are designed to give advanced warning of potential problems so that preventive actions can be taken. Additionally, they help to reveal weaknesses in an organization's procedures or employee behavior before they have a chance to cause real harm.

Being proactive, preventive and predictive is only beneficial if the leading indicator provides timely information that can be effectively turned into action. Given the time-sensitive nature of conditions that could lead to injuries or fatalities, it is important for leading indicators to actively monitor the state of the safety management system and provide detailed information that can be quickly acted upon. For these reasons, the expert panel also described successful leading indicators as actionable, achievable, meaningful, transparent, easy to communicate, valid, useful and timely. Additionally, the expert panel created three broad categories to classify leading indicators:

- **Operations-based leading indicators:** Indicators that are relevant to the functioning of an organization's infrastructure (e.g. machinery, operations); potentially site-specific
- **Systems-based leading indicators:** Indicators that relate more to the management of an EHS system; can be rolled up from a facility level to a region/business unit or corporate level
- **Behavior-based leading indicators:** Indicators that measure the behavior or actions of individuals or groups in the workplace; people-to-people interactions related to supervision and management; useful at site-specific level through management level

The Institute then conducted a survey of its members and Campbell Award winners, asking questions about the use of leading indicators in their organizations, the key enablers of leading indicator implementation and the most significant hurdles to incorporating leading indicators. For more details and information of this phase of the study, please see the previous Campbell Institute white paper, *Transforming EHS Performance Measurement through Leading Indicators*.

## Identifying Leading Indicators

The second phase of this research project addressed one of the major noted barriers to leading indicator implementation, which was the lack of standardized best practices or benchmarks. The Institute held a facilitated Leading Indicators Workgroup meeting in October 2013 to generate a list of possible leading indicators to benchmark. Fifteen EHS executives and professionals representing various Campbell Institute member organizations formed three teams to create lists of leading indicators for each of the three types of leading indicators.

Each team was initially assigned a category to start, and then rotated two times allowing each team to contribute to all three lists. Meeting participants were asked to indicate which indicators they considered the most important. Each participant was allotted ten checkmarks that they could distribute across all three lists to give weight to the indicators they perceived as most significant. (See Appendix for full lists and rankings of these indicators.)

After this in-person, facilitated meeting, the Leading Indicators Workgroup divided into the subgroups: systems-, operations-, and behavior-based. Through a series of conference calls and web-based work meetings, each subgroup discussed the top-ranked indicators of each list, generating definitions and listing various metrics for each indicator. These metrics could be ones that are currently being measured at their organizations or ones that they would consider measuring in the future. Through their discussions, the subgroups revised the names of leading indicators, split some indicators into different component parts, and/or added more indicators to the original list provided to them.

The three separate matrices of leading indicator definitions and metrics were combined into one full matrix of leading indicators. Because some indicators were considered and discussed in more than one subgroup category (systems- and operations-based, for example), the entire reconvened Workgroup together created a single comprehensive definition incorporating all subgroup ideas. Members of the Leading Indicators Workgroup provided final edits and additions to the full matrix via phone conferences, email and at an in-person meeting in April 2014.

To provide some context for the use of certain leading indicators, the Campbell Institute staff conducted qualitative interviews with Campbell members and partners who were willing to share information on their uses of particular leading indicators – how they implemented them, what they did with the information from those indicators, the outcomes of implementation and the connection to lagging indicators. These interviews took place via phone and were between 30 and 60 minutes long. The interviews were then transcribed and are included in this report in narrative form. These short case studies are meant to provide more detail and background on various leading indicators listed in the full matrix.

## Matrix

This matrix presents leading indicators that Campbell Institute members have collectively determined to be "best performing" through their various safety management programs. This does not imply that all of these indicators are measured and tracked at every Campbell Institute organization. Every leading indicator program is unique and tailored for a specific organization.

The leading indicator matrix is not designed to be a reference, nor a consulting tool. The Campbell Institute does not guarantee or recommend using any specific indicator or metric included here.

These pages provide more detailed information regarding certain leading indicators based on the relative weight of their discussion among Campbell Institute members. A full matrix is available at the end of this document.

