

# Serious Injury and Fatality Prevention: **Perspectives and Practices**

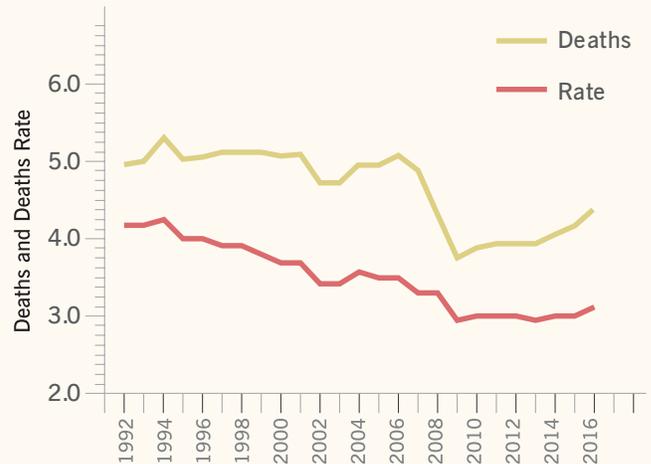




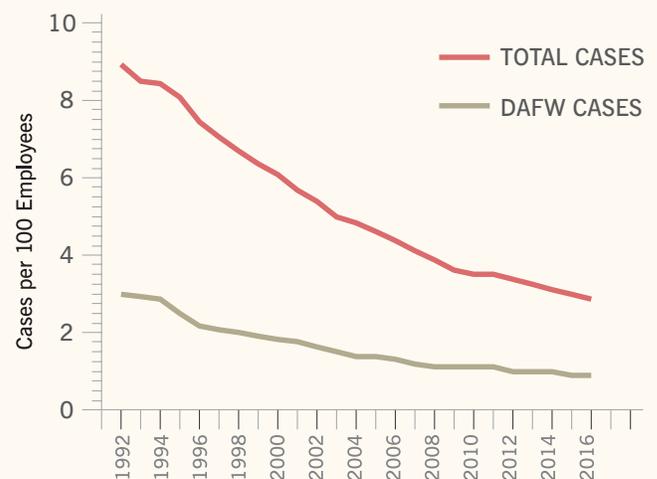
# Background and Previous Work on SIF Prevention

In the past twenty years, the United States has seen enormous gains in workplace safety, particularly as regards total recordable incident rate (TRIR). Since 1993, TRIR has dropped from about 8.5 recordable incidents per 200,000 working hours to less than 3.0 incidents per 200,000 hours in 2016 (Bureau of Labor Statistics, 2017). This reduction in workplace injuries should not be overshadowed by another more disturbing trend in workplace safety, namely that the number of life-altering injuries and fatal incidents has been on a much slower decline (Ivensky, 2016; Martin & Black, 2015). While it is encouraging that the nation's overall recordable incident rate is decreasing, the next step in the journey to safety excellence, and one that Campbell Institute companies are currently pursuing, is the elimination of serious injuries and life-altering events.

## Deaths and Death Rate



## Cases per 100 Employees



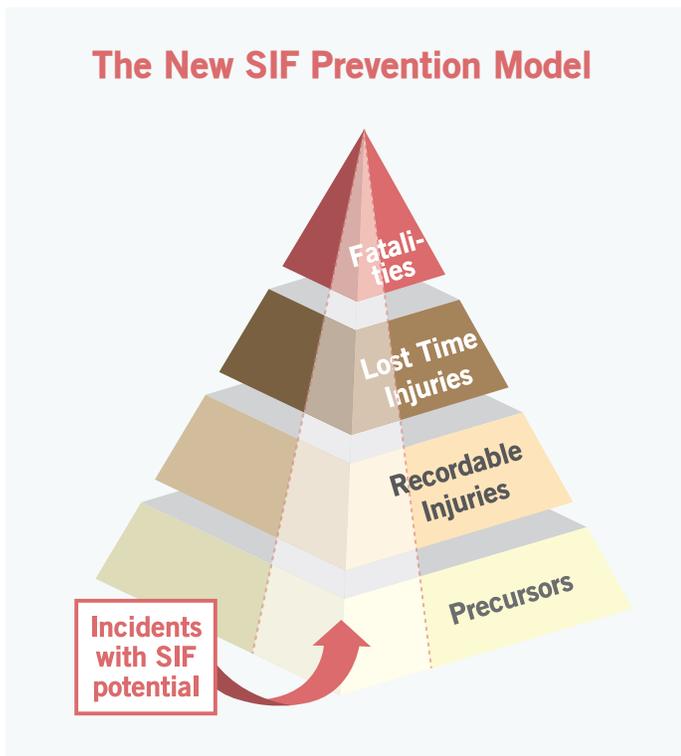
The overall reduction in workplace injuries presents an interesting problem for safety professionals seeking to eliminate serious injuries in their organizations. Unfortunately, for the purpose of data collection and tracking, the reduction in injuries and fatalities means that organizations have less information and data to mine and analyze. Almost ironically, it has become more difficult for organizations to predict when the next serious event will occur because they have become so adept at preventing injuries.

This remains a critical moment in workplace safety to focus on life-altering injuries and fatalities. This paper will first present an overview of the background and research on serious injury and fatality (SIF) prevention. Secondly, this paper outlines how Campbell Institute organizations are addressing SIF by mining incident and near miss data, assessing on risk and severity, and focusing on the potential for SIF.

