



MAKING ZERO INJURIES A REALITY

by

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A Report to
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The University of Texas at Austin

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Executive Summary

This research effort was a follow-on effort to the zero accidents work that was sponsored by the CII in the early 1990s. It was apparent that changes had taken place in how safety was being addressed by many of the progressive or pro-active construction firms. This research study was undertaken to identify the current best practices in the construction industry that make a difference in safety performance and that move the industry toward the goal of zero accidents. Information was obtained by conducting two different studies. One study consisted of 106 replies obtained in a nationwide mailed survey that was sent to the largest 400 construction contractors. The second study consisted of 38 personal interviews conducted on large North American construction projects. The results of these two studies are presented in separate chapters.

This research effort identified nine key topic areas that contribute to improved safety performance. The five high impact areas that were noted in the first zero accident report are among these nine, but there are some notable differences in how these are now being implemented. The nine key topic areas to achieve world class safety performance are noted as follows:

- Management Commitment
- Staffing for safety
- Planning: pre-project and pre-task
- Safety education: orientation and specialized training
- Worker involvement
- Evaluation and recognition/reward
- Subcontract management
- Accident/incident investigations
- Drug and alcohol testing

These topic areas are presented in order of how the development of a safety initiative might take place. There is no attempt to prioritize them. The project team suggests that these initiatives be taken as a consolidated group. There is no “silver bullet” in that good safety performance cannot be achieved with only one of the topic areas being implemented. Of course, it is readily agreed that management commitment is perhaps of paramount importance.

Management commitment for safety is essential to convey to others in the firm that costs, schedule, and quality do not take priority over safety. This can be demonstrated in

a variety of ways. The circumstances may dictate those means that are perhaps most feasible. The commitment must be sincere and it must somehow be conveyed to the worker level. Without this clear communication, safety performance will very likely be compromised.

Staffing for safety is essential on large projects. It requires full-time safety personnel to ensure that the safety needs of the projects are being satisfied. Additional safety personnel will be required when the number of workers is increased. These safety personnel form the core of the training program on the project and they will provide the day-to-day safety support for the field personnel.

Pre-project and pre-task planning continue to play a vital role in jobsite safety. Site specific safety programs ensure that the projects have a safe start and the pre-task safety plans ensure that the daily tasks are performed with safety integrated into the daily work routine.

Safety education is a major component of jobsite safety. The training and education of workers should begin with formal jobsite orientation of every worker. As is true in most settings, the learning process is never completed. As time goes by and as jobsite conditions change, it is necessary to provide additional training to workers. This training tends to be focused on the needs of individuals, whether they are field workers, supervisors, or managers.

Worker involvement is perhaps the area in which the most significant changes have taken place in recent years. This is essentially based on the view that workers are not just a valuable resource to be protected but also a resource that can contribute to achieving the goal of zero accidents. Such involvement can be achieved through several means, including observations of worker behavior, input through worker safety perception surveys, and by worker participation on safety committees.

Worker evaluations and recognition/reward programs have shown some success in improving safety performances. While the traditional incentive programs offer no assurance of good safety performance, some techniques were noted to offer guidance. If incentives are offered, for example, they need not be costly, they should be given often, and they should be based on a specific goal. Good safety performance should also influence evaluations that may directly impact wage increases.

Subcontract management implies that the safety agenda of the general contractor must extend beyond its own employees. If the safety program is to be effective, it must involve the subcontractors whereby they are included in the orientation training, the drug testing, the safety planning, etc.

Accident/incident investigations must be conducted diligently to identify the root causes. Near misses are now included in those events that are to be investigated. These near misses are to be regarded as inexpensive “wake-up calls” that may be instrumental and very valuable in avoiding costly injuries.

Drug and alcohol testing continues to reveal its importance to the achievement of good safety performance. Rehabilitation is currently not widely employed in the industry but may be an area to be given consideration in the future.

By employing the nine key topic areas of safety achievement, firms can be expected to realize significant savings through the reduction of injuries. The cost of investing in a solid safety program will pay off handsomely through the substantial reduction realized in the costs attributed to injuries.

