Edison Electric INSTITUTE

Serious Injury and Fatality (SIF) Precursor Customization Project

Project Summary

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EXECUTIVE SUMMARY

Over the past 30 years, the total recordable injury rate in the electric power generation and delivery sector has decreased substantially. However, in the last decade, the rate of serious injury and fatality events (SIF events) has plateaued. Recent research in other construction sectors found that there are identifiable precursors to SIF events that can be identified systematically through field safety engagements. Inspired by these advancements, the Edison Electric Institute (EEI) formed a team of dedicated safety professionals to explore the customization of precursor analysis for electric power generation and delivery.

Precursor analysis is the process of observing an environment and engaging with field personnel prior to beginning work to determine if known warning signs of SIF events are present. Through a brief discussion with workers and targeted observations of the work environment, an observer can help assess if conditions are sufficiently safe for work to proceed. In simple terms, precursor analysis helps supervision to identify whether the identified ingredients of a SIF event may be present before work even starts. One may also think of precursor analysis as a method to assess SIF potential using information obtained prior to work so that preventive action can take place before an incident occurs. Ultimately, this process has been described by many as “the conversations we should be having with our crews.” When performed properly, a precursor engagement can be completed in approximately 15 minutes. However, it should be noted that precursor analysis should be considered **one of many tools** for SIF prevention. While the model may predict low probability in a particular instance, there still may be a chance of a SIF event.

For clarity and consistency in the process, the EEI team developed two key definitions. First, a SIF event is defined as *an event that resulted in or had the potential to result in a life-changing injury*. Under this definition, high-potential near misses were included. Second, precursors are defined as *reasonably detectable events, conditions, or actions that serve as warning signs of a SIF event*. The most important aspects of a precursor are that they are unusual (i.e., anomalies) and they distinguish work completed without SIF events from such occurrences.

Project Overview

The EEI team’s aim was to develop a research-validated and customized precursor analysis protocol by following a scientific process led by a technical advisor. The process was designed to arrive at a set of 10-20 precursors that have strong predictive power and that can be assessed from brief field engagements. Beginning with 16 validated precursors from the previous general construction industry study, the EEI team reviewed literature and brainstormed additional potential precursors that may be relevant to electric power generation and delivery. This process revealed 43 new precursors that were added to the general industry list, resulting in a total of 59 in the investigation set. From a practical perspective, the team recognized that all 59 precursors could not be included in the protocol because the process to collect information from the field would be too disruptive and cumbersome. Thus, the second phase of the process involved identifying a reasonable number of precursors to be included in the protocol.

The reduction of the precursor set was achieved through a series of longitudinal steps. First, every new precursor was defined clearly so that there was a common understanding of their meaning and intent. Then, a survey was administered in which the team was asked to rate the extent to which each precursor: (1) had high potential to be predictive and (2) applied to both electric power generation and delivery. From this analysis, the team arrived at a set of 28 precursors that were collected from the field for use in a scientific experiment.

Before collecting field data, a case template was created to ensure that data were obtained consistently and reliably. The template included a series of questions and observations that would indicate the presence or absence of the 28 precursors. Using this case template, the EEI team members submitted anonymously two types of cases in their company: cases in which (1) the work resulted in a SIF event and (2) the work was dangerous enough to produce a SIF event, but the work was completed without a SIF event. Importantly, the exact same questions and observations were asked for both case types. In total, 40 cases were collected by members of the research team, constituting both a 50/50 distribution of SIF event occurrences and non-occurrences and a 60/40 distribution of electric power distribution and generation, respectively.

The cache of cases then was used in an experimental process. Cases were presented randomly to the team who reviewed the responses and observations to make a prediction. Specifically, the team was asked to predict whether each case resulted in a SIF event or not *without knowing the actual outcome of the case*. In addition to making a prediction, each team member was asked to identify if each precursor was present or absent in each case. When a member of the team collected a case under consideration, he or she was precluded from participating in the prediction and evaluation process. This process yielded a dataset of suitable size to use multivariate statistics to identify *objectively* the precursors that are most predictive. To ensure a highly reliable procedure, the technical advisor edited each case to ensure that there were no issues with grammar or tense that would reveal the outcome. The experimental process was performed over the course of one year via six face-to-face team meetings.

Results

The resulting dataset was analyzed in a step-wise process. First, data reduction techniques were used to identify the precursors that were most suitable for statistical analysis. These remaining precursors then were used to build a predictive equation using generalized linear modeling. This model revealed the extent to which each precursor helped to predict the outcome.

To enhance practicality, the complex equation was used to create a precursor analysis scorecard (right). The coefficients in the equation were indicative of the relative importance of each precursor. These coefficients were used to form weights for the scorecard and a simulation was performed to assist with the interpretation of the final score. The deliverables of the customization are the scorecard, questions, and observations needed to collect field data to make an assessment and an implementation guide with best practices for field engagements.