To understand how to prevent serious injuries and fatalities, we turn to a classic concept in workplace health and safety, Heinrich's safety triangle. In this original conception, Heinrich theorized that for every major injury or fatality, there were 29 minor injuries and 300 non-injury incidents. While this triangle was accepted as the gold standard for many years, safety professionals today realize that there is a flaw in this theory, namely that not all non-injury incidents are equal in terms of their potential for resulting in SIF. Only some near misses have the precursors that could lead to recordable injuries, lost time injuries, and even fatalities. In order to prevent SIF from occurring, many organizations have realized that they cannot look at the entire triangle, at least not in the way Heinrich originally conceived of it. Instead, they have to isolate that part of the triangle with the potential for SIF and prevent those incidents from occurring.



As Tom Krause of Krause Bell Group explains, this subset of incidents with SIF potential are different from those without SIF potential. Those incidents with the potential for serious injuries and fatalities have different root causes and contextual factors leading up to them. Because of these differences, organizations require a different strategy in order to prevent them. Treating all minor incidents and near misses as if they have the potential to result in SIF can divert attention away from those incidents that contain the most potential to result in something serious (Krause and Bell, 2015).



Todd Conklin has done extensive work to increase workplace safety by understanding human behavior and performance, and our interaction with work processes/environment. He comes to the conclusion that humans are error-prone, yet organizations cannot make their workplaces safer and get to zero injuries and fatalities simply by "fixing the worker." Safety experts advocate looking at the broader picture, such as designing work processes in such a way as to eliminate human error. To put it broadly, all work processes and even corrective actions should be developed according to the hierarchy of controls, making safety less dependent on employee behavior and more dependent on the safety management system (Conklin, 2017; Loud, 2016).

Like Todd Conklin, Rob Fisher agrees that we cannot eliminate the potential for injury or fatality by focusing merely on the worker. Fisher says workplaces also have to address gaps that occur within systems, procedures, or the organization itself. He provides three examples of these gaps. Error traps are unfavorable conditions that increase the probability for error during a specific situation. Error-likely situations are circumstances in which there is a greater opportunity for error when performing an action or task due to the presence of error precursors. Organizational weaknesses are flaws in the processes or values that allow the existence of error traps or other precursors to progress to an event.

The conclusions that we can draw so far is (1) Heinrich's safety triangle, while still a useful and relevant tool for understanding the relationship among near misses, incidents, and injuries, is not as adept when conceptualizing the relationship between near misses and serious injuries and fatalities, because, (2) events with the potential for serious injury or life-threatening consequences are fundamentally different, (3) humans will commit errors, but (4) organizations should repair gaps in their safety management systems rather than "repairing" workers. To really address how to prevent serious injuries and fatalities, we should begin with some definitions of concepts related to SIF and SIF prevention.

A fatality is well-defined, but a quick look at the literature and research on serious injuries reveals that there is not yet an "official" definition of a serious injury. While there is still room to arrive at consensus, thanks to the work conducted by DEKRA and other consulting agencies, a broad definition of a serious injury is a life-threatening or life-altering work-related injury or illness. Taylor Abel, Lead of the Campbell Institute SIF Prevention Workgroup noted that the Institute members in the workgroup interviewed for this paper defined a serious injury in these or very similar terms, whether it be formally or informally.

Having this definition of a serious injury does not make it any easier to develop strategies to pinpoint and address those error traps, error-likely situations, or organizational weaknesses that can lead to SIF. Safety experts agree that a lot of how to prevent SIF hinges upon the ability to identify those situations or work activities that have a high potential for serious injury or fatality. While there is also not an official definition of SIF potential in safety research, Taylor Abel shared that commonly used criteria by Campbell Institute members is that an event has SIF potential if the situation could have been worse and could have resulted in SIF if not for one factor. This one factor could be a control that was in place, the location of a person or piece of equipment, the time of day, or even weather conditions.



An event can also be considered as having high potential for serious injury or fatality if it ranks high in a risk matrix scored on severity and probability. Taylor Abel said that using a risk matrix approach is common among Campbell Institute members for identifying situations as having high SIF potential. While the size and scales of the risk matrix may vary, below is an example of a risk matrix that work teams could use.

As noted in the new safety triangle, those serious incidents with the potential for life-altering and life-threatening consequences have different precursors that precede them. Unlike with Heinrich’s original safety triangle, safety professionals cannot simply reduce minor incidents and expect to reduce serious injuries and fatalities overall – focus must be placed on the specific precursors that have the potential for SIF.

As described by Larry Simmons (Kagerer and Simmons, 2016), a SIF precursor generally has three key aspects: it is a high-risk situation where management controls are absent, ineffective, or not complied with, and will result in a serious injury or fatality if allowed to continue. For a situational example of precursors with the potential for SIF, we can look at the utility industry and working on power lines. This work is inherently high-risk because it takes place at height around high voltage lines, but may involve SIF precursors if a worker is not wearing or is not provided the appropriate PPE, or if the training on how to properly operate the lift has lapsed. These breakdowns in management controls, if allowed to continue, could result in a serious injury or fatality for this particular work.

Kristen Bell of Krause Bell Group describes these characteristics in detail. By Bell’s account, high-risk situations include tasks that are known to be associated with high risk – such as working at height, or confined space entry. Worker engaged in these tasks can face increased risk when risk amplifiers are present. A risk amplifier is an environmental condition or other situational factor, which increases the severity or the probability that an incident will occur. Examples include weather conditions, a work interruption, or a breakdown in communication or

## Impact on Pause-Work and Near-Hit Reporting

<b>3 Certain</b>	3	6	9
<b>2 Possible</b>	2	4	6
<b>1 Unlikely</b>	1	2	3
<b>X</b>	<b>1 Minor Hurt</b>	<b>2 Recordable</b>	<b>3 Life Altering</b>

teamwork. This is an important distinction, Bell says, because we depend on our safety professional to identify high-risk tasks and design resilient controls, while we depend on worker and supervisors in the field to identify risk amplifiers and respond appropriately.

