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TARGET SAFETY: PROGRAMS FOCUSED ON
PREVENTING SPECIFIC INJURIES

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TARGET SAFETY:
PROGRAMS FOCUSED ON PREVENTING SPECIFIC INJURIES

by

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

Under the Guidance of
CII Research Team 216
Target Safety

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EXECUTIVE SUMMARY

This research report presents information on safety programs implemented on construction projects to address specific types of hazards. These programs, referred to as Target Safety Programs, are initiated, developed, and implemented to reduce and eliminate injuries that are associated with specific types of jobsite hazards. While most safety techniques are designed to address safety in a generic fashion, target safety programs are focused on specific jobsite hazards. The objective of this study was to develop a guidance model by which any target safety program could be developed and implemented. The results of the research evolved into a series of nine steps that outline the basic sequence for developing and implementing target safety programs.

Chapter 1 provides an introduction to target safety programs. Various statistics about the safety performance of the construction industry are also presented.

Chapter 2 presents a review of the relevant literature on target safety programs. While there are a limited number articles on target safety programs in the literature, the few programs that were located in the literature are briefly described.

Chapter 3 gives the methodology that was used to conduct the research. Most notably, the research effort was conducted as two separate studies. The first consisted of a questionnaire survey that was conducted with various construction firms, involving over 200 construction projects. The second consisted of ten case studies that were conducted to capture detailed information about target safety programs implemented on construction projects.

Chapter 4 presents the results related to the questionnaire survey that was conducted. The most significant findings are presented that provide an overview of how target safety programs are developed and best implemented.

Chapter 5 consists of detailed descriptions of the ten case studies that were conducted. A wide variety of programs are described which demonstrate the versatility with which target safety programs are developed and implemented.

Chapter 6 presents the conclusions to the research effort and recommendations related to this research study. The most notable conclusion is that the procedures by which target safety programs are developed and implemented are sufficiently uniform that the process can be modeled in a template. The template or model that was developed as part of this research is described in detail in the form of nine distinct steps. The results of this research are sufficiently compelling that it is recommended that the target safety template be utilized whenever a specific jobsite hazard is to be addressed.

The appendices consist of a copy of the questionnaire survey that was used to conduct the first phase of the research. Also presented is the cover letter that accompanied the survey questionnaire. This is followed in the research report by the list of references presented in the literature review.

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CHAPTER 1

INTRODUCTION

The construction industry continues to be one of the most physically demanding and dangerous industries in the United States (National Safety Council). The diversity of construction projects and their ever changing nature expose workers, unlike any other work setting, to new hazards virtually every day. Projects in construction are unique. They are rarely designed or built exactly in the same manner as previous projects and they are always constructed with differing site conditions. Factors such as the landscape, weather, and physical location cause every project to be unique. These factors also have a significant impact upon safety characteristics of each project. While most personnel in the construction industry find project uniqueness to be an attractive attribute for a career in construction, it can have an adverse effect upon their well being.

The U.S. Bureau of Labor Statistics (BLS) indicates that there were 4,365,200 total non-fatal recordable cases in 2002 in all industries (BLS 2003). They estimate that more than 6.8 out of every 100 full-time construction workers experience a work-related injury each year that will require medical treatment, i.e. referred to as the Occupational Safety and Health Administration (OSHA) recordable injuries. Considering that the construction industry employs about 7 million workers (estimates vary considerably), it can be conservatively estimated that about 475,000 OSHA recordable injuries occur each year, which includes all injuries and fatalities, exclusive of first aid injuries.

In general, the construction workforce is highly mobile. For this reason, many contractors are reluctant to invest capital to train those who may soon be someone else's

employees. The result can be an untrained construction workforce that often does not recognize the consequences of working in an unsafe manner.

To counteract this, proactive construction companies have taken major steps in identifying and eliminating the causes of accidents on job sites. As a result, safety has become one of the most important aspects of concern on many construction projects. Construction firms are realizing that the initial investment and the continuous efforts to maintain a good safety record do pay off by not only reducing injuries on the job site, but by also contributing to an “on time” and “within budget” project delivery.

Conscientious construction companies generally have well developed safety programs. These companies devote employee manpower and strong financial resources to maintain the health of their workforce and to prevent high medical and insurance costs. Safety programs have been developed by many firms which have shown an increased concern for the welfare of the construction work force.

With increasing financial ramifications and an increased moral obligation to prevent job related incidents, many companies have realized that in order to prevent job related incidents, companies must not only establish safety programs, they must alter their perceptions of what they can achieve. Companies are setting their goals at not only reducing injuries, but eliminating them. They have called this expectation the “zero-incident” objective.