### Leading indicators by type

**OPERATIONS-BASED**

*Indicators that are relevant to the functioning of an organization's infrastructure (e.g. machinery, operations); potentially site-specific.*

**SYSTEMS-BASED**

*Indicators that relate more to the management of an EHS system; can be rolled up from a facility level to a region/business unit or corporate level.*

**BEHAVIOR-BASED**

*Indicators that measure the behavior or actions of individuals or groups in the workplace; people-to-people interactions related to supervision and management; useful at site-specific level through management level.*

See the complete list of Leading Indicators and Full Matrix on **pages 14–19.**

- Compliance
- Risk assessment
- Preventive and corrective actions
- Equipment and preventive maintenance
- Prevention through design
- Training
- Management of change process

- Hazard identification and recognition
- Leading indicator component evaluation
- Learning system
- Permit-to-work system
- Safety perception survey
- Communication of safety
- Recognition, disciplinary and reinforcement system
- Hazard analysis
- EHS system component evaluation
- Risk assessment
- Preventive and corrective actions

- Leadership engagement
- Employee engagement and participation
- At-risk behaviors and safe behaviors
- Area observations and walkarounds
- Off-the-job safety

# Case studies

## Cummins

### Leading indicator: Training hours

*Leading indicators are a process; there is no perfect mix.*

Four years ago when Cummins was seeking to launch a leading indicator program, management soon realized that doing so would not be a quick or easy process. They asked themselves several questions: Which indicators would be most likely to reduce injuries? Which indicators would motivate desired behaviors? How can the organization contribute to that motivation? After much discussion and debate, they eventually chose a few indicators as a starting point, one of which was training hours.

With twelve months of data in hand, Cummins calculated a simple correlation coefficient for each leading indicator; for training this included the number of training hours against the incidence rate for that same time period. They found a very strong negative correlation (r = -.86) indicating that an increase in training hours was associated with a decline in the incidence rate. This correlation remained strong at the corporate level as well as within the business units.

Cummins was not satisfied, however, with merely identifying training hours as a strong predictor of its incidence rate. They took the next step and set aggressive targets for training to ensure that this indicator remained a priority at each business unit and site. The strength of this correlation also prompted leaders to further investigate why training had such a large impact on the incidence rate. A deeper inquiry revealed that the incidence rate was primarily being influenced by specific training in risk assessment and job safety analysis. The Engine Business Unit (EBU) in particular has a program called Find It Fix It which trains employees to identify and mitigate hazards. Not coincidentally, the EBU showed one of the highest correlations between number of training hours and incidence rate.

Michelle Garner-Janna, director of Corporate Health and Safety at Cummins, notes that having a short list of leading indicators to be implemented at the corporate, business unit and site level is helpful for comparison purposes, but not all areas have the same needs or encounter the same challenges from month to month.

> *"You identify custom leading indicators for each site. We encourage the Business Units and sites to do the same correlation analysis to understand what is working, what is not working and adjust… Every six months, we take a look to see which of our indicators are the most effective and assess what we need to do to continue and improve visibility. Once a year, we update our indicators. If something is not working, we consider dropping it and identifying a new indicator that might be more effective."*

Garner-Janna also mentioned the important lesson that Cummins took away from the launch of its leading indicator program – there is no holy grail of leading indicators.

> *"It's a process that is evergreen. For us, there is no such thing as a perfect leading indicator. At some time, there may be a saturation point for a certain indicator where you see less of an impact. It's a continual improvement process where you're actively measuring the effectiveness and adjusting your indicators based on what that indicator is telling you… You have to continuously evaluate where you stand and make sure you've got the most valid indicator possible."*

# Honeywell

## Leading indicator: Safety observations

*Creating "eyes and ears" to prevent incidents*

Prior to launching its Safety Observation System four years ago, Honeywell relied on a web-based reporting system for near misses. Only managers and supervisors had access to this system, resulting in a hierarchical, bureaucratic process for employees to report events. The system handled reports in English only which given the international scope of Honeywell facilities, proved very limiting. Honeywell executives saw that to improve company safety and drive down the incidence rate, they needed a more sophisticated system to handle near miss and hazard reporting.

Unlike the previous system, the new Safety Observation System is directly accessible to all employees and available in nearly twenty languages, providing Honeywell with more detailed and timely information. Employees report not only near misses and incidents, but also any unsafe behaviors and conditions. Across Honeywell's Building Solutions business unit, over 82,000 safety observations were reported in 2013, equaling roughly eight observations per employee per year. The correlation of safety observations with injury rate is clear – the business unit reduced the number of recordable injuries from 108 in the year 2010 to 54 in 2013. During this same time period, the number of safety observations increased nearly one hundred percent.