In addition to the characteristics of SIF precursors, Don Martin identifies three indicators of SIF: the normalization of deviation, an uncalibrated risk perception/tolerance, and decisions with safety consequences not grounded in empirical data. It is possible to imagine an example of a situation that involves all three of these SIF indicators: a workplace where things have “always been done this way,” a team supervisor who was raised in the company system and therefore lacks a calibrated risk perception, or a team that ignores the incidents and events at other sites just because it has never happened at their site.

There are many other examples of deviation being normalized, beyond the “this is the way we’ve always done it” mindset. For instance, there may be an excess of workers improvising in the field because they do not have adequate knowledge of the official procedure. It could also be that workers have developed workarounds for the sake of efficiency, yet this is a compromise to safety. The

application or interpretation of work procedure may be inconsistent. Variances for work procedures may be granted too easily, and may be coupled with ineffective management of those exceptions or variances. Any of these normalizations of deviation could be a precursor or error-likely situation that could result in SIF.

The second indicator of SIF identified by Don Martin is an uncalibrated perception of risk. Having a lowered risk tolerance or not having the pertinent information by which to make a proper risk assessment can lead people to approach work tasks differently – even unsafely. When picturing a risk matrix, not all members of a work team will have the same axes (of probability and severity) in their minds, and not everyone will have the same scale for those axes. To properly perform a pre-job risk assessment, however, it is important for a work team to have as much alignment as possible on the risk matrix to be used. While it is important that members of a work team land on the same or similar risk rating of an event,

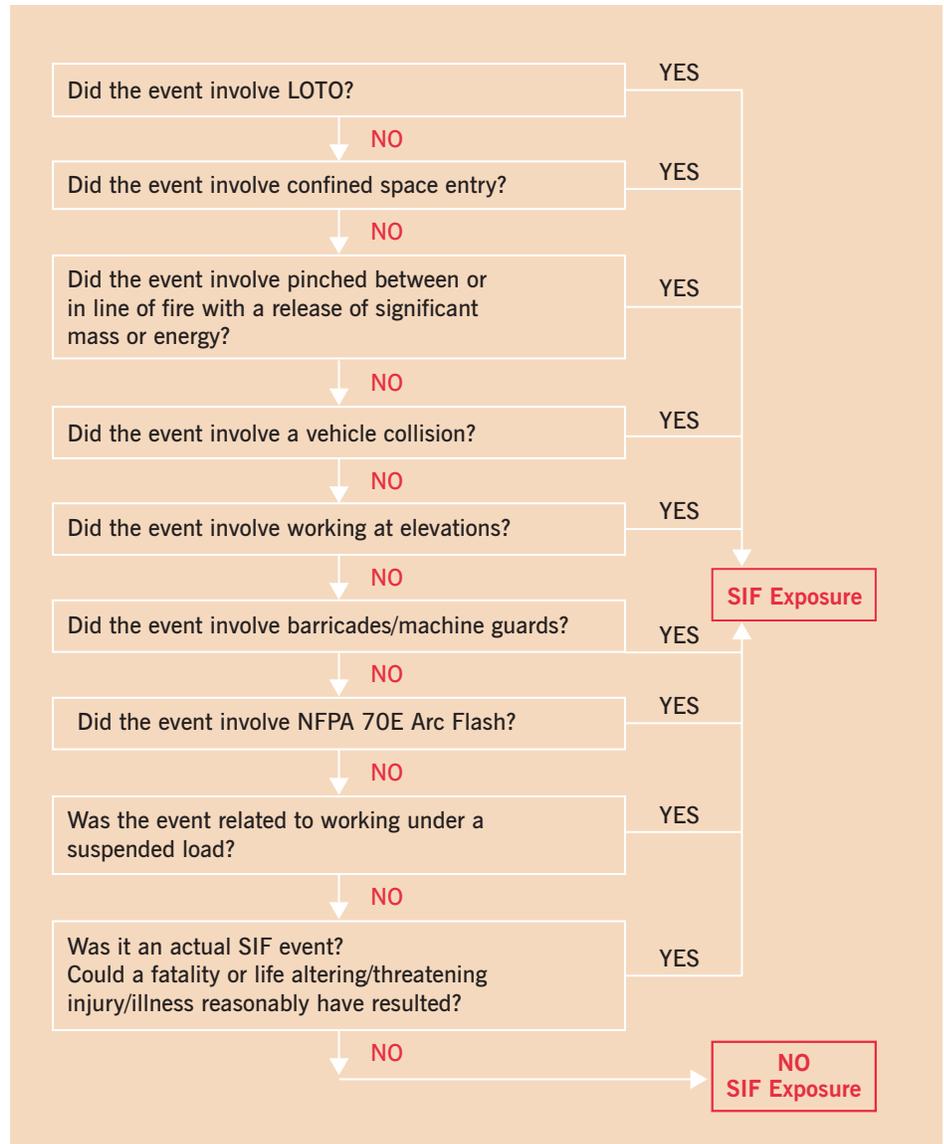
more important is that everyone has the same risk matrix in mind and agrees on the calibration of the axes.

