



Construction Industry Institute®

Using Near Miss Reporting to Enhance Safety Performance

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USING NEAR MISS REPORTING TO ENHANCE SAFETY PERFORMANCE

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A Report to
Construction Industry Institute
The University of Texas at Austin

Under the Guidance of
CII Research Team 301
Construction Safety

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EXECUTIVE SUMMARY

The construction industry continues to rank as one of the most dangerous work environments when compared to other industrial sectors in the U.S. Construction companies are required to record lagging safety leading indicators which include fatalities, injuries, and illnesses. Safety leading indicators provide an opportunity to identify construction site hazards and hazardous worker behavior before a fatality, injury, or illness occurs.

The Construction Industry Institute (CII) is one of the leading organizations sponsoring and conducting research to improve construction safety and health. CII has completed a multitude of research that addresses problems and identifies potential solutions for safety in the construction industry. Safety and health research proposed by CII often builds off previous completed research projects. The interest and motivation for the research detailed in this report by RT 301 originated from research findings of RT 284 which mainly focused on active safety leading indicators for monitoring the overall safety of a construction project (CII 2012). In fact, the research discussed in this report builds largely on previous CII research as shown in Figure 1. The research presented in this report is denoted by a dashed outlined box. The foundational box provides an objective for all safety and health research completed by CII.

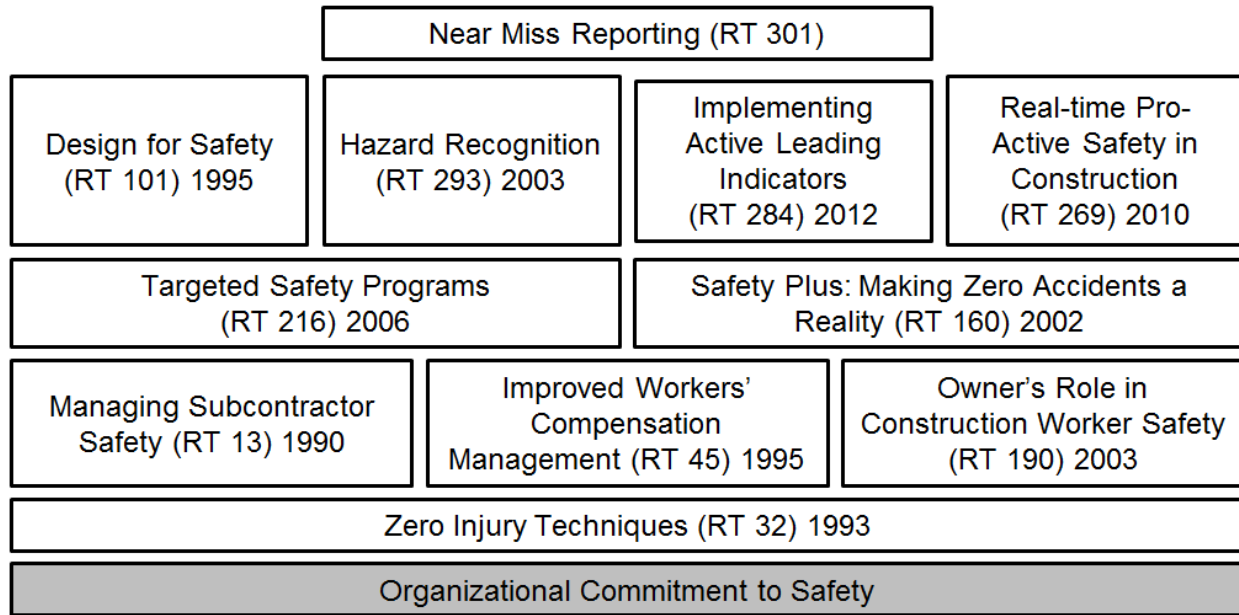


Figure 1: Building Blocks of CII Construction Safety and Health Research

Most recently, CII members have indicated a particular interest in pro-active safety, specifically using safety leading indicators as an additional metric to assess worker safety performance. The research presented in this report along with previous CII research ventures explore pro-active safety and specifically safety leading indicators. Much of the safety and health research completed by CII has been implemented successfully by construction companies and project owners.