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CHAPTER 1

INTRODUCTION

The construction industry continues to be one of the most demanding and dangerous industries in the United States. The diversity of construction projects and the changing nature of construction projects expose workers, unlike any other work setting, to new hazards virtually every day. To counteract this, proactive construction personnel in the industry have taken major steps in identifying and eliminating the causes of accidents on job sites. 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.

The large construction firms account for most of the revenue generated when compared to the total revenue of the industry. Therefore, the safety record and the way safety is structured in these firms are of considerable importance to the industry. “Large construction firms in the United States have made important strides toward improving construction safety. The mean injury rate for the largest firms has dropped by 26% since 1978. Large firms are dedicating more manpower, time, and resources to safety than in the past” (Eich 1996).

Previous research has covered many areas of construction safety, including what the leading firms of the industry are doing to minimize worker injuries, but in recent years very little has been done in isolating and analyzing the methods and practices used to

achieve strong safety performance on large construction projects. Therefore it is the purpose of this research to investigate the safety practices of large construction projects and large construction firms to identify those practices that make one project or one firm safer than the next.

By identifying methods that have proven effective in reducing worker injuries, the construction community will be provided with guidance for the effective means to achieve the zero injury objective.

CHAPTER 2

LITERATURE REVIEW

“Attention to safety in the construction industry has increased dramatically in the United States over the past few decades. The 1990s can properly be called the ‘decade for construction safety’. Several factors have led to the greater emphasis on safety. Although construction work has become safer, there is still much to be accomplished. Since there is now a strong concern for safety in the construction community, one can hope that further improvements will continue to reduce the numbers of fatalities and serious injuries in the industry” (Hinze, 1997).

The large construction companies have the greatest impact on the safety record of the industry. This has prompted researchers to pay particular attention to the methods and techniques used by these companies in their continuing efforts to achieve safety excellence.

“Numerous studies have been conducted in the area of construction safety and how to improve the industry’s dismal safety record. Topics of these research efforts range from behavioral aspects of construction safety to the elimination of physical hazards. However, very limited research has been carried out which isolates or restricts the population to a particular firm size category. Large construction firms are no exception. A better understanding of what large construction firms are doing to aid in the gradual decline of tragic accidents may help accelerate the improvement process” (Eich).

Charles L. Harrison conducted one of the early studies that investigated safety practices in large construction projects in 1979. This study showed a comprehensive

view of what the safety programs of very large construction firms were like at the time (Hinze and Harrison).

The Construction Industry Institute (CII) conducted a study in 1993 that contributed significantly in further defining the measures needed to be taken in order to achieve safety excellence. This study was followed by a validation study conducted in 1998 (Hinze and Wilson).

Zero Injury Techniques

The Zero Accidents Task Force was formed by the CII to continue research into the important area of worker safety. The purpose of the task force was:

- To show owners and contractors how to achieve zero accidents on construction projects.
- To convince management of the value of an effective safety program, through research, by identifying techniques most successful in achieving zero accidents.

The Zero Accidents Task Force research identified five "High-Impact Zero Injury Safety Techniques" that were being used by owners and contractors to achieve the "Zero Injury" objective. The task force defined "safety excellence" as reaching a 1.00 or less on the Bureau of Labor Statistics and OSHA Lost Workday Case Incident Rate (LWCIR). Both small and large owners and contractors can benefit by including the five techniques in a strong, basic safety program. The five high-impact zero injury techniques identified by the task force were:

- Pre-Project/Pre-Task Planning for Safety
- Safety Orientation and Training

- Written Safety Incentive Program
- Alcohol and Substance Abuse Program
- Accident/Incident Investigations

The research also confirmed that zero lost workday incidents are achievable even on larger projects. Of the 25 projects studied, eight had zero lost workday cases, nine had an LWCIR of 1.0 or better (below 1.0), six had LWCIR between 1.0 and 2.0, and two had LWCIR of 3.40 and 4.37, respectively. The projects ranged in size from approximately 200,000 to 6,300,000 work hours completed at the time the research was conducted. The task force further defined the projects with LWCIR greater than 1.0 up to the 4.4 LWCIR project as "good in safety." The task force was unable to find projects with a LWCIR nearer the BLS/OSHA 1990 national average of 6.7. Since "poor safety" projects were not identified for inclusion in the study, the task force could only compare the "good" to the "excellent" projects. Doing so, however, resulted in very identifiable differences in the safety management techniques used. The research clearly showed that the implementation of the five high-impact techniques should allow companies with "good" construction safety programs to advance in safety excellence, and thus achieve zero or near zero LWCIR performance (CII Publication 32-1, May, 1993).