The new system also allows for more input and analysis of near miss and incident data. Supervisors can track the reports made by employees and any user of the system can assess and assign a risk level to the condition or event being reported. Additionally the system provides data on any open or closed corrective actions. Cary Gherman, global director of HSE for Honeywell Building Solutions, observed that the implementation of the Safety Observation System has increased the level of employee involvement and changed the focus at Honeywell from only incidence rate to key leading indicators.

> *"The discussion at Honeywell is on the safety observation rate, our HSE maturity and other leading indicators as opposed to how many incidents we have. We still look at our incidence rate, but that really tells us the effectiveness of our leading indicators and the proactive systems we put in place… This reporting system shows the level of culture, of employee involvement and what employees are doing to identify issues before they become incidents."*

Gherman also notes that the purpose of the Safety Observation System goes beyond just collecting observations. It's about staying ahead of the risks that cause the most injuries and creating vigilant observers of safety hazards at every level of the organization.

> *"You always have to adjust to the types of injuries you see, the kinds of risks that are out there and tell people where to focus their observations. If your observations aren't focused on the things causing injuries, you're going to have a lot of observations, but they will have no effect on your injury rate… If a company really wants to systematically reduce the number of incidents, it must identify the risks that lead to incidents. This safety observation process gives eyes and ears in all our operations to identify and fix issues before an incident occurs."*

## NASA Safety Center

### Leading indicator: Incident investigation

*To predict the future, look at the present*

In 2010, NASA was encouraged by the Aerospace Safety Advisory Panel (ASAP) to provide more detail on incidents and overall safety statistics. The NASA Safety Center team quickly realized that the constraints of its incident reporting database were preventing them from obtaining this detailed information. At that time, NASA had not developed many reporting requirements beyond OSHA to gather information on underlying causes and behaviors of incidents in its agency-wide database. The established categories in the Incident Reporting Information System (IRIS) did not allow for users to adequately code and describe the events that took place. The Safety Center team turned to the open text fields to obtain more data on incidents and develop a series of categories and codes for trending.

To discover these new categories, the Safety Center team looked at all the incidents of 2010 and created a set of activity codes for each incident. These activity codes describe what was happening operationally when the incident occurred and which programs or systems were involved. They repeated this process of categorization and coding for the years 2009 and 2011-2013, and now possess five full years of data.

The NASA Safety Center team knew it could not stop at simply knowing the activities at the time of an incident. The IRIS database also contains information on the initiating event, or the specific action that precipitated the incident. This information is benchmarked against OSHA's injury and illness classification system and is modified to include actions and events that are specific to NASA. Finally, IRIS contains information on the kinds of barriers, controls and corrective actions to be implemented to prevent a similar incident from occurring. To develop these barriers and controls, the Safety Center looked to federally mandated safety programs and NASA's own set of safety and mission assurance rules.

It may seem odd to analyze mishap data to be proactive in preventing future incidents, but this is what Steve Lilley and the others at the NASA Safety Center would argue.

> *"[Our perspective] is that the findings, recommendations and interventions are independent of leading or lagging indicators. It's a matter of discovery whether you choose to call them 'leading' or 'lagging.' They most often point to conditions that exist or continue to exist unless we fix them. Our work moving forward is to gather more data about underlying causes. Then we can start to point to these processes and identify the hazards that lie in these different processes."*

This narrative from the NASA Safety Center shows that an incident reporting database does not have to be built from scratch, but instead can be initially formed with federal regulations as guidelines and then tailored to organization-specific activities. Lilley emphasizes that to be truly proactive and vigilant for as yet unknown hazards, the reporting system must be open to change and updates. Approximately 1% to 5% of cases a year do not correspond to existing IRIS codes or categories, prompting the Safety Center team to update codes and definitions. Making these changes in the present can lead to the tracking of trends and prevention of future events. Conclusion: To plan where you want to go, you have to know where you are.

# USG

## Leading indicator: Site audits

*Making safety everyone's responsibility*

In the early 1990s at USG, certified safety professionals performed audits of USG facilities in Texas. Those facilities that received this thorough, two- to three-day audit saw vast improvements in safety operations over those facilities that did not receive audits. Leadership and plant managers at USG expressed a desire to expand and standardize the audit process to involve operations personnel, not just safety professionals. To do this, the safety department, plant managers, and other leaders had to develop a broad-based, standard document to rate facility operations. This became known as the Safety Activity Rating (SAR).