In the past research studies, safety programs in the construction industry have been examined to see how overall safety management has been used to pursue the zero injury objective. These studies have not examined the details of how specific programs were developed or successfully implemented to reduce specific types of hazards. While

the safety culture of a project might be well established, the details of the implementation of specific programs have not been examined.

The purpose of this research was to answer a fundamental question, “How do construction firms and projects develop, structure, and successfully implement effective programs to prevent or to address specific types of jobsite hazards?” This was to be done by examining in detail those practices of contractors that provide the greatest success in addressing specific types of hazards. A variety of focused safety programs were to be examined. These programs were expected to vary in a number of ways, including the motivation to address the jobsite hazards and the manner in which they were addressed.

By identifying methods that have proven effective in reducing workplace hazards, the construction community will be provided with guidance for the effective means to pursue the zero incident objective. The purpose of this study was to examine the development and implementation of safety efforts to address specific hazards. These programs, referred to as Target Safety Programs, concentrate on the root causes of incidents by focusing on the specific hazards and risks to eliminate jobsite injuries connected with them. The study focus was primarily on the procedures utilized to ensure successful development, implementation, and management of target safety programs that have effectively been implemented on commercial and industrial projects.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

While prior studies have provided considerable information on means by which safety performance can be enhanced, they have not provided any details of how specific safety initiatives might be implemented. That is, they did not focus on techniques that were implemented to address specific types of hazards. There is limited information on techniques that have been implemented to address specific hazards/injuries, as only a few approaches have been reported in the literature.

Since the early 1990s a series of studies have been conducted to identify those practices that have been successfully implemented in the pursuit of the zero injury objective. The first widely publicized study was conducted for the Construction Industry Institute (CII) and was entitled the Zero Injury Techniques (Liska, Goodloe and Sen 1993). That study identified five “high impact” techniques (and the most significant sub-elements) that were employed on projects that were delivered with exemplary safety records. These techniques, reported in 1991 (CII), included:

1. Safety Pre-Project/Pre-Task Planning
 - o Pre-Project (Safety goals, Safety person/personnel, Preplacement employee evaluation)
 - o Pre-Task (Task hazard analysis, task training)
2. Safety Orientation and Training
 - o Owner involved in orientation
 - o Safety policies and procedures
 - o Project specific orientation
 - o Formal safety training
3. Written Safety Incentive Program
 - o Cents per hour for workers

- o Spot cash incentives used with workers
- o Milestone cash incentives given to workers
- o End of project incentives given to workers
- 4. Alcohol and Substance Abuse Programs (ASAP)
 - o Screening done for alcohol and drugs
 - o Screening conducted at random
 - o Inspections for contraband conducted
 - o Post accident screening done for all employees
 - o All project contractors have ASAPs
- 5. Accident/Incident Investigations
 - o Incidents reported to home office
 - o Accidents without injury investigated
 - o Project accident review team established for all accidents or incidents
 - o Project work exposure hours and safety statistics reported to home office

Shortly after the zero accidents study, a construction safety study of the 400 largest construction firms in the United States confirmed the importance of staffing for safety, drug testing, worker training, safety meetings, worker recognition & awards, and accident investigations (Eich 1996).

A follow-up study to the Zero Injury Techniques research was conducted to validate the original findings. That study showed that the industry continued to employ the zero injury techniques, but that the techniques were being implemented differently than initially reported. For example, that study found that while the earlier study found value in conducting injury investigations, this follow-up study found that the proactive firms also investigated near misses, not just injury accidents. While the earlier study reported the value of safety incentives, the follow-up study showed that many firms had replaced safety incentives with safety recognition programs (Hinze and Wilson 1998). Essentially, this follow-up study concluded that the construction industry had matured since the earlier study. The results of that study were used as a justification of repeating the CII Zero Injury study.

The CII sponsored the follow-up study that was entitled “Safety Plus” and this study was conducted by examining in detail the safety efforts employed on 38 large construction project. That study identified nine areas of best practices (Hinze 2002) that were also noted in a follow-up CII study on shutdowns (Hinze and Godfrey 2002). These nine areas included some variation of the initial five high impact techniques and four new techniques. These were identified as follows:

1. Top management commitment to safety
2. Staffing for safety
3. Pre-project and pre-task planning
4. Worker training
5. Worker recognition
6. Worker involvement in the safety process
7. Drug testing
8. Incident investigations
9. Subcontractor management

An extensive search of the available literature resulted in identifying a few articles that addressed the subject of targeted safety programs. Little has been written about the importance of these programs and whether these programs are a common practice within the construction industry. Most of the applicable articles were found in industry journals and periodicals.