The five High-Impact injury techniques are included in more detail as they were presented in the study by the CII task force:

Pre-Project/Pre-Task Planning for Safety

Project hazard analysis is the systematic review of the scope of a project, focused on identifying potentially hazardous tasks, conditions, toxic/hazardous materials, or

special training/procedures required to perform work. The intent is to identify those hazards that exist and to develop a safe, cost-effective plan to perform the work.

Implementation - project/job analysis

A formal or informal hazard analysis is typically performed using a project hazard checklist as a guide. The project owner/contractor team reviews the preliminary design, existing plant and environmental conditions, and local requirements to identify potential loss exposures and special execution planning requirements for training, permits, special equipment, etc. Subcontractor bids should also include an analysis of the hazards of the work to be done from their perspective: any hazardous materials to be brought on site, special equipment needs or training required, etc. The project manager reviews the analysis to determine whether design, cost or procedural changes are indicated. An initial survey is conducted at the earliest possible stage of design or at the initial construction planning stage. The scope of work is reviewed for known tasks, local/plant conditions, exposures, and hazards that will exist on site. The exact hazards and the equipment, training, or procedures necessary are identified. If possible, design or construction methods are modified to eliminate the hazards. If the hazard cannot be eliminated, then appropriate safety procedures, equipment, training, etc., are developed, purchased, or planned. These are incorporated into the Site Specific Safety Plan.

Task hazard planning description

The review of the tasks to be performed includes the identification of planned procedures, potential hazards, proper equipment to use, the safe work environment to be maintained, and employee skills/training required to perform the work.

Implementation - task safety planning

Phase I: Foreman's weekly planning/scheduling meetings: Task analysis and planning generally occurs at the crew level and is conducted jointly by the crew members and the foreman. Here, the tasks to be performed in the upcoming week are reviewed and general execution strategies and obvious hazards are identified. Also, hazardous interactions between simultaneous activities/crafts are identified and resolved.

Phase II: Worker's task safety planning: This level of task analysis and planning directly involves the foremen and workers as each day's work is outlined. Here the foreman identifies the work to be done and how it is planned to be executed. At this time the whole crew discusses any hazards anticipated, equipment needed to do the job safely, special training or new procedures needed to work safely, and personal protective equipment to be provided and worn. This technique improves hazard awareness, assures better employee compliance, and improves employee participation and buy-in to the safety program.

Safety Orientation and Training

Orientation and training are inseparable words where construction safety is concerned. The activities go hand-in-hand and should include both owner and contractor personnel. The orientation is the "safety first step" given an employee before going out on the job site. It should be performed in a meeting room setting. It is given to all personnel, including visitors, who wish to spend field time on the project site. The orientation content is all-inclusive. All information that people need to protect

themselves and others from injury is included. While the content will be the same for large or small contractors, the time spent will depend on the type of work, the stage of completion and the attendant exposures that are present.

Outline of orientation content

- Introductory remarks (using senior site personnel)
- Type of project, type of owner, identity of the general contractor, and the number of subcontractors involved. How is the project managed? Who is responsible for what? What will the completed project provide the owner? What is the project geography or layout? Where is first aid available?
- An explanation of the site safety philosophy - "Zero Injury." The top management commitment to zero injuries and the provision of the resources to achieve that objective. Requires the buy-in of all employees.
- Current safety performance status of the project.
- Explanation of safety incentive programs.
- Safety presentation - Presentation by a supervisor or for large jobs by a safety professional.
- Safety is the first priority, for all employees, from top management to the worker. The expectation is that there will be NO INJURY. Safety rules will be observed with NO exceptions.
- Safety is a line responsibility and it extends to the foreman and the workers. Where safety professionals are used, explain their technical supportive role.
- Detailed emergency and fire procedures and evacuation routes.