To create the SAR document, Don Schaefer, director of Safety and Fleet Operations met with plant managers and other group leaders every 6-8 weeks for nearly two years to decide on a rating system and the descriptions for each rating category. Schaefer notes that this initial planning phase can provide real value beyond the desired reduction in injury rate:

> *"The key is to take the time to go through a year or two of meetings to hash out what works for your company. How does this fit your culture? Where are you in your safety progress? What's the right next step for you? The real value lies in a group of operational managers deciding what is important and how the document should read. Then they own it."*

To conduct a Safety Activity Rating, a team of six consisting of a plant manager, employees, operators and supervisors visit a different USG site and perform an audit using the SAR document. Afterwards the team lead reviews the report with the plant manager who received the audit to develop corrective actions to address any weaknesses found in the report. The scores from the audits are seen by the safety department, but are otherwise not published and shared to the entire company. Schaefer emphasizes that these scores are used not to force-rank facilities and incite competition, but rather for self-evaluation and improvement within sites.

The Safety Activity Rating process not only allows a team to view another facility's operations in an unbiased way, but also provides team members the opportunity to see what other sites do well and mentally benchmark these processes against what takes place in their home facilities. Besides the reduction in injury rate that USG has seen, a major outcome of SAR has been a heightened awareness of safety among employees. As knowledge increases, so does participation and compliance, leading to a reduction in incidents. Finally, Schaefer notes that because the SAR process is conducted by operations personnel and not safety professionals, it reinforces the idea that safety is every worker's concern.

> *"When you put safety professionals in every location, people have a tendency to say that anything that has to do with safety is that person's responsibility. What has helped USG be successful is that safety is everyone's responsibility. That's the culture we've been operating in since the early 1900s. [The SAR] is another way to take that a step further to educate a wider audience about what they should be looking for regarding safety."*

# Fluor
## Leading indicator: Leadership engagement
*Management in action leads safety improvement – by Sara Simmons, Fluor HSE Communications*

In every project, no matter how unique or geographically remote, Fluor's first commitment remains the wellbeing of employees and the local community. While Fluor has been and continues to be a high-performing organization in safety performance among industry peers, its goal is to learn faster, spot problem areas and take action before someone gets hurt, non-compliance occurs, a client is disappointed, or the HSE culture and reputation is negatively impacted. Leading indicators, especially those in the area of HSE leadership, help achieve this goal while also minimizing risk and driving a positive safety culture. Leadership demonstrates buy-in, active participation and consistent actions that support positive HSE messages.

Fluor has established an effective suite of leading indicators that it assesses with its Corporate HSE Audit Tool. This tool includes measurements in the areas of program development and coordination; training, communication and HSE culture initiatives; field execution and management in action. By measuring how well it performs in these key areas, the tool provides a leading indicator of future safety performance.

The Corporate HSE Audit Tool was revamped in 2012 to put more weight on leading indicators. The first six months of audit scores revealed the greatest need for improvement in the management in action category. Corporate HSE presented these findings to executive leadership, along with a list of specific actions that managers should swiftly set in motion.

These actions included managers' participation in field workers' orientation process and a demonstration of values by clearly defining management expectations in regard to safe work behavior, hazard and near miss reporting, and stop-work authority. Leadership is also expected to walk the site, at least once weekly, with the sole purpose of assessing HSE conditions, noting any deficiencies and ensuring that appropriate corrective actions are taken. Twice per week, managers visit a work crew at the start of their shift to participate in the safe work planning process to identify hazards and risk mitigation measures, observe and record the surrounding conditions, and come to a consensus on how the work shall be performed safely. These activities reinforce the importance of work activity planning and leadership's commitment to safety. In establishing a sustainable HSE program, Fluor has recognized that HSE success begins with diligent management engagement.

Six months following the communication of low scores in this area, management in action became the highest scoring category in the Corporate Audit. This turnaround resulted from Fluor's leadership engagement in the process. Managers' simple, routine activities positively impacted the work on site and helped further promote and advance a positive HSE culture. Jeff Ruebesam, vice president of Corporate HSE, explained how this fine tuning of expectations and visible demonstration of management's values showed that simple things done well and routinely make a big difference.