EEI SIF – Precursor Analysis Scorecard

PRECURSORS	(check if deficiency is present)	WEIGHT
Safe Work Procedure	☐	3
Hazard Recognition	☐	2
Departure from Routine	☐	3
Plan to Address Change	☐	1
Safety Attitudes	☐	1
Rules and Procedures	☐	3
Familiar with the Task	☐	2
Risk Normalization	☐	3
Productivity Pressure	☐	3
Perceived Safety Culture	☐	3
Stop Work Execution	☐	2
Workers Inactive in Safety	☐	2
Pre-Task Plan	☐	3
	TOTAL WEIGHTED SCORE:	

Lower Potential for SIF ← | → Higher Potential for SIF

SCORE	0	1	2	3	4	5	6	7	8	9	10	11	12	13	..	30

The two-year effort combined scientific rigor with a practical perspective to arrive at a research-supported strategy for assessing the likelihood of a SIF event from brief field engagements. The next steps for the team are to validate the strategy with new data, create a comprehensive field implementation strategy, and devise a method to collect, report, and share SIF precursor data within the EEI community.

Detailed information about the precursor customization process is provided in the *Research Summary.*

Lessons Learned

During the data collection and analysis process, the team learned several valuable lessons:

1. **The process of predicting a SIF event is <u>far</u> more difficult than conducting a retrospective root cause analysis.** The electric power generation and delivery industry sectors are adept at root cause analyses of SIF events once they have occurred. However, the transition from a retrospective analysis to a predictive analysis proved to be extremely difficult, even for the industry-leading experts on this team. With the precursor analysis protocol, the approach became methodical, efficient, and accurate with predictions that outperformed expectations. Specifically, the protocol added consistency in the field engagements and added objectivity to the assessment of the likelihood of a SIF event.
2. **Precursors are different from root causes.** The terms precursor and root cause often are used interchangeably. However, not every root cause is reasonably detectable or predictive. Thus, our team arrived at the conclusion that all precursors are root causes, but not all root causes are precursors.

3. **Precursor analysis can be used to predict the occurrence of SIF events at a rate that is statistically significant.** This process involved a blind, randomized experiment designed to measure the extent to which precursors may predict the occurrence and non-occurrence of SIF events when presented with information collected before work begins. The results indicate that, when using the analysis protocol, the method can be used to make consistently accurate predictions.
4. **The method used to collect data from the field is a Field Safety Engagement.** Although the team considered a wide variety of precursors, those that were most predictive were those that were collected via a conversation with workers. Fortunately, many organizations have safety professionals and field leadership who regularly visit sites to conduct safety observations and hold conversations. The precursor analysis method provides structure and strategy for these engagements so that they may be done with greater effectiveness.
5. **Precursor analysis should be considered one of many tools for SIF prevention.** Although the model shows predictive capacity, users should be cognizant that the model is providing an assessment of probability. That is, the scorecard provides an indication of relative likelihood. However, even when low probability is predicted, there is still a chance of a SIF event.

Putting Precursor Analysis into Practice

The process of engaging with field personnel to collect precursor data was referred to as *Field Safety Engagements*. The term precursor analysis now is used to reflect the process used to report and analyze the resulting data from the scorecard.

Field safety engagements rely on candid and accurate information provided by field personnel and are strong when an observer has rapport with them, is knowledgeable about the work procedures and the hazards, has built trust and uses friendly body language, and assures the workers that their information will be kept confidential. The best investigators are often field-level supervision and safety professionals.

This methodology should not be used as a stand-alone process. It is best implemented as a component of regular safety planning. For example, leadership may wish to perform a field safety engagement as part of regular observations, provided that field personnel are aware that the process is non-punitive. Field safety engagements have been implemented in construction as a part of pre-job planning or as part of a typical safety walkthrough.

Precursor analysis often is used to find deficiencies, but it also can be used to identify and celebrate strengths and success. Performing a field safety engagement, addressing residual concerns, and releasing completed work should be celebrated as effective safety management. In this way, the method may indicate that the observer and field personnel have fostered a culture of safety.

Recommendations for Reporting and Analytics

When collected using the precursor scorecard, the resulting data takes a simple and anonymous form. For example, precursor scoring may include the presence or absence of each precursor in a new observation and the outcome of the situation (occurrence or non-occurrence of a SIF event). Such information could be collected to determine areas for improvement. For example, if the precursor *productivity pressure* often is observed prior to any intervention, this intelligence can be used to improve organizational planning and management. This enables organizations to be more proactive with their safety programs by using higher volumes of data collected directly from the field. Rather than responding to injuries, organizations can use precursor data to make corrections before precursors manifest in the field and injuries occur. When multiple organizations pool data, industry trends can be established, and new patterns may emerge.

Detailed recommendations for the use of precursor analysis is provided in the *Implementation Guide*.

The **Edison Electric Institute** (EEI) is the association that represents all U.S. investor-owned electric companies. Our members provide electricity for about 220 million Americans, and operate in all 50 states and the District of Columbia. As a whole, the electric power industry supports more than 7 million jobs in communities across the United States. In addition to our U.S. members, EEI has more than 65 international electric companies with operations in more than 90 countries, as International Members, and hundreds of industry suppliers and related organizations as Associate Members.

Organized in 1933, EEI provides public policy leadership, strategic business intelligence, and essential conferences and forums.

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