- Detailed explanation of all site safety rules and procedures.

Safety training description

While the above is clearly training in and about safety, it does not provide in-depth safety training. More specific training should be scheduled (prior to the need) in a classroom setting for subjects such as the following:

- Hazard communication
- Material Safety Data Sheets
- Lock out/tag out procedures
- Scaffold erection and use
- Use of fall protection devices
- Proper respirator use, fit and care
- Special tools; e.g., hydraulic wrenches, etc.
- Rigging safety/lift signals
- Crane and equipment operations
- Confined space entry procedures
- Chemical handling safety procedures
- Electrical safety practices
- Radiation safety policies
- Safety harness inspection and uses
- Emergency response training
- Argon/fuel gas procedures
- Hot work

- Forklift safety
- Job safety analysis
- Accident/incident investigation

Safety Incentives

Safety incentives have been shown to be beneficial on some construction sites. Incentives may be established exclusively to reward safety performance or they can be part of a broader project incentive program that could include schedule, cost and quality. In this latter case an integrated incentive program will need to be designed by the parties with methods of measurement and milestones established to manage the program with fairness.

Implementation

"Monetary incentives" were ranked as one of the highest items of distinction between the "excellent" and "good" projects. Typically the programs were of the "cents per hour" (the worker incentive depends on the number of injury-free work hours and on the amount of the incentive set aside per hour) type and covered the trades as well as the foremen. Safety incentives come in two basic forms: gift items and monetary awards. Historically, "good safety performance" awards to craft workers have been the "gift" programs using items such as ball caps, jackets, belt buckles, radios, and various types of gift certificates. While this type program is commonplace and may have a positive impact on safety performance, it does not significantly reduce the frequency of injuries.

However, a "gifts" program can be the forerunner to the type of incentive that many of the projects in the research group used: monetary incentives.

The key result of monetary incentive awards to workers was the way communications opened up with the start of the incentive program. When "my incentive money" is at stake, then everyone feels the urgent motivation to insure that all safety items are highlighted and covered in discussions.

Administration

Once the amount of the incentive is determined, care must be used to insure equity is established. Frequent payments were found to be commonplace. The typical format was monthly awards combined with an end of the project award. Awards are typically based on reaching "Zero" Lost Workday Case goals for a month or quarter. Separate checks given to each trades person by their foreman is typical. The check amount for each eligible person is for "hours worked that month" multiplied by the "cents per hour" award. In some of the 25 projects the owners participated in funding the incentive program. In other cases the contractor funded the program.

Measurement

The worker and foremen incentive awards are typically awarded or distributed when meeting OSHA Lost Work Day Case goals. The Lost Work Day Case goals were usually zero.

Observations and cautions

The Task Force felt that human suffering and the cost impact of worker injuries avoided through the use of monetary incentive systems are sufficient justification to override objections based on administrative difficulties. The expense of a properly structured incentive program is more than offset by the cost savings in achieving safety excellence and, in fact, will yield a net profit.

Clear, simple, and concise communication of the incentive program to craft workers is essential. So that everyone knows how he or she is performing, this communication should be ongoing. Incentive payments to craft workers need to be at reasonable frequency, such as monthly or quarterly as the longest interval. They should be paid in a separate "Safety Incentive" check. The incentive programs were not used to replace other essential elements of a fully developed safety program. In fact, if an already effective safety program was not in place first, the task force pointed out that monetary incentives may not yield an improvement. Incentive programs are not easy to administer to the satisfaction of every single employee. Incentives will be especially troublesome to those employees who work on the project but who are not eligible for the incentive payments. These objections can be overcome by the careful structuring of the incentive program.

Drug and Alcohol Abuse Programs

From the research results, this technique had a significant overall impact on reaching the zero lost workday case level of safety performance. In the past five years, the use of drug and alcohol abuse programs in construction had profoundly improved safety in the workplace. There were many sources for effective program guidelines.