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Chapter 1: INTRODUCTION

The construction industry employed approximately 5.8 million workers in 2013 which accounted for 4% of the total U.S. employed workforce (BLS 2013a). Historically, the number of fatalities experienced by the construction industry has been on the decline, but has stagnated in recent years (ILO 2003). Since 2003, the construction industry averaged approximately 1,010 fatalities per year. The percentage of construction fatalities when compared to the total U.S. workplace fatalities is approximately 19% each year (BLS 2013a). This percentage of workplace fatalities is much higher than the 4% employment the construction industry has of the U.S. workforce. The Center for Disease Control and Prevention (CDC) reported that construction fatalities resulted in approximately \$10 billion worth of loss due to direct and indirect costs between 1992 and 2002 (CDC 2006). This study also reported the average cost of each construction fatality during that time period was \$864,000 (CDC 2006). The National Safety Council (NSC) estimated a cost over \$10 billion for fatal and non-fatal construction industry is 2008 (NSC 2008). In 2007 alone, the cost of fatal and non-fatal injuries cost the industry approximately \$6 billion and \$186 billion respectively (Leigh 2011).

This research aims to enhance the measurement and understanding of safety performance by workers on construction sites. Methods to improve safety performance measurement or understanding are needed to ultimately improve construction site safety performance. A majority of construction safety performance measurement strategies currently assess lagging indicators which are measurement criteria based on accidents. These lagging indicator safety measures are reported by construction companies to the Occupational Safety and Health Administration (OSHA) on a periodic basis (BLS 2013c). Lagging indicators are often measured in units of lost workday, number of injuries, or fatality rate. A major limitation to this form of safety assessment is that accidents must occur before hazards or unsafe worker behavior can be identified and mitigated.

Another form of safety measurement called leading indicators can pro-actively assess safety performance by measuring processes, activities, and conditions that define performance can predict future results (Hinze et al. 2013). One such safety leading indicator is a “near miss” which is defined by the U.S. Department of Labor as the following: *“An incident where no property damage and no personal injury occur, but where, given a slight shift in time or position, damage and injury easily could have occurred (BLS 2013c).”*

One advantage of measuring safety leading indicators is that data can be generated and analyzed without the requirement of an illness, injury, or fatality to occur. The primary subject matter of this research is to create and implement a near miss reporting program for recording, measuring, and analyzing near miss data for construction sites.

The major contributions of this research include a near miss reporting program including best practices for reporting, analyzing, and disseminating near miss information. This program includes guides for implementation into a construction company and potential barriers associated with reporting near misses. By reporting and analyzing near misses on construction sites, safety information of potentially hazardous areas can be disseminated through worker safety education and training to increase safety awareness.

Chapter 2: BACKGROUND

The construction industry continues to experience a high number of workplace fatalities and injuries when compared to other U.S. industry sectors. Much research has been performed in construction safety in an attempt to enhance worker safety performance. A research needs statement and statements regarding the research focus are derived from findings of this background review and presented at the end of this section.

2.1 Construction Industry Accident Statistics

The Occupational Safety and Health Act of 1970 requires construction companies to report all fatalities, injuries, and illnesses that occur during or as a result of the work environment (OSHA 2011a). Reported accidents are categorized into the following: 1) Occupational fatality, or 2) nonfatal injury, or 3) illness. Each of these categories result from a worker becoming fatality wounded, injured, or ill from an event or exposure in the work environment. In an attempt to normalize safety performance between construction companies, the OSHA employs the Total Recordable Incident Rate (TRIR) which uses a base of 200,000 cumulative worker hours for the ratio (OSHA 2013). Figure 2 shows the average construction industry TRIR compared to CII participant companies. Although Figure 2 shows improvements in safety performance from 1989 to 2012, safety improvements within the construction industry have been minimal since 2008 (CII 2013a).