> *"It does take a lot of time, but it's very impactful if you do it. It promotes getting out in front of things, making sure you're managing on a daily basis and making sure you're visible as a leader… You take people who are present at a site in key operational roles and inject them back into the work crews to participate in safety planning. By doing that, people see that management, and not just the HSE people they expect to see, are paying attention to these issues and are actively engaged."*

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## Summary and future directions

The matrix represents the collective knowledge of leading indicators and associated metrics as practiced by Campbell Institute member and partner organizations. It was developed to be a reference to guide other companies on their Journey to Safety Excellence and to help Campbell Institute organizations maintain their world-class status. Additionally, this paper and the information it contains can be used to not only convince senior executive management of leading indicators' importance and predictive power, but also demonstrate through key examples how particular leading indicators have produced positive outcomes in occupational safety. As noted in this study and a previous Campbell Institute white paper on leadership, getting senior-level management to embrace leading indicators is crucial to advancing leading indicator implementation, minimizing risk, and reducing incidents and injuries.

Those who worked on the matrix at its various stages emphasized the need to include metrics that not only measure whether a process was completed, but also measure the quality of the procedure. For instance, the indicator of risk assessment contains a metric not only for the number of assessments conducted, but also the percent of assessments that have been reevaluated for validity. Similarly, preventive and corrective actions are measured in terms of how many have been verified by managers in addition to the number of closed action items.

The case studies provide more of the background and thought process behind some of the leading indicators described in the matrix. The narratives from Honeywell and the NASA Safety Center demonstrate that recording and tracking safety observations and incident root causes through a widely accessible, online system creates more vigilant employees and enables teams to quickly implement preventive and corrective actions. The narrative from USG shows that creating a metric for quantifying operational employees' participation in site audits creates opportunities for sharing best practices and makes safety everyone's responsibility. Fluor's case study demonstrates the importance of leadership engagement to improve site safety operations and promote a positive safety culture. Lastly, the narrative from Cummins shows that a leading indicator program can start small, yet have significant positive results. At the same time, a leading indicator may prove valid and effective for one company in a certain period, but may not be as effective elsewhere or lose its predictive power over time. A "perfect mix" of leading indicators just doesn't exist.

While the matrix represents a collaborative effort on the part of Campbell Institute members and partners to create a list of top leading indicators and associated metrics, it is far from a wholly comprehensive record of all leading indicators that could be used in the prevention of occupational injuries and incidents. This matrix can be seen as an ongoing project to be edited, amended and added to as collective knowledge and experience of leading indicators continue to grow.

As this leading indicator project continues, the Institute plans to delve deeper into the key elements of these indicators in practice, such as the design of indicators, collection of metrics, implementation planning, cost of implementation, correlation with lagging indicators and return on investment, among other factors. Subsequent phases of this leading indicator research project may also continue along the steps of the benchmarking process, such as asking Campbell member organizations to implement new metrics and/or set new goals for leading indicators based on the knowledge received from the matrix. Further research could also evaluate the benefits of these new targets and metrics and monitor the progress of organizations as they continue to benchmark and learn from fellow Campbell members.

Continued benchmarking may also include some of the more detailed steps of consortium benchmarking (Schiele & Krummaker, 2011), where Campbell members may perform site visits and observe operations of fellow organizations to gather new ideas to implement at their own organizations. Lastly, the matrix columns could be expanded to indicate the maturity level necessary for implementing a leading indicator or metric and may also include the associated lagging indicators of each leading indicator or metric as outlined in Hohn and Duden (2009).

The future directions of this particular leading indicator research project are varied and vast, and direct the Campbell Institute toward even more innovative ways to promote occupational safety and health. What is clear is that the process of collecting, benchmarking and assessing leading indicators can generate practical knowledge, new methods, and techniques for improving the safety of employees and make all workplaces safer.