Many of the contractor associations offered guidelines for their members. These programs varied widely in their thrust. "Test sample handling protocol" and the "accuracy of the testing laboratory" are the most critical aspects of such programs.

Distinctive elements found by the research

There are many elements of drug and alcohol abuse programs. The elements that were distinctly prevalent in the projects achieving safety excellence were:

- a. Regular inspections for contraband.
- b. Screening tests conducted at random.
- c. Screening tests conducted for alcohol.
- d. Lower tier contractors required to have drug and alcohol abuse programs.
- e. Programs administered to ALL employees.
- f. Screenings done after accidents (post accident).

Accident/Incident Investigation

The investigation of an accident/incident sends a message of management concern to all employees on a project. Similarly, the failure to investigate accidents also sends a message, one of management disinterest and apathy toward worker safety. Owners and contractors who were able to achieve zero or near zero injuries on their projects had rigorous procedures on all aspects of accident investigations. Such investigations find the real or root causes of accidents, result in recommendations for accident prevention and insure that follow up action does occur. Some of these were covered in the implementation information that follows.

Implementation

The following is a list of questions (along with their answers) that describe the various aspects of the investigation process.

-Who should investigate accidents?

- Responsible parties, including both owner and contractor; people with appropriate skills, knowledge and interest in the prevention of future occurrences. Who was involved? Were there any direct or indirect witnesses?
- Use of experts where appropriate.
- Use other resources; i.e., safety professionals.

-How should top management respond?

- In cases of serious injury senior owner and contractor management should visit the site of the injury within 24 hours.
- Role is to insure all needed investigation priorities and resources are available.

-What should be investigated?

- All recordables, all first aid cases, plus any "near misses" that could have resulted in serious injury.

-When should accidents be investigated?

- As soon as practical is a good rule. The more serious the injury or near miss the more quickly the investigation should begin.
- A good rule is to investigate all serious injuries immediately.
- Do not allow any investigation to get in the way of "caring for the injured or other people."

- Other questions: Are key witnesses and injured parties accessible?

-Where should the investigation take place?

- Typically at or near the site of the injury. Interviews can be both on site and in a nearby office setting.

-What type of information should be assessed?

- Determine the severity or potential severity of the accident?
- Have similar accidents happened before?
- Take statements from witnesses.
- Is there an agreement among witnesses at the scene?
- Get hard evidence that cannot be easily disputed.
- Address any circumstantial evidence.
- Send the report to all interested parties, including the highest management levels.

Investigations procedures checklist

1. Set your attitude to be impartial, concerned, and determined to protect others.
2. Go to the scene of the accident promptly.
3. Talk with the injured person, if possible. Talk to the witnesses and get facts.
4. While at the scene of the accident, look for evidence of the accident and listen for clues of causes for the accident from conversations around you.
5. Encourage people to give their ideas for preventing the accident.
6. Study the possible causes. Remember that accidents usually have more than one "contributing factor." Include unsafe conditions as well as unsafe practices.

7. Write a report using narrative form. Never write the report while talking to the injured employee or witnesses.
8. After writing the report, read it back for accuracy and read it to your accident investigation team. After all agree that it is correct, all team members should sign it.
9. Follow up to ensure that conditions are corrected.
10. Publicize any corrective action.

Zero Injury Techniques Validation

In 1998, the National Center for Construction Education and Research (NCCER) and the M. E. Rinker, Sr. School of Building Construction at the University of Florida conducted a survey to examine the impact of the Zero Injury Techniques report published by the CII (Hinze and Wilson, 1998).

The format of this study asked the 18 responding construction firms to provide information of the following:

- Whether the responding company agreed with the importance played by the five high-impact zero accident techniques.
- Specific information on techniques that have been changed in the five high-impact areas as a result of the zero accidents research findings.
- Information on any other specific changes that the company has implemented to improve project safety.
- Suggestions on specific techniques that were felt to be worthy of adoption in the future.

- Specific information on safety performance from 1994 through 1996.