Occupational injury rates in the construction trades are high compared to the general workforce in the United States. The Bureau of Labor Statistics (BLS) reported an overall rate of lost time or medical injuries or illnesses of 8.4 per 100 full-time workers in 1994. During the same year, a rate of 11.8 per 100 full-time workers was reported among the construction trades as defined by the Standard Industrial Classification (SIC) code 15 (building construction by general contractors). BLS data, the primary source of data on occupational injuries and illnesses in the construction trades, are based on a sample of

injury reports provided to the Occupational Safety and Health Administration (OSHA) by selected employers. Employment statistics are used to estimate full-time workers.

Construction workers not only have higher overall rates of work-related injuries than other trade groups, but they are also among the most likely workers to experience serious occupational injuries. Fatal and lost work time injuries in the construction trades continue to rank among the highest in the United States, clearly documenting the need for preventive action.

2.2 What is World-class Safety?

What is world-class safety, and how can companies achieve it? While people may have differing definitions, the core attribute is: moving beyond safety compliance toward safety excellence. The 2003 American Society of Safety Engineers Professional Development Conference offered an interesting and timely roundtable discussion on this topic. While the participants' answers to the question varied, they agreed upon several companies that in their estimation, defined world-class safety (ASSE 2003).

Three of those companies mentioned – Bechtel Group Inc., DuPont and Johnson & Johnson – were chosen as America's Safest Companies by Occupational Hazards for 2003. From the relatively small and safety-oriented Quincy Compressor of Bay Minette, Ala.(a small firm recognized for its outstanding safety performance), with its 141 employees, to mighty Johnson & Johnson, with 108,000 employees in 54 countries, what do America's Safest Companies have in common? They all treat safety as a core business value, not a priority. It is not a process, and not a program, but a value. Representatives of several firms that are proactive in safety contributed to the discussion of being world class in safety.

“When you prioritize something, that means it’s not always going to be at the top of your list. A core value is woven into everything you do, every business decision you make,” says Kevin S. Berg, principal vice president and manager of Environmental, Safety and Health Services at Bechtel. “Safety is considered a very essential part of our business functions,” reveals Chris Andrews, safety and training coordinator at Bon L Manufacturing of Newnan, Ga (ASSE 2003).

In addition, many of the 2003 class of America’s Safest Companies use safety as a measure of business success. “Safety is a key indicator of organizational excellence. A safe plant typically has high employee morale, high productivity and minimal product defects,” says Joseph Van Houten, Ph.D., CSP, worldwide director of Planning, Process Design and Delivery, Johnson & Johnson Safety & Industrial Hygiene.

Others acknowledge that business success would not be possible without a safe workplace and safe workers. James A. Buzzard, the president of MeadWestvaco, calls employees “the most important resource we have and we depend on them for the success of MeadWestvaco. Implementing the processes and systems for safety excellence, and integrating them into our everyday activities, develops safe behavior and a safe workplace for our employees.” Keith Shumacher, plant manager at Quincy Compressor stated that, safety “is a race with no finish” (ASSE 2003).

The firms recognized for their exemplary safety performances included those where safety is aggressively promoted at the corporate or top management level. This research was interested in how these ideals were actually transformed into specific approaches that are applied on construction projects. A few articles that were identified provided some insights into this process.

2.3 Jacksonville Electric Authority (JEA)

Heat stress is a problem that affects up to an estimated 10 million workers in the United States each year. Workers who regularly toil in hot, humid, strenuous conditions and those who must wear heavy protective apparel may know the signs. In severe cases, heat stress can lead to nausea, fainting, collapse, or even unconsciousness and death. At any stage in the heat stress continuum, worker productivity and alertness suffers. Other problems commonly caused by heat stress include: increased accidents, absenteeism, and low employee morale. Dehydration is a prime cause of heat stress and can quickly occur when workers do not have ready access to fluids. In hot, hardworking conditions, workers can lose up to 1.5 liters of water each hour in the form of sweat. Sweat-laden skin and clothing reduce the heat dissipation normally performed by the body. The National Institute for Occupational Safety and Health recommends drinking five to eight ounces of cool fluid (water) every 15 to 20 minutes when working in a heat stress-prone setting. This recommendation can be difficult to satisfy for some workers who work where water coolers are not nearby or where it is impossible to carry water bottles to the work area.