The final indicator of SIF is data collection and analysis that is not done in a mindful, targeted way. As has been found in research on leading indicator analysis, in order to be truly effective, data collection has to be much more than simply gathering numbers for the sake of gathering numbers. The data about SIF potential, near misses, and precursors should provide organizations useful and actionable information, for this is the only way for organizations to be proactive and use these leading indicators to prevent serious injuries and fatalities. Cognitive biases should also be controlled so as not to skew the analysis of SIF prevention data – just because an event has not occurred before should not affect how one ranks it in terms of severity. When discussing safety data analysis in general, Don Martin cautions that safety decisions should always be grounded in empirical data that provides an accurate picture of the work being performed. For instance, analysis of work tasks should be able to answer what exactly are workers being exposed to, and analysis of corrective actions should be able to answer if workers are effectively being protected.

With this background on SIF terms and definitions, and where serious injuries and fatalities fall within the new safety triangle, we turn to the research on the actions and interventions to prevent SIF. DEKRA recommends three steps for developing serious injury and fatality intervention strategies. The first is to educate everyone in the organization about SIF exposure, but particularly senior leaders who may still conceive of safety and injuries/fatalities through Heinrich’s classic triangle. It is important for everyone in an organization to be vigilant of the risks, exposures, and potential precursors that could lead to SIF, especially given that risk perception may be affected by the downward trend in non-fatal injuries.

The second step is to provide visibility to SIF exposure. By focusing efforts on discovering and eliminating SIF potential, organizations are being proactive in stopping these life-altering and/or life-

## Decision Tree Sample



threatening incidents before they occur. As the interviews with Campbell Institute organizations reveals, this intense focus on the SIF potential of near misses and incidents is what provides these organizations the leading indicator data necessary for taking proactive measures.

The last step is to identify precursors for serious injuries and fatalities. Determining precursors requires that safety and operations people conduct gap analyses of their procedures, controls, and employee behavior. Conducting such analyses and

using SIF decision exposure flow charts can help organizations determine if a situation or work task has precursors that could lead to SIF. These are the methods that organizations can utilize to pinpoint those error traps, error-likely situations, and organizational weaknesses that can compromise safety and may manifest as SIF.

Don Martin also writes that most of the preventive measures for SIF are housed within the job hazard analysis (JHA) and pre-task risk assessment procedure. In other words, our ability to prevent serious injuries and fatalities is augmented when we have better, more frequent checks of risk potential before, during, and after the work activity. Is the JHA collaborative, that is, does it involve everyone on the team that will be part of the work activity? Is there a field-level risk assessment just before work begins? Is there a reassessment of risk potential during the work activity? Has everyone agreed on the triggers for a pause or stop of work? Asking these questions during the pre-task risk assessment phase and throughout the work process can help work teams to more accurately assess the level of SIF risk potential associated with the work tasks.

As Todd Conklin mentions, organizations cannot focus all attention on simply “fixing the worker” to prevent serious injuries and fatalities. Instead, attention should be paid to changes that can be made at an organizational level to the safety management system. For instance, corrective actions should be designed to be more mature along the hierarchy of controls. Less mature controls are those that depend the most on employee behavior, like relying on them to put on PPE, and should be avoided. The most mature controls depend the least on employee behavior and design out the risk to the worker.

## Hierarchy of Controls

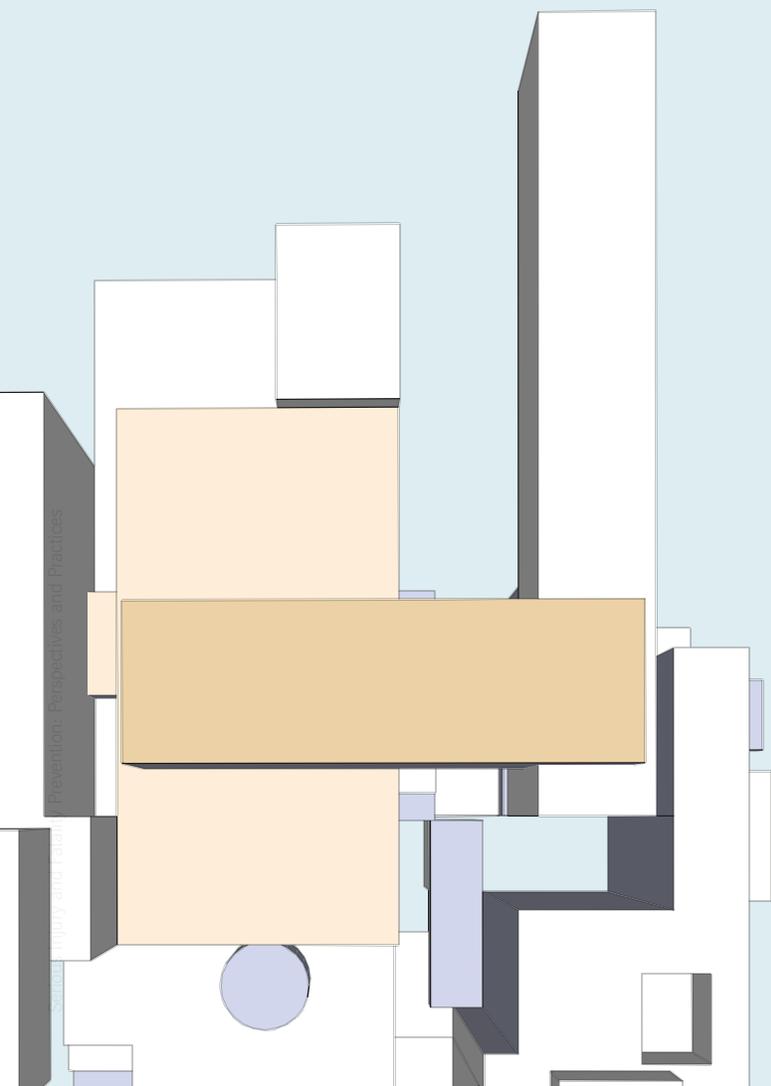




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# Campbell Institute Member Approaches to SIF Prevention