# Appendix

## Full matrix

*S = Systems-based, O = Operations-based, B = Behavior-based*

| Leading Indicator/description | Associated Metrics |
|---|---|
| **Risk assessment** *(S,O)*<br>Identification of the tasks, hazards, and risks of a job prior to work, and the implementation of protective measures to ensure work is done safely. | Number of assessments conducted per plan |
| | Percent of assessments completed per plan |
| | Ratio between the levels of risk identified (high, medium, low) |
| | Scoring the steps of an operation on severity, exposure, and probability |
| | Number of assessments communicated |
| | Number of risks mitigated or controlled |
| | Number of assessments validated by EHS manager |
| | Percent of assessments reevaluated and revalidated |
| | Percent of routine tasks identified |
| | Percent of tasks identified |
| | Percent of risk assessments completed per schedule/plan |
| | Number of assessments to evaluate potential severity |
| **Hazard identification/ recognition** *(S)*<br>Evaluations and assessments (not necessarily audits) through management and employee observations to identify potential hazards. | Number of near miss reports |
| | Number of unsafe observations (conditions or behaviors) |
| | Number of safe observations (conditions or behaviors) |
| | Number of unsafe observations per inspection |
| | Number of unsafe observations reported per employee per time period |
| | Number and percent of previously unknown or uncategorized hazards discovered |
| | Inspection count (collection of observations) |
| | Ratio of safe to unsafe observations |
| | Weighted percent safe observations (using risk matrix) |
| | Frequency of 100% safe |
| | Number of checklists filled out |
| | Number of comments for unsafe observations that clarified nature of the hazard |
| | Number of people trained in hazard identification |
| | Number of unsafe observations recorded by a trained person |

| | |
|---|---|
| **Risk profiling** *(S)*<br>A review of the collected hazard identification data, prioritization of preventive and corrective actions, and identification of areas for continuous improvement. | Correlation rate between leading and lagging indicators |
| | Number of reviews and comparisons (to check quality of the process) |
| | Number of repeat findings |
| | Number of gaps in hazard identification process |
| | Number of incidents with a root cause related to inadequate risk assessment |
| | Number of root causes not previously categorized or identified in risk assessment |
| | Number of assessments deemed unacceptable |
| | Percent of life-threatening risks, low severity risks, etc. |
| | Percent reduction in overall risk score |
| | Number of risks by specific category (e.g. fall protection, confined space, housekeeping, etc.) |
| **Preventive and corrective actions** *(S,O)*<br>Any measure to correct behavior that could result in failure or defect, as well as any proactive measure to prescribe safe behavior and prevent non-conformance. | Average days to close |
| | Number of days to completion |
| | Percent closed on time (within X hours or by due date) |
| | Number of open issues that need to be closed |
| | Number of open issues that haven't yet had a corrective action assigned |
| | Percent of preventive and corrective actions communicated |
| | Number of effective corrective actions verified by managers |
| | Number of corrective actions for critical issues validated for effectiveness by managers |
| | Number and percent of issues in conformance with recommended corrective actions |
| | Percent or ratio of corrective actions at each level of control (according to hierarchy of controls) |
| | Percent or ratio of corrective actions according to hazard type (e.g. confined space, fall protection, etc.) |
| | Number of issues flagged at 30 days, 60 days, etc. |
| | Number of corrective actions prioritized by risk (e.g. high severity, low severity, life-threatening, etc.) |
| | Number of divisional targets that have dropped below a 90%-completed rate |
| **Management of change process** *(O)*<br>Formal process to ensure appropriate planning around HR activities, union negotiations, seasonal changes in employment, and changing management. | Percent of tasks completed |
| | Number of facilities running 10% overtime |
| | Number of facilities experiencing X% turnover |
| | Number of gaps in management of change review |
| | Number of new assessments for changes in processes or equipment |
| | Number of new trainings for operators |