Worker hydration is a problem that was addressed by the Jacksonville Electric Authority (JEA). As the eighth-largest municipal electric utility in the nation, JEA provides electricity, water, and waste water services to more than 750,000 accounts in a 900-square-mile service area in and around Jacksonville, Florida. For the JEA field workers, a major problem arose in getting proper hydration for workers working in trenches that were 6 feet or more in depth, making a quick break for water quite difficult. To solve the problem, JEA implemented a two-pronged approach to avoiding dehydration

and heat stress. The first prong was a corporate culture change to a behavior-based safety program. The program effectively standardized numerous safety practices across JEA and put in place a training and education component focusing on safety topics- heat stress and dehydration among them. The second prong involved adopting a new approach for staying hydrated, anywhere and any time. This was a backpack-style system containing an insulated, 70-ounce drinking reservoir that provides sufficient cool drinking water for two or three hours. An insulated tube delivers water via a patented valve mechanism from which users drink by biting down and sipping, similar to drinking from a straw. The system is filled with water through a port on the outside of the unit (McLachlan, and Aenchbacher 2006).

JEA established a written procedure for protecting employees from hazards associated with working in high-heat atmospheres and to increase employee awareness of such hazards. It was decided that the specific heat stress monitoring and work cycle management procedures would be instituted when the temperature exceeded 85 degrees (70 degrees F if the worker was wearing semi-impermeable or impermeable clothing, or an encapsulating suit): measuring heart rate and temperature, interrupting exposure to heat once excessive discomfort was felt or symptoms of heat-related disorders were detected, fluid replacement, personnel protective apparel, including reflective clothing, ice vests, wetted clothing, and water-cooled garments (McLachlan, and Aenchbacher 2006).

2.4 Intel Corporation

Intel Corporation has been recognized throughout the world as a leader in the design and manufacture of integrated circuits. Recently, Intel has been gaining

worldwide recognition as one of the safest places to work. Intel's safety performance has achieved world-class status and continues to improve as a result of detailed data collection and analysis and its focus on three main elements: 1) strong programs, 2) individual commitment, and 3) leadership. Since 1994, the Intel employee recordable injury rates have dropped 84 percent to a level of 0.18 (Phillips and Burris 2001). Just as impressive is the safety performance improvement that has been realized on Intel construction projects. From 1994 to 2001, the recordable injury rates on Intel construction projects dropped dramatically, to 0.86. To understand the significance of this accomplishment, one has to keep in mind that these rate reductions have occurred against the backdrop of phenomenal company growth, including a 200 percent increase in construction activity.

Five-year construction injury data collected on Intel construction projects indicated cuts and lacerations were the most frequently occurring injuries on Intel's construction sites. Of these injuries, the vast majority were cuts to the hands or forearms. Based on these data, Intel's project EHS professionals, representing all six Intel regions throughout the world, developed a plan of action to achieve hand injury elimination. Jim Braun, Intel Project EHS engineer, stated "Many cuts are caused by tools, such as utility knives, that some might call 'inherently dangerous'. "There are alternatives that pose little or no risk of causing a cut to the hand or forearm. Our job is to convince construction workers that they should adapt the alternatives" (Phillips and Burris 2001).

Faced with the knowledge that reducing or eliminating hand cuts would make a dramatic impact on injury rates, Intel construction management and Intel Project EHS set about engaging the entire construction community at Intel to solve the problem. Task

forces were formed for each of the six major regional construction projects. These teams, made up of Intel, general contractors, and the trade representatives, initiated a traditional safety approach to assessing and mitigating risk. Using six key steps, the teams developed and implemented their plans. These steps included:

- 1) Assessing the Risk
- 2) Developing Job Hazard Analysis
- 3) Training the Foremen and Crews
- 4) Observing the Crews
- 5) Measuring Results
- 6) Repeating the Process

Blake Devine of Baugh Construction explained the process as, “We coach our trade contractors that getting rid of the hazard altogether is the best way to prevent injuries” (Phillips and Burris 2001).

2.5 Bechtel

In the construction sector, serious injuries to the hands occur at almost twice the rate as in all of private industry, but not at global giant Bechtel, where the rate is a fraction of the industry average. The fact that injuries to the hands, wrists and fingers remain a serious problem for U.S. companies is probably not news, but what may be surprising is how many of these cases are serious enough to cause lost workdays.

According to the Bureau of Labor Statistics, in all industries there were nearly a quarter million injuries (cuts, abrasions, etc.) and illnesses (dermatitis, etc.) to the hands, wrists and fingers involving days away from work in 2002, more than one-sixth of the total for that year. The incidence rate for this type of problem in all of private industry was 37.2 per 10,000 full-time workers, but it was far higher in manufacturing (55.1) and higher still in construction (67.7). Despite the prevalence of hurt hands in construction,

Bechtel Group Inc. drove its global hand, wrist and finger lost workday case rate down to an incredible rate of 3.0 per 10,000 full-time employees (Nash 2004).