Organizations with superior records in environment, health, and safety (EHS) like Campbell Institute members constantly seek ways to improve upon EHS. It is not surprising that many of them have already embarked on designing programs, training, and messaging that focus on preventing the most serious life-altering and life-threatening injuries. Like other organizations across the country, they have noticed a drop in their non-fatal recordable injury rate, but their fatality rates may not be at zero – and even one fatality is too many. For this research, we interviewed six Campbell Institute members and partners about the serious injury and fatality prevention in their organizations – their reasons for initiating a SIF prevention program, how “serious injury” and other terms are defined, the process for determining SIF potential, and the training, communication, and leadership around SIF prevention. Even if some Institute members have only just recently started implementing some SIF prevention strategies, their processes and approaches based on the background from the previous section can be enlightening for other organizations looking to begin their own programs.



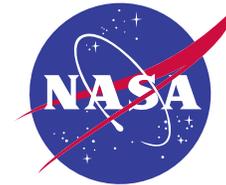
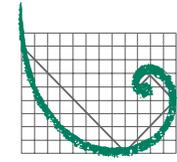
# The motivation to learn about, develop, and implement a SIF prevention program

There appears to be a mix of both external and internal forces that drive Institute organizations to develop and implement SIF prevention programs. There may be existing guidelines (as in the airline industry) that dictate the establishment of a safety management system, of which SIF prevention is an integral part. For others, particularly service providers or government organizations, the impetus for SIF prevention may come from clients or the public at large. Companies like AECOM, a global engineering firm that designs, builds, finances, and operates infrastructure assets, and ERM, a global provider of environmental, health, safety, risk, and social consulting services, are helping their clients reduce SIFs, so it follows that they should also have SIF prevention programs in place. While engineering and consulting may not seem like a high-risk activity, the services that these companies provide place their employees and those who they manage close to and exposed to situations with SIF potential. As an agency dependent on taxpayer dollars, NASA has always been conscious of the protection of its employees and the public in general, which is why they have been focused on preventing high visibility mishaps for over twenty years.

As for internal forces, all the organizations are driven by their cultures of safety and the desire to be proactive about preventing incidents and injuries. Even though they all rank at the top of their respective industries in terms of low recordable metrics, they know that safety is a journey of continuous improvement. In order to be truly best in class, they realize that they have to do more to prevent serious injuries and fatalities. While they may not occur with frequency, implementing a SIF prevention program is how these organizations move to the next level of maturity.

## Defining “serious injury”

Not all of the organizations interviewed have an official definition of a serious injury because their SIF prevention programs are still in development. Most organizations, however, define a serious injury as a permanent impairment or life-altering state, or an injury that if not immediately addressed will lead to death or permanent or long-term impairment. ERM and AECOM have a definition of a serious injury or incident that corresponds with the incident’s ranking on a severity matrix. Exelon Utilities and SDGE use a definition from the Edison Electric Institute that lists fourteen categories of serious injuries. SDGE also relies upon the Cal-OSHA definition of a serious injury, which is based on the outcome (e.g. disfigurement, amputation, etc.) and the level of medical treatment required. A serious injury at NASA has the functional definition of a “high visibility mishap” which involves a high degree of safety risk, not just as related to personal injury, but also towards the completion of critical mission milestones.



For several organizations, an incident is considered “serious” not only because of the risk to personal safety and health, but also in terms of property damage, security, environmental impact, and public image or reputation. These are all areas where, should a serious incident occur, the organization’s ability to continue doing business or performing work would be curtailed.

## Defining “SIF potential”

Like the definition of a serious injury or incident, some organizations do not have an “official” definition of SIF potential. In general, however, organizations classify a near miss incident as having SIF potential if it could have resulted in a serious injury or fatality if not for certain barriers or countermeasures, or if one factor around the event had been changed. This is the general definition of “potential” for NASA, AECOM, and ERM.



AECOM looks for risk potential in all incidents, not just near misses, by assessing the potential severity and potential probability. The key for AECOM when assessing SIF is to evaluate the barriers (potential probability) that were present or absent when the incident occurred. This moves the discussion from focusing solely on the worst possible case scenario to the worst credible case scenario and incorporates critical control success/failure. This viewpoint does not have total

consensus, however. NASA believes it is important to consider both the worst credible injury and the worst possible injury to avoid missing any pertinent information.

Exelon Utilities has a list of eleven specific situations that are considered to have SIF potential, mostly taken from DEKRA guidelines. The twelfth situation is a catch-all “Other” category for anything not captured by the previous eleven categories.

## Defining precursors of SIF

Most organizations define a precursor for SIF as a condition or behavior that if left uncorrected could lead to a serious injury or fatality. This is very similar in language to the definition from DEKRA that states a precursor is “a high-risk situation in which control methods are absent, ineffective, or not complied with, and if allowed to continue, would potentially result in a fatality or serious injury.” Exelon Utilities prefers to be liberal in their definition of a precursor in order to encourage individuals to report conditions – which can later be ranked in terms of severity.