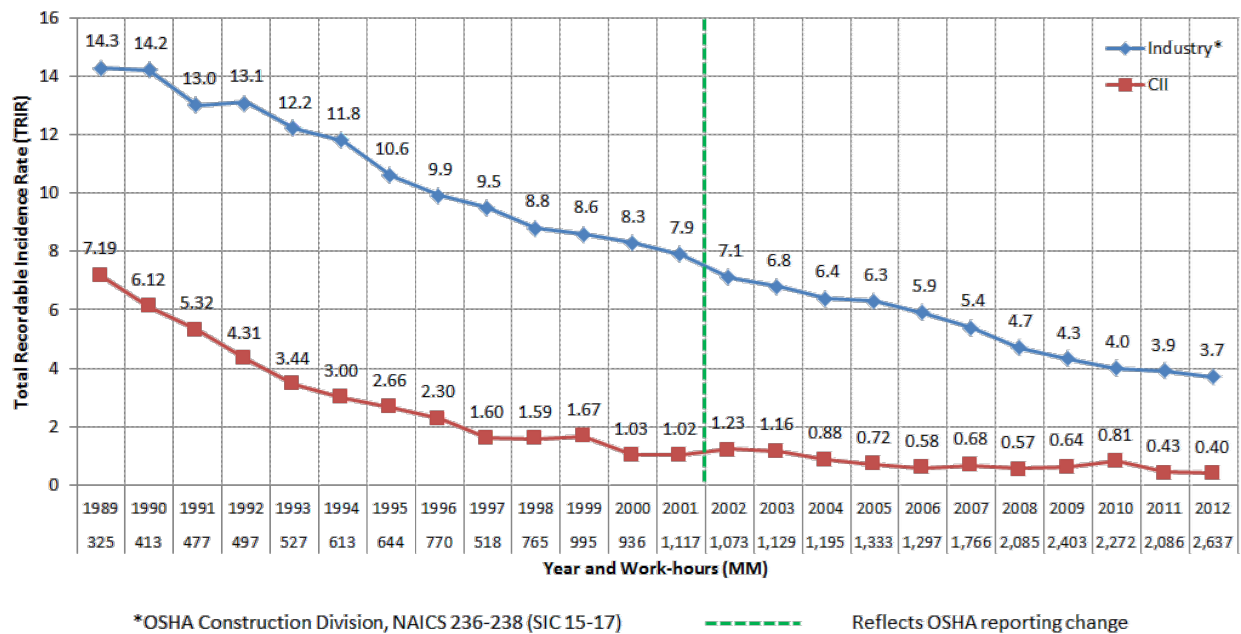


Figure 2: OSHA TRIR per Year for Construction Companies (CII 2013a)

In 2011, the Bureau of Labor Statistics (BLS) recorded that for every 10,000 workers, there were 117 recordable cases where the injury or illness was nonfatal and required days away from work. These values were almost identical to the previous year. A direct function of severity of injury or illness is the number of days away from work due to the injury or illness. For 2011, the median number of days missed due to injury or illness was eight per year, the same value as 2010 (BLS 2012).

Worker injuries on construction sites also present safety concerns. These types of accidents negatively impact the success of a construction project through lost work time, increased medical costs, and decreased productivity. In 2012, the construction workers experience 179,100 non-fatal injuries (BLS 2013a). This number was slightly lower than the 184,700 injuries reported for the construction industry in 2011. All reported injuries and illnesses values are limited to accidents involving employees who were absent from work as a result of the injury (BLS 2013a). Table 1 shows a summation of non-fatal injuries recorded by the

construction industry per year. Values in parentheses represent the percentage of cases when compared to the total non-fatal injuries experienced by the U.S. private industry sector.