Bechtel's enviable record with hand protection took place in the overall context of an organization that is committed to achieving "zero accident performance," according to Kevin Berg, manager of the company's environmental, safety and health services. Berg contended that while construction by its nature poses more hazards to the hands, many of the things one must do to protect the hands are simply the hallmarks of any good safety program. "Almost everything we do is actually done by people with their hands," said Berg. Roughly 30 percent of the company's recordable injuries involved the fingers, hands and wrists (Nash 2004).

When asked about the biggest challenge in hand protection, Berg's unhesitating reply was that worker participation is the key to success. He stated that hand protection is very simple and that all the education programs in the world do not amount to much unless workers actually don the gloves. "We can put all the processes in place, but if the worker isn't engaged, it's only on paper," asserts Stephen Walter, site safety representative for Bechtel at its Hanford, WA. construction site. "We have to make it come alive for them." Early last year, after performing observations, Walter discovered that during any given 15-minute period, 4 percent of the 600 workers at Hanford were not wearing hand protection. "That means you have a considerable number of people at risk," he explains. So last June, the four weekly toolbox meetings were devoted solely to making the case for hand protection. "We challenged our supervisors to focus on this so we could see improvement." How can you spend a month talking about gloves? Walter explained that hand injuries took up one week. Workers then learned about the various

types of gloves, another week was spent on explaining how to use them and in the final week all the points covered were reviewed (Nash 2004). .

The effort paid off: by August, observations revealed workers were wearing hand protection 99 percent of the time when it was required, and Walter said that number has held up since then. In order to encourage workers to wear appropriate hand protection, Bechtel has adopted a behavior-based observation process that employs two perspectives. “We reinforce positive behavior, and question at-risk behavior.” Both approaches are essential for the success of the program, according to Phil Williams, a carpenter who works with Walter at Hanford. Many of the craft workers on site at Hanford are not used to working for Bechtel and “are more oriented to production than safety,” he explains (Nash 2004). .

According to Williams, asking workers who should be wearing gloves, but were not, was the most effective way of leading people to internalize safe work habits. Many craft workers were not accustomed to wearing hand protection and when questioned why they did not wear gloves, the answer they most often gave was, “I forgot,” Williams explains. “But if you ask them, ‘Why aren’t you wearing gloves?’ they will decide for themselves to put them on. I’ve seen this several times.”

At Bechtel’s Hanford, Wash. Project, eliciting worker participation in safety involved more than performing observations and asking questions, however. Employees were involved in the selection of gloves and Bechtel had a wide variety of styles available, so that workers could choose the hand protection that they felt was most appropriate to the specific task. “We make an effort to educate workers on the types of gloves we have available,” said Walter. “When you have eight types of gloves, you have

something for many different types of activities. If one kind of glove doesn't work, we tell them to try another." As a result of improvements in the design of hand protection, Walter contended that, gloves rarely interfere with the performance of a particular job. "Fifteen years ago, you didn't have a lot of choice beyond cloth or leather, but now gloves provide greater protection and are more comfortable," says Walter. Finally, as in any excellent safety program, PPE is used only when engineering solutions are impractical. "We try to empower workers to make engineering suggestions, instead of wearing PPE," Walter explained. For example, workers had been required to wear gloves while doing computer wiring, but after some workers suggested a way to do the work without using box cutter knives, the company decided gloves were no longer necessary (Nash 2004). .

"Instead of seeing workers as adversaries, where the company tries to force you to work safe, workers are taking responsibility to make improvements with the help of the company," Williams stated. "From a craft point of view, the fact that the company is allowing workers to be part of the solution is the best thing we have going for us out there." From a safety point of view, it may also be the best thing going for Bechtel (Nash 2004). .

When it comes to identifying the biggest challenge for hand safety, Jim Lapping, the vice president for safety, health and environment at Power Maintenance and Constructors in O'Fallon, Ill, Agreed with his colleague at Bechtel that the problem lies in getting workers to wear the gloves. "Being able to wear the gloves and work effectively at the same time is another way of saying the same thing," explained Lapping, whose company does repair and maintenance work at coal-fired power plants. "The trend

in glove design is to create gloves that more effectively balance comfort and dexterity with the level of protection that is needed,” stated Portia Yarborough, Ph.D., a research chemist with DuPont in Wilmington, Del. “People seem to want lighter and thinner gloves with a palm dip to enhance the grip,” noted Elizabeth Parrish, global marketing manager for cut protection in the Advanced Fibers and Composites group at Morristown, N.J.-based Honeywell International. Both women said that progress in developing synthetic fibers has allowed glove manufacturers to offer workers what they want: improved dexterity that does not compromise protection. “Many gloves also have some type of form-fitting stretch component, such as spandex, that also improves dexterity,” added Yarborough (Nash 2004).