SDGE has an informal definition of a precursor as a flaw or weakness (in an action or tool) that if left uncorrected, could result in a serious injury or fatality. Some events, like electrical contacts, are considered to have SIF potential and have SIF precursors even if they do not meet the Cal-OSHA criteria of requiring hospitalization or medical attention.

NASA defines a precursor as “an occurrence of one or more events that have significant failure or risk implications.” They are trying to nail down another definition that involves severity and likelihood, perhaps including language such as “one failsafe away from a more serious incident.”

AECOM recognizes that each business unit has their own set of critical hazards/high-risk activities and may have different precursors associated with them. They are in the process of determining what those are from case studies and data analysis. Knowing the critical hazard/high-risk activities and controls can protect people, but identifying the precursors of failure goes a layer deeper to incorporate behavior-based safety, human performance, operational influences, and overall company culture.

## Determining SIF-potential events

The processes for determining if an event had SIF potential can be quite different from organization to organization. Also different is the person or group of people that are tasked with evaluating SIF potential. At AECOM, all incidents are entered into a system database. Anyone who enters an incident is required to enter potential severity and potential probability on a scale from 1 to 5, with the total risk assessment being the multiplication of those two numbers. Anything with a total score over 10 is labeled “high potential risk.” Safety managers are responsible for data quality review and obtaining more information to make a sound risk assessment if needed. AECOM has always required full investigations for recordable and “serious” incidents based on actual consequences but over the last year, began



extending the requirements to include high potential incidents and a full Executive Incident Review (EIR). The EIR and distribution of lessons learned will become a formal metric for the global business this year as part of advancing their SIF prevention approach. AECOM believes that this will further their SIF awareness efforts and also force improved data quality and other data analysis needs.

At ERM, all incident and near miss reports are reviewed by the safety team, which includes two people at the global level, a regional health and safety director, and another health and safety professional the next level down. This is the review body for assigning potential to an incident or near miss. If the individual making the report does not enter a level of potential, the review team will contact that person when performing the investigation. Those incidents or near misses that have a rating of 7 to 10 will be reviewed again at the global level.

At Exelon Utilities, a person from safety and another person from HP (human performance) screen all the condition reports submitted by people in the field on a weekly basis. The first review is rather conservative – if anything appears to have the potential for SIF, the report is sent up to the safety manager who makes the final decision. The company compiles a monthly conditions report, which is reviewed by senior leadership and applicable stakeholders. The information from other peer utility companies is compared to calibrate and find common trends.

At NASA, after the event is reported to safety and mission assurance (SMA) professionals at a NASA Center, a determination is made if it meets the “high visibility” definition (provided earlier). Determination of SIF potential can be made at the NASA Center Director or designated representative, such as the Center SMA Director. For

close calls where the public was exposed to serious risk, consultation with the NASA Mishap Investigation Program Executive at NASA Headquarters may occur to decide whether to elevate the investigation from a Center-level investigation to an Agency-level investigation.

At United Airlines, the senior manager of data analytics and his team are in the process of mining incident and near miss data for SIF potential, looking back at two years of data. They expect that a lot of the information will come from the high-consequence injuries and their top injury drivers, which are ergonomic exertions and slips, trips, and falls.

## Coaching and training for SIF prevention

AECOM has committed to SIF prevention as one of their three corporate strategies in order to bring awareness and resources to the topic. All employees will be trained in the SIF prevention approach during the annual global safety training. Additional executive, manager, and employee-specific training and awareness initiatives will explain the value of assessing potential risk, the need to report all incident no matter the actual outcome, and the roles and responsibilities of each person to support incident prevention. SIF prevention terminology and tactics have and will continue to be incorporated into existing tools and practices for constant reinforcement. ERM has a safety training package that covers SIF prevention, and SIF prevention is one of the topics commonly covered by global safety day events or quarterly/monthly regional training events.



Exelon Utilities has not conducted specific training of employees in the twelve criteria of SIF potential, but they focus heavily on the tools to mitigate SIF. They have created teams to conduct trainings in specific areas, such as job briefings and hazard recognition. Teams of field employees (not necessarily safety professionals) develop documents and presentations to be delivered during safety meetings.

Similarly at SDGE, there has not been a formal training program to coach employees in SIF prevention. They have, however, incident investigation teams that perform root cause analyses after events and share the information with other work teams when there are lessons to be learned.

At NASA, training in SIF prevention is part of general mishap investigation and reporting training specified agency-wide for safety and mission assurance (SMA) personnel. The prevention piece is separate and flows from each corrective action plan.

## Communication around SIF and SIF prevention

As noted earlier, AECOM will require an Executive Incident Review and Lesson Learned Summary for all High Potential Incidents. Medium- and low-potential incidents receive investigation, review, and share learning at every level of management corresponding to the potential risk. Parts of the business have already integrated high potential incident awareness into their weekly communications. Monthly business reviews include a robust safety component where operational leadership reviews their safety core value metrics performance and any recordable or high potential incidents. Prevention efforts and near miss reporting are praised and reinforced formally and informally through recognition programs.

At ERM, the timeline for communications depends on the severity level. For those actuals with a severity level of 7 or 10, reports will flow all the way to the Global CEO, Legal Department, and Global HSSE Director. The actions for potentials are not spelled out quite so clearly, but from practice, if there is severe potential, the notifications follow the same guidelines as for actuals. High potential events are still investigated the same way as actuals.