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| **Learning system** *(S)*<br>Any activity or program (such as training, communication, coaching, and on-the-job training) to teach employees and management about EHS issues and procedures (skills, knowledge, and values) and learn from prior incidents. | Number and percent of completed training goals (by individual, group, or facility) |
| | Percent compliance versus goal |
| | Number of training hours (hours worked per facility/BU/corporate or per time period) |
| | Number of training hours (per employee, per site, per time frame) |
| | Number of incidents with a root cause that includes lack of training |
| | Number of certified trainers |
| | Dollars spent per year on training |
| | Number of new employees who complete orientation |
| | Number and percent of positive post-training evaluations |
| **EHS management system component evaluation** *(S)*<br>An audit of an organization's safety management system to assess conformance with system expectations and goals. | Maturity score (percent of system component compliance) |
| | Number and frequency of audits performed |
| | Number of findings (instances of non-conformance) |
| | Number of corrective actions |
| | Number of management system root causes identified by incident investigations |
| **Recognition, disciplinary, and reinforcement program** *(S)*<br>The recognition of safe behavior or the correction of unsafe behavior to reinforce the objectives of the EHS management system. | Percent of personal EHS systems goals met |
| | Number of disciplinary actions |
| | Number of incident root causes tied to disciplinary actions |
| | Number of recognitions for safe behavior |
| **Leading indicator component evaluation** *(S)*<br>Correlation and trend analysis of key performance indicators to evaluate the outcomes of leading indicator implementation. | Year-over-year analysis of correlation rates |
| | Annual analysis of correlation rate |
| | Number of comparisons with predictive measures to performance outcomes |
| | Number and percent of predictive measures meeting predictive goals |
| | Number and percent of predictive measures meeting performance outcomes |
| **Communication of safety** *(S)*<br>Sharing of information to stakeholders, employees, and management regarding safety metrics/indicators and EHS policy. | Number of users of EHS dashboard |
| | Number and frequency of employee meetings |
| | Number of tailgates/pre-shift safety talks completed |
| | Number of bulletin boards with current/relevant information |
| | Percent conformance with communication expectations/needs |
| | Frequency of communication to stakeholders, employees, and management |
| | Number of website hits |
| | Percent completed and communicated |
| | Number of page views of safety blog |

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| **Safety perception survey** *(S)*<br>Polling employees on impressions and perceptions of management and/or organizational safety performance. | Number and frequency of perception surveys<br>Percentage of employees polled<br>Response rate<br>Percent of positive/negative poll results<br>Employee-management gap analysis |
| **Training** *(O)*<br>Any event that attempts to enrich or increase knowledge, skills, and ability to prevent incidents and/or control hazards. | Ratio of training hours to work hours per month<br>Number of safety talks and safety training sessions<br>Number of assessments to determine the type of training needed |
| **Compliance** *(O)*<br>Adherence to standard operating procedure. | Number of regulatory inspections without findings (not necessarily fines)<br>Percent of defect-free agency inspections |
| **Prevention through design** *(O)*<br>Implementation of design elements to eliminate defects and ensure only one safe way of performing a task. | Number or percent of designs that pass validation or quality test |
| **Leadership engagement** *(B)*<br>Leaders' behaviors and actions that demonstrate their extra effort and commitment to ensuring safety. | Number of employee suggestions implemented by leadership<br>Number of employees volunteering for initiatives<br>Number of managers/supervisors participating in critical design reviews<br>Percent of positive ratings of managers and supervisors by employees |
| **Employee engagement and participation** *(B)*<br>Employee behaviors and actions that demonstrate their extra effort and commitment to ensuring safety. | Participation rate<br>Number of on-the-job observations from employees<br>Number of off-the-job observations from employees<br>Number of employees personally engaged by supervisors in walkarounds<br>Percent of coached observations<br>Percent of employees documenting observations<br>Number and quality of comments<br>Percent job turnover<br>Number of grievances submitted<br>Number of employees leading safety meetings |
| **At-risk behaviors and safe behaviors** *(B)*<br>At-risk behaviors or safety violations that are observed by individuals, supervisors, and management. | Number of observations<br>Ratio of positive to negative observations<br>Number of observers<br>Percentage of supervisors meeting observations goals<br>Ratio of peer-to-peer observations to supervisory observations<br>Hazard severity of observations<br>Ratio of high-risk observations to low-risk observations<br>Percent of coached observations |

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| **Area observations/ walkarounds** *(B)*<br>A workplace tour to observe the safety performance of people (e.g. activities, behaviors, work tasks). | Number of walkarounds |
| | Number of supervisors meeting goals |
| | Percent meeting safety performance standard |
| | Percent deviating from safety performance standard |
| **Off-the-job safety** *(B)*<br>Efforts aimed at managing, tracking, and reducing incidents and injuries that occur outside the workplace. | Number of off-the-job observations from employees |
| **Permit-to-work system** *(S)*<br>Formal written procedures to control types of work that are potentially hazardous. | Number of safety inspections and audits |
| | Number of gaps in completion |
| | Number or percent of supervisors and manager who have completed training in permit-to-work systems |
| **Equipment and preventive maintenance** *(O)*<br>Identification of critical pieces of equipment for more frequent maintenance when it's nearing the end of its "life." | Percent of maintenance time spent on planned versus unplanned maintenance |
| | Number of defects found in equipment |

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