Safety managers may want to be aware of something else going on in the hand protection industry. ASTM International (formerly the American Society for Testing and Materials) established the cut standards used to determine the level of protection that gloves provide. Effective March 1, ASTM revised its “Standard Test Method for Measuring the Cut Resistance of Protective Apparel” (F1790-04). The changes in test protocol mean that the same glove may receive a lower cut protection performance value as compared to the previous ASTM standard. “Safety managers should be aware that when buying new gloves, the new numbers may be lower even though the glove performance hasn’t changed,” explained Yarborough. “If injuries are occurring, they should take a look at these numbers, but if they aren’t having injury problems, then it’s probably not a concern” (Nash 2004).

2.6 Alertness Solutions Fatigue Countermeasures Group

Alertness solutions is a scientific consulting firm that translates knowledge of sleep, circadian rhythms, alertness, and performance into practical strategies that improve safety and productivity in our 24-hour society. Modern society operates around the clock, but this 24-hour requirement challenges the human brain and body by degrading the quantity and quality of sleep, disrupting the body clock, and creating fatigue. These factors take a toll on alertness, performance, productivity, and safety. Our society- at both the organizational and individual levels- continually pays a high price for fatigue-related risks that result in errors, incidents, and accidents. Alertness solutions creates tailored strategies and comprehensive approaches that: improve safety, performance, and productivity. In addition they devise innovative ways to address the complex and diverse aspects of managing alertness. The mission of Alertness Solutions is to develop and evaluate countermeasures to mitigate the adverse effects of these factors and maximize performance and alertness.

An international group of scientists identified fatigue as “the largest identifiable and preventable cause of accidents in transport operations (between 15 and 20% of all accidents), surpassing that of alcohol or drug related incidents in all modes of transportation. Fatigue engendered by sleep loss and circadian disruption can degrade all aspects of human capability. Significant reductions in operator performance can affect judgment, decision-making, attention, reaction time, alertness, memory, and mood. These degraded performance factors can increase fatigue-related risks and reduce the operational safety margin. In spite of these well-documented effects, the contributory or causal role that fatigue may play in an accident is often underestimated or potentially

ignored. One reason for underestimating its contribution is that there is “no blood test for fatigue.” To include or exclude fatigue as contributory or causal in an accident requires the evaluation of two specific aspects of the accident. First, were identifiable fatigue factors present at the time of the accident? Second, if fatigue factors were present, did fatigue-related performance decrements contribute to or cause the accident? Four specific physiological factors related to fatigue are:

- 1) amount of sleep (acute loss and cumulative debt)
- 2) continuous hours of wakefulness
- 3) circadian rhythms (time-of-day)
- 4) sleep disorders

Fatigue created by sleep loss and circadian disruption can influence waking performance, vigilance, and mood. These decrements are known to affect errors, accidents, and safety. Accident investigations frequently find evidence that fatigue-related performance was contributory or causal in the accident. The findings include fatigue factors such as: degraded judgment and decision making, cognitive fixation, poor communication/coordination, and reduced reaction time. By applying these principles, notable reductions have been recorded by various firms.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The objective of this research was to determine how construction firms and projects develop, structure, and successfully implement effective programs to prevent specific types of jobsite hazards. Safety practices were to be examined with a specific focus on the procedures utilized to ensure success in program implementation.

3.2 Phase 1: Research Survey

CII Project Team 216, the team specifically formed to assist in this project undertaking, decided that a large sample size was most desirable for this research effort. This was based on the realization that construction firms may implement a variety of safety interventions to address specific hazards (falls, cave-ins, heat, noise, or conditions that injure hands, eyes, backs, feet, etc.). To accomplish the objective of obtaining a large sample size (over 100 responses) the project team decided that the project team members would play an active role in data collection.

In order to have consistency in the information about specific safety interventions on construction projects, a survey was developed. An initial version of this survey was prepared, and this survey was the central focus of discussion at the first meeting of the project team. As a result of this discussion, considerable modifications were made to the survey. The survey, considerably changed from the first version, was examined again at

the second meeting of the project team at which time the survey went through further modifications.

After the survey was considered reasonably refined, a pilot study was conducted. One of the team member companies (an owner) was sponsoring a safety forum for several of its contractors during the second week of August of 2004. The researchers were asked to give a presentation at this forum and were also afforded the opportunity of administering the pilot study with the forum attendees. Participation was voluntary, but 28 attendees provided responses to the survey. After the pilot study was conducted and the resultant data were analyzed, it was apparent that additional revisions to the survey were needed. By September 2004, the final version of the survey was approved by CII Project Team 216 and the University of Florida Institutional Review Board (IRB).