“Results of this study show that construction firms are implementing a variety of programs to improve safety performance. More importantly, these programs are effective in favorably influencing safety performance, whether measured in terms of recordable injury incident rates, lost time injury incident rates, or experience modification rates. While there is some concern regarding the merits of safety incentives, there is a general agreement that the five high impact techniques play a vital role in safety performance. Contractors are continuing to devise means by which safety program enhancements can be made. The commitment to safety is clearly sincere. Further developments in safety enhancement programs can be expected” (Hinze and Wilson).

CHAPTER 3

RESEARCH METHODOLOGY

The purpose of this study is to assess the current status of the safety performance of large construction projects and large construction companies. This is intended to be an update of and a follow-up to the 1993 CII “Zero Injury Techniques” study, the 1998 validation of that study, and the 1996 “Safety Practices of Large Construction Firms” study by William Eich. Unlike Eich’s approach, this study will focus on the safety methods and practices used on large construction projects as well as the practices of large construction companies.

The 1993 CII study identified effective safety techniques (Five High-Impact Zero Accidents Technique) and since then many of the large companies that lead the ongoing efforts to improve overall safety on the job site and reduce the number of injuries, have implemented these techniques. However, no formal effort has been made to subsequently assess the impact of these techniques in a large project setting. This study will determine the extent that these techniques are used and at the same time determine the overall effect they have on the safety performance of the projects where they are implemented and in large construction firms where they are implemented.

Data Collection

Considering the intent of the study, two surveys were conducted. One survey was focused on large construction firms, while the other was conducted with large construction projects. While both surveys asked questions about the five high impact

techniques suggested by the CII study, questions also were included about the implementation of innovative approaches not addressed in the prior study. The surveys constituted the primary means for gathering data. Both surveys covered all five techniques suggested by the CII study and additional areas that were suspected as influencing the safety environment on large construction projects and the practices of large construction firms.

For the study of large construction firms, the research instrument was a six-page survey containing over 60 questions. The surveys to identify safety practices in large construction firms were mailed to the largest construction firms in the United States. These firms were all those included in the top 400 United States firms listed with the ENR 400 which are primarily firms with annual volumes of business exceeding \$100 million. A few of the largest firms have business volumes that approach or exceed \$10 billion. A total of 106 replies were received. Some of the completed surveys contained only portions of the information requested, most notably excluding information about safety performance measures. Also, 11 surveys were returned due to inaccurate addresses. The surveys were mailed in September 1999 and the replies were received through December 1999.

The study of large construction projects was conducted through site visits and personal interviews. The research instrument consisted of a ten-page survey containing over 200 questions. The study of the large construction projects was conducted through interviews because it was felt that more detailed information would be obtained if the interview approach were used. The response rate was also expected to be very low if this study had been done through a mailed survey. For this study, personnel from 38 different

large construction projects located in North America were asked to participate in the study. All agreed to participate, resulting in 100% participation. While most interviews were conducted in person, some were conducted over the telephone, especially when project location made site visits impractical. Of the 38 completed surveys, the first 23 responses were obtained by means of interviews conducted on the project sites. The remaining interviews were conducted via telephone interviews by graduate students at the University of Florida. The interviews were generally conducted with the project safety representative, and a few were conducted with project managers.

About half of the projects included in the study were constructed for owners or by contractors who were CII members. All projects that were identified by the research team were approached for participation in the study. Only projects that had a contract cost in excess of \$50 million were sought for inclusion in the study. To facilitate data collection in the western United States, a subcontract was awarded to the University of Nevada, Las Vegas. Through this subcontract, ten interviews were conducted in the Pacific states region. The 38 projects included in the study were being constructed by more than 25 different construction firms. Most interviews were conducted between June and September 2000, while a few telephone interviews were also conducted in October and November. The projects were located in more than 10 states throughout the United States. Two of the interviews were conducted over the telephone with projects located in Canada.