For SIF actuals at Exelon Utilities, team members are required to perform a formal apparent cause evaluation (ACE), which is roughly a 5-page investigation report. Even for SIF potentials, team members are encouraged to perform an ACE. The output of an ACE is to develop corrective actions, which may be communication or process changes. The ACE document is shared with teams during meetings so that they can discuss what happened, the lessons learned, and the corrective actions. Corrective actions are tracked in a software system, and there are closure criteria around each corrective action. In the case of a serious incident, the team will lock down for 6-8 weeks to perform a root cause investigation (RCI). This requires high levels of sponsorship and engagement from all utilities, and it is often a great administrative burden, but the value of performing RCIs cannot be understated. Exelon Utilities also has its Quest newsletter, which focuses on the positive “good catches” on the part of employees.

At NASA, serious hazards that can lead to SIFs are communicated to employees in concert with the type of hazard and who may be exposed. Education for hazards is embedded in periodic required training for certain employees, and in agency (NASA Safety Center) or Center-level safety campaigns, educational products and services directed against such hazards. When a SIF (high visibility) record is created in NMIS (NASA Mishap Information System), email notifications are automatically sent to all who have been pre-identified with a need to know.



At United Airlines, the new hire training covers how to prevent cumulative strain and trauma on the body. The safety team will send out safety stand downs and safety stops, also safety notable bulletins. The company is working on predictive messaging, part of which is informing people of what is happening in operations. The organization wants to get more into technology and pushing messages out in real time to frontline supervisors and leads so they can be informed of the risks and hazards their teams face.

## Metrics and organizational targets for SIF prevention

It goes without saying that Institute organizations still track traditional safety metrics such as incident rate, near miss rate, and DART, but several are also tracking metrics that are specific to SIF prevention. NASA tracks SIF close calls (near misses) in the same category as SIF mishaps (actuals). The NASA Safety Center gives NASA Safety Directors discretion in setting their own targets for these numbers, but in general having zero SIF incidents is the goal.

Similarly, Exelon Utilities tracks the numbers of SIF actual incidents and SIF potential incidents. They have deliberately not set targets for these metrics in order to reduce any hesitancy or reluctance to report SIF actuals or near misses. Like near miss reporting programs in general, organizations can expect to see a spike in the number of near misses when they roll out the program because people are more aware of hazards in their environment, or they feel more comfortable reporting the things they have been seeing. Exelon Utilities does not want to place undue pressure on workers by setting goals or targets for these metrics.

Exelon Utilities also strives to bring more attention to the metric of SIF potential incidents so that it receives the same consideration as the OSHA recordable rate. While Exelon Utilities companies are consistently in the top decile for OSHA recordable performance, they are aware that this metric does not tell the entire story of safety at the organization. As noted earlier, workplaces have been getting better at reducing and preventing the minor injuries that drive up the OSHA recordable rate, but may be shocked to learn that they still had several instances that were close to being life-altering or life-threatening. Placing more attention to the SIF potential metric provides a better picture of the state of safety at an organization.

AECOM is approaching metrics for SIF prevention in a gradual, progressive manner, meaning that the first metrics should be related to awareness, culture, and tactics to address SIF rather than requiring a reduction in the number or rate of SIF or Potential SIF. If the organization starts to focus on reduction metrics too soon, this may lead to underreporting and the downgrading of high potential incidents, resulting in a false feeling of success. The goal at AECOM is to eliminate the number of actual serious incidents and uncover the potential risks that have been hidden in the data. Their metrics strategy supports the gathering of good potential risk baseline data and gives the culture (in terms of learning and reporting) time to mature before assessing success.



## Leadership support of SIF prevention efforts

As has previously been found in other research on leading indicators or safety initiatives of any kind, the support and sponsorship from executive leadership of Institute members is crucial for the resources and timely implementation of SIF prevention efforts. The safety team at AECOM has developed more trust with its executives by demonstrating respect of their time and positions of authority through the SIF prevention approach. Instead of involving them in the review of every recordable incident (which are mostly medium- or low-potential risk), they are only asked to review and discuss incidents that are SIF actuals or potentials. They provide reports that are more streamlined, fit for purpose, and a better use of executives' time and expertise. In addition, triaging the incident review and corrective action responsibility to the corresponding level of management based on low, medium, or high potential risk reinforces ownership and standardizes escalation to an appropriate level of authority.

Without the support of ERM's executive leadership, nothing would happen in the organization; their support is highly critical. Leadership is highly engaged in the discussions around SIF and in the global safety days. SIF prevention is discussed almost every time that leadership is visiting.

At Exelon Utilities, the safety team has been empowered by the executive leadership to perform formal investigations on SIF potentials as if they were actuals, even though this is not required. Executive leadership serves as a final check to confirm that a formal investigation was necessary.

CEO Oscar Muñoz has set the tone for United Airlines since he arrived at the company, urging compliance because it leads to safety and reliability. Last year in 2017, he coined the statement, "We fly right," meaning that United does everything the right way – working safely and compliantly. Earlier in 2018, Muñoz developed the core four set of values for United: safe, caring, dependable, efficient. United executives talk about safety at every opportunity in a top-down-driven process. Currently the company is looking to drive the safety message more from the bottom-up in order to have everyone from employees to executives embrace safety.

# Barriers and successes in implementing a SIF prevention program

To go from the concept of a serious injury and fatality prevention program to actual implementation, the organizations interviewed were consistent in mentioning that there should be careful planning around the process and roles and responsibilities of the SIF prevention program – who submits data and how, who reviews the data, the criteria for determining SIF potential, etc. The concept of SIF prevention needs to be thoroughly discussed and owned by the entire organization, especially those who are most exposed to risks. These individuals should be closely tied to the people who can make resource decisions about the types of defenses and controls that can be put in place.