The survey sought information on a variety of safety interventions or programs that were implemented to address specific jobsite hazards. These programs were expected to vary in a number of ways, including the motivation to address specific issues and the manner in which they were addressed. The final survey consisted of five sections which were related to the following topic areas:

- 1) general project information
- 2) project work force and subcontractors
- 3) project safety performance
- 4) specific safety programs- project level
- 5) programs implemented on past projects

The surveys asked for descriptive information about the projects (size, type contract, labor arrangement, duration, cost, etc.). Most of the survey questions asked about information pertaining to specific interventions that were implemented to address specific hazards. Many questions could be answered by simply checking a box or by

providing some numerical information. Other questions requested open-ended responses. A copy of the survey, titled “Target Safety Questionnaire,” is presented in Appendix A.

The surveys were provided to all of the CII project team members. In some cases, the project team members distributed the surveys to their own personnel on construction sites, while some surveys were distributed to companies with some type of affiliation with the project team members. A majority of the surveys were completed by firms that were not CII members. As a result, the findings of this research are not unique to CII members. Once the surveys were completed, they were sent directly to principal investigator of the research project at the M.E. Rinker, Sr. School of Building Construction at the University of Florida for inclusion in the database.

The statistical program, Statistical Package for the Social Services (SPSS), was selected to analyze the data. This program enables data manipulation and facilitates statistics generation. All of the raw data, aside from the narrative comments provided in the survey, were included in the data analysis.

In this research study, the data of particular interest related to those safety programs that had innovative approaches. In addition, the statistical analysis sought to identify those practices that were associated with improved safety performances. Safety performance, measured in terms of the OSHA recordable injury rates (RIR) achieved on the projects, was examined as to the extent that they were influenced by various practices.

Of particular interest in the data analysis were correlations between specific practices and the perceived effectiveness of the various safety interventions. Reports that were generated by the SPSS program displayed the level of statistical significance associated with the comparison of two variables. The level of significance between the

correlations of two variables demonstrated the strength of the relationship between the variables. The level of significance indicated the probability that the relationship between variables occurred by chance. As the significance level approaches zero, the probability becomes smaller that this relationship occurred by chance. For this study, a correlation was considered statistically significant when the level of significance was below 0.05.

3.3 Phase 2: Case Studies

The objective of this research was to determine how construction firms and projects develop, structure, and successfully implement effective programs to prevent specific types of jobsite hazards. The findings from the first phase of this study involving the questionnaire surveys provided the insights by which further information could be obtained. Most of the survey responses provided valuable information about target safety programs, but the survey responses lacked the detailed information that was sought. In fact, it was determined that about half of the responses did not describe target safety programs. For example, several responses related to implementing incentive programs, worker orientation programs, and similar generic programs to improve safety performance. While the information was of interest, it did not meet the criteria of the target safety program, as specific hazards were not the focus of these efforts. Of those responses that related to programs that did satisfy the target safety criteria, most provided only abbreviated information, with little or no details. As a result, the CII Project Team #216 determined that the best course of action would be to conduct a second study that would obtain more detailed information through in-depth case studies.

It was decided that the detailed information obtained through case studies would adequately supplement the information obtained in the first phase of the research. All projects selected for the case study were identified through members of the CII Project Team #216, including representation from owners and general contractors. Because of the nature of the in-depth information being sought, authorization had to be provided before the site visit could take place. The target safety programs investigated consisted of those developed and implemented by owners, general contractors, and subcontractors.

Before a site visit was made, the CII contact person would brief their site representatives on the goals of the research effort. After this, the project contact information was provided to the research team. Telephone contacts were then made with a project representative and a site visit was scheduled. For over half of the jobsite visits, a CII Project Team member would schedule the jobsite visit and accompany a member of the research team on the site visit. Site visits were begun with a general conversation with the site contact person, often a safety representative of the owner or general contractor. The objectives of the research were then described in detail to ensure that the site contact person fully understood the research objectives.

Often specific programs and policies for implementing target safety programs were not apparent at the beginning of the interviews. Although the project safety personnel (the contact individuals) had prior awareness of the objective of the research, many did not fully grasp the actual intent of the research until it was fully described to them during the site visit. As a result, some of the target safety programs were not identified until the site visit was well underway or until a jobsite walkthrough was conducted.