Table 1. Non-fatal injuries of the construction industry (BLS 2013a)

Year	Total
2012	179,100 (6.0%)
2011	184,700 (8.6%)
1992- 2010	3,153,701 (10.6%)

2.2 Safety Leading Indicators

Construction companies are currently required to document work-related accidents resulting in injury and illness of employees (BLS 2013a) which are classified as lagging indicators because the assessment happens after an accident occurs. Historically, safety performance is determined by lagging indicators such as number of illnesses, injuries, or fatalities that result from an unsafe act or hazard (OSHA 2013). Safety lagging indicators are unable to reflect if a hazard has been mitigated, the potential severity of an event, or the event causation (Lindsay 1992, Flin et al. 2000). Unlike lagging indicators, safety leading indicators including near misses are measurements of processes, activities, and conditions that define performance and can predict future results (Hinze et al. 2013, UKHSE 2012, Hinze 2006). Examples of safety leading indicators include behavior-based safety (Fang and Huang 2004, Lingard and Rowlinson 1997, Choudhry et al. 2007, Zohar and Luria 2003), jobsite hazard analysis (OSHA 2002, Rozenfield et al. 2010), and safety training (Agnew and Daniels 2011, Jaselskis et al. 1996, Goldenhar et al. 2001, Ho and Dzung 2010). One such safety leading indicator is a near miss which is defined by the U.S. Department of Labor as an incident where no property damage and no personal injury were sustained, but where, given a slight shift in time

or position, damage and injury easily could have occurred (BLS 2013c). Other industries such as manufacturing have adopted these terms for other purposes including describing upstream and downstream processes (Sullivan and Sheffrin 2003). Currently, neither the U.S. Department of Labor nor OSHA require companies to collect and analyze safety leading indicators including near miss data (OSHA 2011b).

The Safety Pyramid created by Heinrich shown in Figure 3 illustrates that a multitude of minor incidents are required for one major incident to occur, and even more near misses should occur for some minor incidents (OSG 2009).



Figure 3: Heinrich’s Safety Pyramid (OSG 2009)

The Safety Pyramid provides a motivation to reduce the number of actual accidents by identifying accidents that had potential to occur. Derived theories from the Safety Pyramid including the Domino Theory and the Loss Causation Models are categorized as linear causation models by many safety theorists (Toft et al. 2012). These models suggest that accidents are results of a sequence of events. Several modifications and augmentations have been applied to the original safety pyramid including “incidents without damage or loss” and “unsafe hazards

and conditions” (Phimister et al. 2003). This supports previous research efforts claiming that all serious injury to workers can be successfully prevented through zero injury techniques (Hinze 2002, Huang and Hinze 2006, Hecker et al. 2005, Hinze and Wilson 2000).

Leading indicators are measurements of processes, activities, and conditions that define performance and can predict future results (Hallowell et al. 2013). These measurements provide guidance on where corrective interventions are necessary. A leading indicator is the result of periodic measurements of a specific safety performance metric. Leading indicators provide opportunities for safety managers to identify areas of safety performance that need improvement before injuries are experienced (Hinze et al. 2006).

Near misses are categorized as a type of safety leading indicator. Near miss incidents are typically not reported in terms of hours or worker exposure, but rather as single events or instances (Hinze and Godfrey 2003). By recording near misses, construction workers can be educated on strategies to prevent future accidents (Cambrail et al. 2010). Near misses meet or exceed requirements of defining an actionable leading metric (Hallowell et al. 2013):

- Data must be numeric
- Data must be easily understood
- Data must be perceived as credible
- Data must signal the need for action
- Data must be related to other indicators
- Data must not generate unintended consequences

Any safety leading indicator should create a consistent measurement procedure such that data recorded is meaningful. A developed measurement process includes: 1) personnel knowledgeable about the process to be measured, 2) personnel trained to collect information and

data in a consistent fashion, 3) a defined methodology for information and data collection, 4) a defined frequency and schedule for information and data collection, 5) tools formatted for the consistent collection of information and data, and 6) a repository for the information and data.