There can be many barriers to implementing a SIF prevention program. One mentioned by Exelon Utilities is that it can be difficult at the outset to get all in the organization calibrated in terms of the relevant precursors to report. NASA agrees that this is also a barrier; not everyone has the same preconceptions of risk, which may result in underreporting or irrelevant reports. In a similar fashion, AECOM notes that SIF prevention is not a topic around which there is much standardization or best practices, which can make it difficult to take a SIF prevention program from concept to implementation. To make the topic more understandable for a wide audience, AECOM has decided on the terminology of “high potential incident prevention” to have people focus on the potential for a serious incident, and to know that “incident” can apply to more things than just physical injuries.

Another barrier mentioned by NASA can be the different perceptions and priorities of leadership, seeing as they may weigh aspects of risk differently based on roles and responsibilities. Exelon Utilities cautions that communication about SIF prevention cannot remain solely at the top of the organization; the information must be driven to employees as well. Not extending this information to frontline employees can result in more of a divide between leadership and employees in terms of their perceptions and prioritization of SIF prevention.

Campbell organizations have also realized qualitative successes with their SIF prevention programs. For Exelon Utilities, this has meant the streamlining of the SIF precursor and potential reporting process. They found that if the reporting process was too tedious and onerous, this could discourage employees from submitting reports, leading to underreporting. An easier, more streamlined process coupled with a culture that does not assign blame for reporting has resulted in more trust of the system and the organization. As a result of their program, NASA has found success in being able to measure the effectiveness of the defenses they have implemented to protect people and systems from serious incidents.

## Connecting SIF prevention to other emerging concepts

Some of the organizations in this study have already begun connecting components of their serious injury and fatality prevention programs to research in other emerging concepts of the safety world. For instance, some NASA Centers are making associations between SIF prevention activities and the characteristics of high reliability organizations (HROs), specifically using reward systems to encourage desired behaviors and remaining vigilant to failure. It is important to recognize, however, that organizations and systems can be highly reliable yet still unduly expose workers to risk.

Exelon Utilities has been working with DEKRA to perform a safety culture assessment, which has offered them recommendations for educating employees on brain-centered hazards and how to engage the slow brain to better identify hazards and perform their jobs safely. So far, the learning on brain-centered hazards has been implemented at only one Exelon Utilities company, but executive leadership has been supportive of the effort and will most likely institute the fast brain/slow brain training at other utilities going forward.

# Conclusions and Future Directions

The topic of serious injury and fatality prevention is far from being completely explored. Currently at the National Safety Council, a research team is conducting a comprehensive literature review of the published articles and research on serious injury and fatality prevention. The object is to discover what consensus there is, if any, on definitions of “serious injury,” “SIF potential,” and “SIF precursor.” Another objective is to review the existing literature for evaluations of SIF prevention practices – which policies, procedures, and actions are most promising for preventing and eliminating serious injuries and fatalities. To date, no literature review like this has been done for SIF prevention research. The results of this review coupled with the practices of Campbell Institute organizations could be highly informative and instrumental to helping all types and sizes of organizations to develop their own SIF prevention programs.

The SIF Prevention Workgroup within the Campbell Institute has served as the basis for this white paper and still has further work planned for future research and publications. One project may be a think-tank style, thought-leadership piece that puts forth definitions of “serious injury,” “precursor,” and “potential,” much in the same vein as the Institute’s leading indicators research from years past. And noting that most Institute organizations are only a few years into their SIF prevention programs and activities, there is still much more that can be researched and recorded as best practices and interventions for SIF.

Additionally, there are other intersections for research in serious injury and fatality prevention with other research within the Institute and the safety world in general. For instance, as noted by experts such as Todd Conklin and Don Martin, there is a strong connection between the study of human performance and prevention of SIF. Because humans are prone to make errors, an organizational focus on improving human performance is key to eliminating the distraction that can be the root cause of serious injuries and fatalities. Eliminating distraction does not mean “fixing the worker,” however – it can refer to the streamlining of work procedures, removing ergonomic hazards, improving communication between workers and supervisors, among other things.

There is an intersection here as well with research in workplace fatigue and the fatigue initiative within the National Safety Council. Many of the worst workplace incidents in history that have resulted in serious injuries and multiple fatalities have at their cause worker or operator fatigue, which led to distraction and error. Helping organizations understand the level of fatigue risk present in their work sites and providing tips on how to implement fatigue risk management systems can be instrumental in reducing workplace SIF incidents.

A final connection with other Campbell Institute research is how serious injuries and fatalities can be prevented through better visual literacy for hazard recognition. Currently the Institute is pursuing a research project to see if teaching workers skills for observation and hazard recognition leads to more proactive hazard reports, among other metrics. When workers are better able to observe and take in the details of their work environments, they have a heightened ability to pinpoint hazards that may pose a threat to their health and safety. Teaching workers to be more visually literate can be a key element in preventing SIF from occurring.

With these forthcoming projects, it is clear that this is only the first of potentially several white papers on serious injury and fatality prevention. In the months and years to come, the Institute hopes to provide more material, data, and updates on the subject of SIF prevention. This compilation of information will serve the Institute in carrying out its mission of helping organizations achieve and sustain EHS excellence – by preventing the most serious and tragic incidents from occurring.

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