After a target program was identified and described by the project contact person, other personnel were generally introduced to the researcher. Although there were no structured questions developed for documenting these cases studies, a general topic outline was followed to ensure that specific topics were examined. The following questions were presented to all contact individuals as a guide for the jobsite interviews:

- What kind of project is this? (duration of the project, number of workers, number of subcontractors, etc.)
- Description of the target safety program in general terms?
- How did the target safety program begin?
- What were the steps that were followed to develop the Target Safety Program?
- Describe any impediments that were encountered as the program was developed and implemented.
- Was the program well received by the workforce?
- Was the program successful? If so how was success measured?
- What support did corporate management provide in order to develop and implement the program?

After a comprehensive interview was conducted with the jobsite representative, usually the safety manager, a jobsite tour was provided in order to put the program in context. Next, shorter interviews were conducted with other project team members, including personnel representing the owner, prime contractor, and often a subcontractor. By discussing the target program with various personnel a thorough understanding of the target program was developed. Whenever information was available, documentation about the target safety program was also obtained. It was noted that since a formal introduction of the research team was made by a member of CII Project Team #216, there was no reluctance to share any information about the safety efforts on site or the written documentation related to the target safety programs. Twelve jobsite visits were conducted involving introductions being made by four different construction contractors and three owners. Ten case studies were chosen from the twelve projects. Two of the

projects had developed safety programs with first class program implementation, but did not have strong target safety programs that warranted inclusion in this study.

Copious notes were taken during the jobsite visits. Along with the written information about the target safety program that was provided to the project team, a case study write-up was drafted. Each case was organized in a chronological order. The purpose was to identify common means of developing, structuring, and implementing target programs, regardless of the hazard being addressed. As these case studies were written up, it became apparent that the target safety program tended to follow similar patterns of initiation, development and implementation. Because of the similarities, a standardized format evolved for the case study descriptions.

CHAPTER 4

SURVEY RESULTS

4.1 Introduction

Prior safety studies have not examined the details of how specific programs are developed or successfully implemented to address specific hazards. While the safety culture of a project might be well established, the details of the implementation of specific programs have not been extensively examined. This study captured data of specific program implementation through five different portions of the survey which were as follows: general project information, project workforce and subcontractors, project safety performance, specific safety programs - project level, and programs implemented on past projects.

This study identified attributes that contribute to successful target safety programs. A target safety program was defined as a technique, program or approach that was implemented at one or more construction sites to reduce or eliminate specific hazards. There were initially 225 completed surveys that were received. When these were examined, it was determined that some respondents provided information on programs that did not satisfy the description being used to define target safety programs. For example, some respondents described programs in which they implemented safety toolbox meetings on their projects to reduce worker injuries. Surveys that described these types (not focused on a specific hazard) of programs were eliminated from the sample. This resulted in 120 valid and usable responses to the survey. This study sought

to identify and understand attributes associated with targeted safety programs and for this reason, only the 120 responses that dealt with targeted programs were analyzed, i.e., only information and data obtained on these programs are displayed in the tables and figures presented in this chapter.

4.2 Respondent Characteristics

Before presenting information on the target programs, information will be provided on the types of projects represented by the 120 respondents. This will help to characterize the nature of the projects that are represented in the data. By most standards, the projects could be characterized as being either medium or large. The average budgeted cost of the projects was over \$128 million (the median was \$38.5 million). The median total construction duration was estimated to be 18 months while the median duration to date was 10 months (55% complete with 96,000 hours expended to-date). The median number of subcontractors on a project was 12 with these subcontractors completing 57.7 percent of the work (see Table 4-1).

Table 4.1: Descriptive Information about Projects Included in the Study

Case Processing Summary	Mean	Median	Minimum	Maximum
Cost (\$)	128,200,000	38,500,000	70,000	2,500,000,000
Total Duration (months)	22.4	18.0	2	120
Duration to Date (months)	12.9	10.0	0	54
Estimated Project Hours (#)	827,232	253,000	375	8,000,000
Hours to Date (#)	397,840	96,000	0	4,000,000
Percent Complete	57.4	55.0	0	100
Percent Subcontracted	70.0	57.7	0	100
Number of subcontractors	21.8	12.0	0	300
Percent Negotiated	15.9	5.0	0	100

The survey respondents were individuals who were familiar with the programs being implemented on the construction sites. While the survey respondents could be employed by virtually any party associated with the construction of the project, it was felt that the type of firm represented by the respondent would not bias the data. Nearly three-fourth of the respondents represented contractors and most of the remaining respondents represented owners. A few respondents considered their employer's role to be that of a contractor/owner client (see Table 4-2). In terms of geographic dispersion of the projects, ninety eight percent (all but two) were located in the United States while one was located in Europe and another was located in South America.