Survey Format

Both surveys used in this research followed similar formats. All questions were addressed to corporate or job-site safety directors. Since the collection of the data for the large construction projects was through one-on-one interviews with the safety representative (primarily) of the projects, the extensive format of the survey did not appear to affect the response willingness of the participants, i.e., respondents were comfortable in addressing virtually all questions that were asked. Of the questions in the large construction projects survey, approximately 60 percent were questions that could be answered by a short answer (such as “yes” or “no”) that could be easily noted or recorded by the interviewer. The remaining questions requested information that was mostly descriptive or numerical in nature. A copy of both surveys, titled “Safety Survey of Large Construction Firms” and “Safety Survey of Large Construction Projects”, can be found in Appendix A.

Large Construction Firm Survey

The large construction firm survey addressed important safety issues that reflected current trends in the construction safety practices of larger contractors. The survey included questions related to safety personnel, safety incentive programs, job site safety, safety audits, incident investigations, safety communications, drug testing, and general organization information. The final portion of the survey asked questions about the safety performance of the firm, including worker hours expended and the number of near misses, OSHA recordable injuries, and lost time injuries.

Large Construction Project Survey

Both surveys (large firm and large project) covered the five high-impact areas outlined by the 1993 CII study. In addition to these five areas, the large construction projects survey covered some other project-related safety issues. The interview questions related to: safety performance (OSHA recordable injuries, lost-time injuries, near misses), safety personnel, first aid stations, behavior based safety, safety perception surveys, safety incentives, safety dinners, personal protective equipment, drug testing, worker and management safety training, accident/incident investigations, toolbox meetings, subcontractor safety, site specific aspects of safety and general organization information, general information about the project and the involvement of the owner in the safety related activities. Because the information was sought through interviews, a greater amount of information could be retrieved and in greater detail.

Some questions in the survey were focused on behavior-based safety programs. Many large firms that have safety as a major emphasis in their agenda have implemented behavior-based safety programs. These programs involve workers on the project by creating a team of safety observers (workers trained to observe) who periodically take time to observe other workers and determine if the work is being done safely or not. The team of observers reviews the observations of several workers and tries to detect trends in worker behavior that may affect the level of safety of the job site.

Owner and insurance carrier involvement in project safety are also among the general areas of project safety that were examined in the large project survey. There were not examined in the large company survey.

Data Analysis

A statistical program called Statistical Package for the Social Services (SPSS) was selected to analyze the data. The program facilitates data manipulation and statistics generation. Two files were created to code the information of each survey for the analysis. They are the “data definition file” and the “data file”. The data definition file created a list of variables, which corresponds to each variable in the survey. The data file contained the raw data.

In the SPSS program the specific test used to assess the relationship of different variables with safety performance was the Kendall’s Correlation Coefficient. The correlation coefficient measures the strength of the linear relationship between two variables. The range of the coefficient is the interval between -1.0 and $+1.0$. A value approaching $+1.0$ indicates the strongest possible linear relationship, while a value close to -1.0 indicates the strongest possible negative linear relationship. A value of 0 shows no relation between the two variables (Kliemele and Schmidt 1991).

In this research study, the information of particular interest related to those safety practices that influenced safety performance. Thus, the statistical analysis sought to identify those safety practices that were significantly related with safety performance. Safety performance was measured in terms of the number of OSHA recordable injuries incurred per 200,000 hours of worker exposure. For both studies, the respondents were asked to provide information on the number of OSHA recordable injuries and the number of work hours recorded.

The correlation test generates the statistical level of significance associated with the comparison between two variables. According to the level of significance of the

association of two variables, one can draw conclusions about the strength of the relationship between the two variables. Essentially, the level of significance indicates the probability that the relationship between the variables occurred by chance. As the significance level approaches zero, the probability becomes smaller that this relationship occurred by chance. For example, if the level of significance between two variables is 0.005 (0.5%), then there is a probability of 5 in 1000 that the relationship between these two variables can be attributed to chance. To further illustrate, if a comparison between the safety records of projects which hold toolbox meetings and those that do not shows a 0.005 level of significance, this would indicate a strong relationship between safety performance and conducting toolbox meetings.

For this research, a correlation was considered to be statistically significant if the level of significance was below 0.05. Findings with a level of significance in the interval between 0.05 and 0.10 are considered indicative of a trend and are also reported.