2.3 Near Miss Definitions

The reviewed literature indicated that definitions of a near miss vary across individual companies and across industries. The difference in definitions reveals the challenge of accurately defining a near miss across any industry. Many attempts have been made to define a near miss including:

- A potential to, but does not result in harm (Phimister et al. 2004)
- An instantaneous event which resulted in the sudden release of energy and had the potential to generate an accident (Cambraia et al. 2010)
- An event that signals system weaknesses that if not remedied, could lead to significant consequences in the future (Phimister et al. 2010)
- An event that leaves no evidence of injuries or property damage (Williamsen 2012)
- An incident or unsafe condition with potential for injury or property damage (Ritwik 2002)

A leading large construction corporation defines a near miss as an incident in which a condition exists or an act was carried out that had the potential for injury, property damage, environmental release, or an adverse health exposure to take place. Because of various circumstances, the potential injury or exposure did not occur, but the potential was recognized. A near miss analysis report written by the Wharton School Center for Risk Management and Decision Processes defined a near miss as an event that signals a system weakness that if not remedied could lead to significant consequences in the future. As such, a near-miss is also an

opportunity to improve system structure and stability, and an opportunity to reduce risk exposure to a potential catastrophe (Phimister et al. 2004, Phimister et al. 2010).

According to the National Firefighter Near Miss Recording Program, a near miss is defined as an unplanned event that did not result in injury, illness or damage, but likely would have had there not been a fortunate break in the chain of events. The International Association of Fire Chiefs (IAFC) founded the near miss program in 2005, through funding from the Department of Homeland Security (DHS) and Fireman's Fund Insurance. The program established the following goals (IAFC 2012):

- 1) To give firefighters and Emergency Medical Technicians (EMT's) the opportunity to learn from each other through real life experiences;
- 2) To help formulate strategies to reduce the frequency of firefighter and EMT injuries and fatalities; and
- 3) To enhance the safety culture of the fire and emergency service

The system provides a volume of near miss experiences which are shared with firefighters and Emergency Medical Technicians (EMT's) around the country. The collected data is used to formulate strategies to reduce firefighter injuries and fatalities. Information is disseminated by podcasts, electronic mail, and seminars (IAFC 2012).

2.4 Near Miss Data Recording

After interviewing senior managers of various construction projects, one study found that near miss reporting had not been given the same consideration and importance as accident investigation (Gyi et al. 2010). Near miss reporting strategies also vary from company to company. One company uses the following steps for identifying and recording a near miss:

- 1) Incidents occurs
- 2) Employee reports the event

- 3) Superintendent records the event
- 4) Management discusses the event at the next management meeting
- 5) Safety department publishes briefing report
- 6) Safety department makes recommendations on how to avoid such an event
- 7) Supervisors and safety team review the effectiveness of the corrective actions
- 8) If corrective actions are not effective, the supervisors and safety team reviews and establishes new procedures until the corrective actions are effective
- 9) If corrective actions are effective, a final report is issued to all project team members

An energy production corporation uses a reporting system to report and respond to workplace accidents. This incident reporting and action tracking tool is used to report and track all safety incidents. Serious incidents must be entered and reported in it as soon as possible after the incident but no later than two business days after the event. Exposure incidents must also be entered and reported within two business days after determination that the exposure incident occurred. The report is automatically distributed to managers and other safety personnel when the appropriate reporting fields have been completed. Specific fields of the report are required to be completed to record the investigation and corrective actions. After a full investigation has taken place and actions to avoid recurrence have been identified, the information is entered in the system.

Other companies implement automated technology to record and analyze near miss incidents (Williamsen 2012). Caterpillar, a heavy construction equipment manufacturer, uses an Autonomous Real-Time Tracking System of Near Miss Accidents (ARTTS-NMA) on construction sites (Williamsen 2013). This system employs ultrasonic for outdoor and indoor real-time location tracking, sensors for environment surveillance, Radio Frequency Identification

(RFID) for access control as well as storage of safety information about workers, equipment and materials, and wireless sensor networks for data transmission. All system components are integrated into a RFID sensor network architecture that features a relatively low cost and fast implementation with a wireless network (Wu et al. 2010).

2.5 Near Miss Reporting Methods

A research report about near miss reporting methods used by the University of Texas healthcare system describes the development and implementation of the “close-call reporting system”. This system allows the report to be submitted anonymously so that reporting personnel are not identified by their superiors. A multidisciplinary healthcare team adapted this approach to develop a close call categorization scheme based on human factor principles. This system, which is available in web-based and paper formats, allows reporters to submit close calls in a risk-free manner and enable the collection of information about the etiology of close calls. This information is used to identify areas of vulnerability and to develop interventions that can prevent problems from recurring. The development and implementation processes provide a comprehensive framework that can be used for future deployments of similar patient safety systems. The framework includes the following categories for consideration when developing a near miss reporting system:

- 1) Definition of a close call
- 2) Potential barriers encountered
- 3) Feedback mechanisms to reporters
- 4) Format and content of the system

The research team developed close-call categories including blood transfusion, diagnostic test procedure, equipment and devices, falls, medication, other treatment, surgery, therapeutic procedures, and contributing factors (Martin et al. 2005).

Another method of reporting incidents in the healthcare industry, specifically when working with hydrogen, is the Hydrogen Incident Reporting Tool (Schaaf and Kanse 2004). This tool is intended to facilitate the sharing of lessons learned and other information gained in real experiences that occurred while working with hydrogen. The target audience for this tool is users of hydrogen technology in the healthcare industry. A web-based database was created for users to allow access for the intended users at any location with internet access. The safety event record in the database is characterized such that it facilitates a means for users to search and access information about specific records. The following list shown in Table 2 displays the different search criteria (Schaaf and Kanse 2004):

Table 2: Search Criteria for Recorded Close Call Events (Schaaf and Kanse 2004)

Category	Description
Title	Uniquely characterizes the nature of the safety event in a shortened form
Severity	Identifies the event as an incident, near miss, or non-event utilizing the noted definitions (a non-event is defined as a situation, occurrence, or other outcome that is relevant to safety)
Description	Describes the incident and contains any applicable information such as discussion of causes, other reports, photographs, and sketches
Lessons Learned	Defines the lessons learned and specific suggestions for avoiding similar incidents in the future
Causes	Characterizes the primary cause(s) of the event (e.g. abnormal operations, laboratory experiment, routine maintenance, and equipment failure)
Setting	Where the event occurred (e.g. laboratory, hydrogen production facility or hydrogen delivery vehicle)
Equipment	What types of equipment were involved (e.g. flexible hosing, piping and fitting, storage vessel, or cylinder)
Characteristics	Defines the hydrogen involved as high pressure or low temperature
Discovery	Defines when the event was discovered (e.g. during operation, maintenance, or inspection)
Hydrogen Release	Notes whether hydrogen was released during the event

Ignition	Notes the source of ignition, if applicable
Damages	Characterizes the nature of the damage or injuries
Factors	Characterizes factors contributing to the event, ranging from human error to equipment failures

One of the most effective methods reviewed for data collection of near misses is an online database format. Many industries have an online database that is searchable using industry specific criteria. These databases are comprised of information that is submitted voluntarily by the workers that are involved in the incident or by other witnesses of the event. Dissemination of the analyzed information has been shown to dramatically increase both the number and quality of reports (Cambraia et al. 2010).

2.6 Near Miss Reporting Methods in Other Industries

Near miss reporting has been found to be an effective management tool in other U.S. industrial sectors. Statistically significant decreases of lost time injury rates in offshore drilling suggest an increase in near miss reporting may lead to a 60 percent reduction in lost time injuries. A near miss reporting rate of 0.5 near miss reports per person per year was correlated with a 75 percent reduction in lost time injuries (Phimister et al. 2010).

It is estimated that 44,000 patients die as a result of medical errors annually in the U.S. (Henneman and Gawlinski 2004). One study recorded errors related to transfusion medicine for a period of 19 months beginning in 2001 (Lawton and Parker 2002). The researchers recorded 819 near miss events. They concluded that of the 819 near misses reported, the median number of events per month was 51 and that overall, 61 of the events were potentially life threatening. The three most concerning events that were recorded were: 1) samples collected from the wrong patient, 2) mislabeled samples, and 3) requests for blood for the wrong patient (Callum et al. 2001). Barriers and reporting incidents of nursing homes were also investigated (Wagner et al. 2006).